ISSN 0102–3616

SBOT
SOCIEDADE BRASILEIRA DE ORTOPEDIA E TRAUMATOLOGIA

RBO
REVISTA BRASILEIRA DE ORTOPEDIA

VOLUME 56 • N° 2 • MARCH/APRIL 2021

OPEN ACCESS

Thieme

ISSN 0102-3616

Brazilian Orthopaedic Journal

Indexed in PubMed/PubMed Central (2015), SciELO (2007), ScopusTM (2011), LILACS (1992) and affiliated to Associação Brasileira de Editores Científicos (ABEC).

ISSN 0102-3616

Brazilian Orthopaedic Journal

Volume 56, Number 2/2021

RBO
Brazilian Orthopaedic Journal

Update Articles

Original Articles

Thieme Revinter Publicações Ltda

online www.thieme-connect.com/products

Cover design: © Thieme

Revista Brasileira de Ortopedia is published semiannually by Thieme-Revinter Publicações Ltda., Rua do Matoso, 170, Rio de Janeiro 20270-135, Brazil.

Editorial comments should be sent to **journals@thieme.com**. Articles may be submitted to this journal on an open-access basis. For further information, please send an e-mail to openaccess@thieme.com. The content of this journal is available online at **www.thieme-connect.com/products**. Visit our Web site at **www.thieme.com** and the direct link to this journal at **http://www.rbo.org.br**

Revista Brasileira de Ortopedia is an official publication of the Brazilian Society of Orthopedics and Traumatology (Sociedade Brasileira de Ortopedia e Traumatologia, SBOT), It is listed in PubMed, PubMed Central, Scopus, SciELO, and LILACS (Literatura Latino-Americana e do Caribe em Ciências da Saúde). Thieme Medical Publishers is a member of the CrossRef initiative.

ISSN 0102-3616

Medial Knee Arthrosis: A Pathology with a Progressive Evolution

Artrose medial do joelho: Uma patologia de evolução progressiva

Gilberto Luis Camanho[1]

[1] Department of Orthopedics and Traumatology, Faculdade de Medicina, Universidade de São Paulo, São Paulo, SP, Brazil

Rev Bras Ortop 2021;56(2):133–137.

Address for correspondence GilbertoLuis Camanho, Departmento de Ortopedia e Traumatologia, Faculdade de Medicina, Universidade de São Paulo, Rua Dr. Ovídio Pires de Campos, 333, Cerqueira Cesar, São Paulo, SP, 05403-010, Brazil (e-mail: gilbertocamanho@gmail.com).

Abstract

Medial arthrosis of the knee is an evolutionary pathology that occurs due to progressive muscle imbalance. The muscles of the knee region have a large imbalance caused by the difference of power and lever arm. With the progression of life, this imbalance manifests itself more importantly, especially due to the loss of muscle strength due to aging. Pathological postures begin to occur and determine areas of support and pressure harmful to the joint. Meniscal injury is typical in the evolution of this pathology, as well as cartilage injury. The recognition of this pathology enables good results with less aggressive treatments, such as correction of muscle imbalance and consequent reeducation of joint support. Economic and partial meniscectomy brings good results in the early stages of the degenerative process. Progressive evolution leads to knee degeneration and the consequent need for broader surgeries.

Keywords

- arthrosis
- meniscus/injuries
- osteonecrosis

Resumo

A artrose medial do joelho é uma patologia evolutiva que ocorre em decorrência de desequilíbrio muscular progressivo. Os músculos da região do joelho têm um grande desequilíbrio, provocado pela diferença de potência e braço de alavanca. Com a progressão da vida este desequilíbrio se manifesta de forma mais importante, especialmente em decorrência da perda de força muscular em função do envelhecimento. Posturas patológicas passam a ocorrer e determinar zonas de apoio e pressão lesivas para a articulação. A lesão meniscal é típica na evolução desta patologia, assim como a lesão da cartilagem. O reconhecimento desta patologia possibilita resultados bons com tratamentos menos agressivos, como a correção do desequilíbrio muscular e consequente reeducação do apoio da articulação. A meniscectomia econômica e parcial traz bons resultados nas fases iniciais do processo degenerativo. A evolução progressiva leva à degeneração do joelho e à consequente necessidade de cirurgias mais amplas.

Palavras-chave

- artrose
- menisco/lesões
- osteonecrose

received
January 6, 2020
accepted
February 20, 2020
published online
July 22, 2020

DOI https://doi.org/10.1055/s-0040-1710333.
ISSN 0102-3616.

Thieme Revinter Publicações Ltda., Rua do Matoso 170, Rio de Janeiro, RJ, CEP 20270-135, Brazil

Introduction

Arthrosis is a frequent clinical condition with which we generally deal without adequate systematization.

Three types of arthrosis are considered:

1. arthrosis of inflammatory cause – it is a result of an inflammatory degenerative process, osteoarthritis, or consequent to inflammatory or infectious arthritis, in which the lesion of the subchondral bone is the most important;
2. posttraumatic arthrosis – it is a result of traumas affecting the articular surface such as fractures, and osteochondritis, in which the cartilage is the most affected; and
3. mechanical arthrosis – it results from shaft deviations or joint instabilities in which the subchondral bone and cartilage are affected.

These are different conditions that, if mistaken, will lead to disastrous therapeutic attitudes.

In the knees, and probably in other joints, such as the shoulders, there is a type of arthrosis that results from the evolution of a muscle imbalance leading to mechanical arthrosis, with very clear characteristics. In the knee, the arthrosis is what compromises the compartment, determining a varus deformity. It is a degenerative process that evolves progressively, if not treated. We will analyze the evolution of this degenerative process of mechanical cause.

Etiopathogenesis

The knee is subjected to poorly-balanced muscle forces, which are balanced by activity and hypertrophy.

It has a single extensor group and three flexor groups, two of which are, apart from flexors, also rotators, one medial and one lateral. The medial flexors are the hamstrings, the lateral one is the femoral biceps, and the gemellus muscles are powerful flexors.

The balance of these forces allows harmonic movements in day-to-day activities and in sports.

In the daily clinical practice, we observe cases of muscle imbalance in which the extensor group (quadriceps) overcomes the flexor (biceps, semitendinosus, gracilis and sartorius, and the gemellus muscles) group, or in which the flexors overcome the quadriceps, leading to several complaints.

Over the years we lose 30% to 40% of muscle strength, and this loss is not uniform: the larger muscles will suffer more than the smaller ones.

The quadriceps loses part of its strength, and the flexors, even losing some strength themselves, prevail; as the medial flexors are in greater numbers, a deformity in flexion and internal rotation occurs progressively, which leads to the varus.

In a study with patients with degenerative varus versus normal volunteers, Molina et al[1] observed that there were up to 9 degrees of internal rotation of the tibia in the pathological varus of medial arthrosis.[1]

Anterior cruciate ligament (ACL) failure is progressive and has been clearly described by Ahlbäck[2] in the evolution of medial arthrosis of the knee. In his classic work, the author limits the indication of valgization osteotomy of the tibia to "stable" knees, that is, those still containing the ACL; and to this end, the author defines the limitations of competence of the ACL.

Varus deformity occurs progressively and determines an increase in tension in the lateral ligament complex, which opposes varus deformity. This postural imbalance overloads the ACL, which is positioned to avoid the valgus, which progressively fails, allowing the anteriorization of the tibia in relation to the femur.

This change in support and pressure zones caused by tibial "migration" determines meniscal and cartilage lesions of various degrees, causing a characteristic arthrosis in the medial compartment.

Intra-articularly, the meniscus is the first structure to suffer, because it receives an increase in posteromedial weight in the transition between the body and the posterior horn.

An anterior migration of the tibia occurs in relation to the femur (►**Figure 1**).

The meniscal lesion of this medial arthrosis is typical in the transition already described, and we chose to call it a meniscal injury due to fatigue because of its progressive aspect. The cartilage and subchondral bone may present lesions for the same reason.

We will consider the characteristics of each of these lesions in isolation, but they occur concomitantly, and there may be meniscal lesions with varying degrees of lesions of

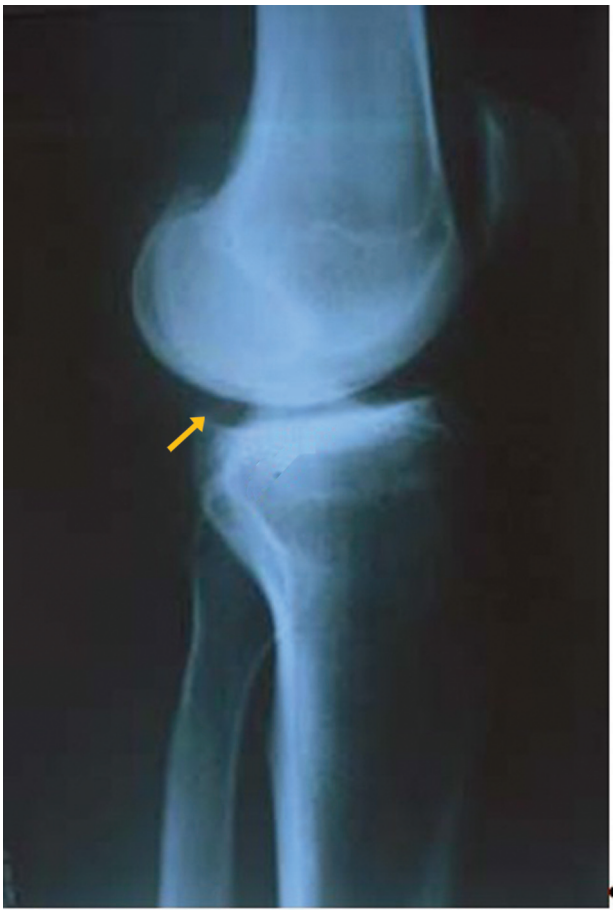

Fig. 1 Profile radiograph of the knee demonstrating anteriorization of the tibia in relation to the femur. The posterior osteophyte in the tibia is noted, which is characteristic of this migration.

the subchondral bone and cartilage, or any other association of lesions.

Meniscal Fatigue Injury

Impairment of the meniscus structure can occur for a variety of reasons. Situations ranging from trauma to degenerative processes can alter its integrity. The clinical picture is very similar regardless of the etiology, but the therapeutic approach is completely different.

In 2006,Camanho et al[3] studied a group of patients with isolated meniscal injury diagnosed by MRI, who were divided into three groups according to the etiology:

1. one group with clearly traumatic injuries;
2. one group with degenerative meniscal lesion clearly resulting from the degenerative process of the joint; and
3. one group that was called "meniscal injury due to fatigue", in which the meniscal lesion had specific characteristics that differed from those of the other two groups.

The authors were aware of the similarity regarding the profile of the patients in the group with degenerative injury and in the one with the lesion called fatigue injury. They were patients in the same age group and with the same distribution according to gender, but different clinical and radiological picture and different therapeutic approach.

In patients with degenerative meniscal injury, involvement of the meniscus is part of the degenerative process of the joint, making the meniscal lesion a part of the problem, which is not always responsible for the main symptoms.

In patients with meniscal injury due to fatigue, the clinical characteristics are quite clear, and the meniscal lesion has its own characteristics. They are:

1. spontaneous onset of pain or pain after a minor trauma (disproportionate to the symptom)[4];
2. night pain requiring a change in knee position;
3. normal radiographic examination, without signs of arthrosis; and
4. magnetic resonance imaging (MRI) demonstrating radial lesion in the transition between the body and the posterior horn of the medial meniscus, with extrusion of the meniscal body, without signs of arthrosis (►**Figure 2**).

The big difference is cartilage involvement, which occurs in the evolution of medial arthrosis.

Osteochondral Injury

By medial and posterior support, instability due to ACL insufficiency and varus deformity to the articular surface suffers, and progressively larger osteochondral lesions occur.

The extent of these lesions and of the varus deformity define a divider in the severity of medial arthrosis.

Initially, they are focal lesions in the posteromedial region that progress as the instability generated by the ACL failure and the varismare accentuated.

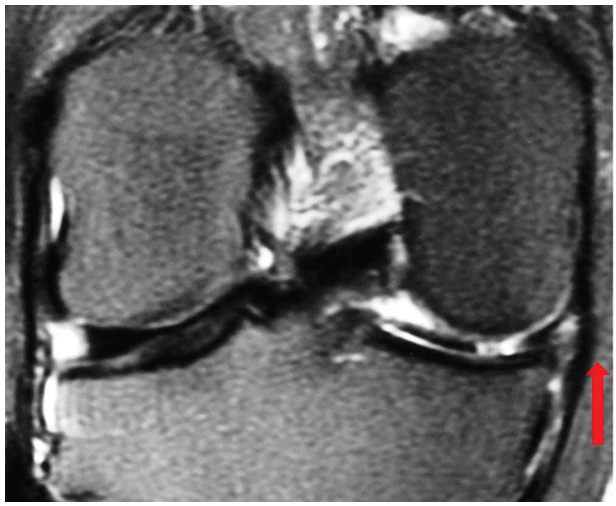

Fig. 2 Magnetic resonance imaging (MRI)scan of the knee demonstrating a posteromedial meniscal injury.

The progression of the deformity and anteriorization lead to an increase in the area of the chondral lesion, aggravating the condition.

The accentuated varism and the anteriorization of the tibia define the severity of the picture.

Overload of the subchondral bone can lead to a fatigue fracture, which has already been confused with primary osteonecrosis.[5] The so-called primary osteonecrosis is an injury that occurs as a result of a fracture due to insufficiency, as demonstrated by Yamamoto and Bullough.[6]

The clinical presentation is very similar to that of the meniscal lesion of these patients: sudden pain after an effort or a minor trauma. The image of the bone edema on the MRI is characteristic (►**Figure 3**).

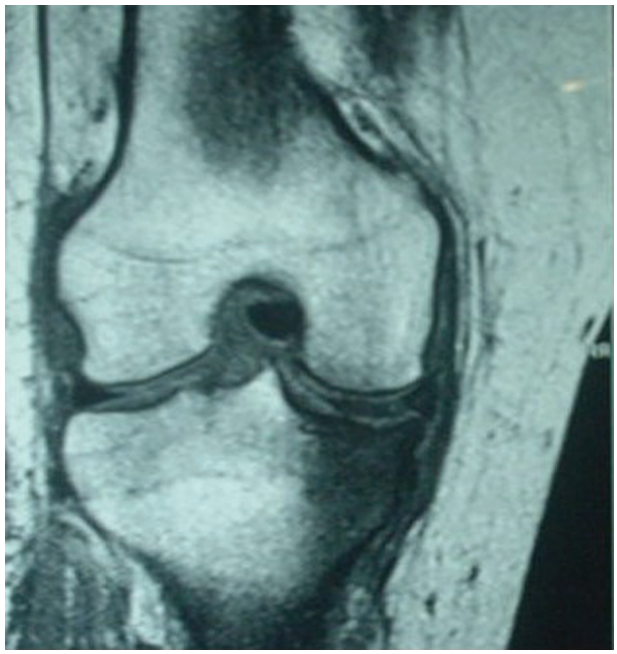

Fig. 3 Magnetic resonance imaging (MRI)scan showing bone edema in the tibia, demonstrating a fatigue injury.

Clinical Presentation

The clinical presentation is progressive and depends on intrinsic lesions. In general, it begins with an acute and important pain, without cause proportional to the symptom,[4] in the medial region of the knee. The physical examination demonstrates the position in flexion and internal rotation. The patient points to medial pains in the insertion region of the medial flexor muscles, the so-called goosefoot, and in the medial interline.

These pains, which are caused by increased weight concentrated in the medial region due to the varus and internal rotation, are called "goosefoot bursitis." Palpation demonstrates an increase in sensitivity in this medial region. There is difficulty to extend, which in some cases causes pain. Flexion with monopodalic support causes pain. The complaint of pain at rest is characteristic of the condition, especially at night. The report of joint effusion is rare.

Imaging Exams

Radiographs demonstrate the progression of the varus and the degree of anteriorization of the tibia in relation to the femur.

In the early stages, the radiological changes are very little accentuated; but radiology is the best way to evaluate varus deviation. Magnetic resonance imaging demonstrates the appearance of subchondral bone edema and the typical meniscal lesion in the transition between the body and the posterior horn of the medial meniscus (►**Figure 3**).In some rare cases, the meniscal injury occurs in the insertion of the meniscus into the root of the tibial plateau. The evaluation of cartilage involvement is best performed by MRI, although it is not characteristic.

Treatment

The treatment depends greatly on the evolution phase of the medial arthrosis. In the initial phases, without meniscal injury, muscle rebalancing with stretching exercises and quadriceps recovery brings good results. In cases of acute pain and image of bone edema, it is interesting to partially remove the load with a pair of crutches. When the MRI detects meniscal injury, without detectable osteochondral injury, isolated meniscectomy, followed by a muscle-rebalancing program, brings good results in 90% of the cases.

It is very important to differentiate fatigue injury from degenerative injury; this differentiation is made by radiographic study. If there are signs of arthrosis, it is a degenerative injury. In this case, meniscectomy is not a good indication, as it leads to good results in approximately 50% of the cases.[3]

We studied 87 patients with meniscal fatigue injury, without detectable cartilage injury.[7,8]

All patients in the present study had MRI and radiographs that were efficient for the diagnosis of absence of cartilage lesions, because only in one case we found signs of chondral injury in the arthroscopy that had not been diagnosed in the evaluation by image.

Our patients had radial meniscal lesion in the transition between the body and the posterior horn of the medial meniscus diagnosed by MRI, which was confirmed in all cases by arthroscopy.

We performed partial meniscectomy in all cases, seeking to rectify the meniscal curve, excluding the radial lesion. Although there is some controversy as to the evolution of partial versus total meniscectomy, for us it is clear that partial meniscectomy brings better results. Some authors[9] suggest that regardless of the type of meniscal lesion, the conservative treatment may bring results in more than 50% of the cases. We believe that this interpretation may occur in short evaluation periods, as the symptoms of meniscal injury are disabling in the long term.

Our results were considered good in 85% of the cases with an average of 87 in theLysholmscale, and the poor results manifested themselves in the first 6 months of evolution. Twelve patients evolved with pain and rapidly to a picture of radiological arthrosis or insufficiency fracture.

Some patients persisted with symptoms for approximately two months postoperatively, but then remained well until the end of the evaluation period. The main complaint of these patients was pain putting weight on the leg and difficulty in going up and down stairs. We believe that bone injury due to fatigue, although without radiological translation, combined with quadriceps fragility were responsible for these symptoms, as they improved with the evolution and improvement of quadriceps strength.

Regarding the high percentage of good results (85%), we believe that the absence of cartilage injury is responsible.

Higuchi et al[10] demonstrated that it is not age and gender that are responsible for the poor results of the meniscectomy, but rather the presence of chondral injury. Schimmer et al[11] observed good results in 90% of the patients submitted to meniscectomy with age and sex like those of our group, but without chondral injury in 12 years of follow-up.

In nine patients, we had a result considered bad due to the appearance of pain and joint degeneration. This early degeneration can be attributed to the type of meniscal lesion that, once corrected, leaves the tibial plateau unprotected.

Only in one case we found previous cartilage injury in the arthroscopic evaluation, which may be related to the evolution to arthrosis, so in the remaining eight cases there was joint degeneration after the meniscectomy.

We had, in our poor results, three cases of bone injury due to insufficiency, which is also called primary osteonecrosis.[5]

Once the deep chondral lesion or varus axis deviation is verified, compared with the other side, meniscectomy will no longer bring satisfactory results.[12]

As long as we are dealing with a stable arthrosis, according to the criteria of Ahlbäck[2] valgization osteotomy of the tibia is a good approach in patients in good health.

We prefer the Puddu technique, because it presents predictable corrections.

In patients with compromised health or in those who are high-functioning elderly, the unicompartmental prosthesis is the best indication in patients with medial arthrosis with

Table 1 We suggest the following algorithm for the treatment

Medial Arthrosis	
1 - Meniscal Injury Without Radiological Arthrosis Without Pathological Varism (Ahlback)	Meniscectomy + Muscle Rehabilitation
2 - Chondral Injury Non-unstable varism (Ahlback)	Unicompartmental Prosthesis
3 - Severe varism or signs of instability (Ahlback)	Total Knee Arthroplasty

stable knees, according to the stability criteria established by Ahlbäckand cited in the study by Camanho et al.[13]

In patients with medial arthrosis in knees with ACL failure, that is, unstable varus, the therapeutic indication is total knee arthroplasty (►**Table 1**).

Final Considerations

We believe that medial arthrosis of the knee is an evolutionary process resulting from a muscle imbalance, which can be treated at any time. When the therapeutic indication is adequate and early, good results may be expected.

Conflict of Interests
The author have no conflict of interests to declare.

References

1 Molina RD, Sado JJ, Mendlovitz PS, Camanho GL. Avaliação da deformidade rotacional do joelho em paciente com genuvaro e osteoartrose. Rev Bras Ortop 2002;37:430–435
2 Ahlbäck S. Osteoarthrosis of the knee. A radiographic investigation. Acta Radiol Diagn (Stockh) 1968;277(Suppl.):277, 7–72
3 Camanho GL, Hernandez AJ, Bitar AC, Demange MK, Camanho LF. Results of meniscectomy for treatment of isolated meniscal injuries: correlation between results and etiology of injury. Clinics (São Paulo) 2006;61(02):133–138
4 Camanho GL. Dor aguda no joelho do paciente idoso. Rev Bras Ortop 2008;43(09):361–366
5 Norman A, Baker ND. Spontaneous osteonecrosis of the knee and medial meniscal tears. Radiology 1978;129(03):653–656
6 Yamamoto T, Bullough PG. Spontaneous osteonecrosis of the knee: the result of subchondral insufficiency fracture. J Bone Joint Surg Am 2000;82(06):858–866
7 Demange MK, Gobbi RG, Camanho GL. "Fatigue meniscal tears": a description of the lesion and the results of arthroscopic partial meniscectomy. Int Orthop 2016;40(02):399–405
8 Camanho GL. Lesão meniscal por fadiga. Acta Ortop Bras 2009;17 (01):31–34
9 Englund M, Guermazi A, Roemer FW, et al. Meniscal tear in knees without surgery and the development of radiographic osteoarthritis among middle-aged and elderly persons: The Multicenter Osteoarthritis Study. Arthritis Rheum 2009;60 (03):831–839
10 Higuchi H, Kimura M, Shirakura K, Terauchi M, Takagishi K. Factors affecting long-term results after arthroscopic partial meniscectomy. Clin Orthop Relat Res 2000;(377):161–168
11 Schimmer RC, Brülhart KB, Duff C, Glinz W. Arthroscopic partial meniscectomy: a 12-year follow-up and two-step evaluation of the long-term course. Arthroscopy 1998;14(02):136–142
12 Badlani JT, Borrero C, Golla S, Harner CD, Irrgang JJ. The effects of meniscus injury on the development of knee osteoarthritis: data from the osteoarthritis initiative. Am J Sports Med 2013;41(06): 1238–1244
13 Camanho GL, Viegas AC, Camanho LF, Camanho CR, Forgas A. Artroplastiaunicompartimental no tratamento da artrose medial do joelho. Rev Bras Ortop 2007;42(09):285–289

Bone Defects in Revision Total Knee Arthroplasty

Falhas ósseas nas revisões de artroplastia total do joelho

Alan de Paula Mozella[1,2] Hugo Alexandre de Araújo Barros Cobra[1]

[1] Knee Surgery Center, National Institute of Traumatology and Orthopedics (INTO), Rio de Janeiro, RJ, Brazil
[2] Faculty of Medical Sciences, Universidade do Estado do Rio de Janeiro (UERJ), Rio de Janeiro, RJ, Brazil

Address for correspondence Alan de Paula Mozella, M.D., M.Sc., Centro de Cirurgia do Joelho, Instituto Nacional de Traumatologia e Ortopedia (INTO), Av. Brasil, 500, Caju, Rio de Janeiro, RJ, 20940-070, Brazil (e-mail: apmozella@terra.com.br).

Rev Bras Ortop 2021;56(2):138–146.

Abstract

The increase in the number of revision total knee arthroplasty surgeries has been observed in recent years, worldwide, for several causes. In the United States, a 601% increase in the number of total knee arthroplasties, between 2005 and 2030, is estimated. Among the enormous challenges of this complex surgery, the adequate treatment of bone defects is essential to obtain satisfactory and lasting results. The adequate treatment of bone defects aims to build a stable and lasting support platform for the implantation of the definitive prosthetic components and, if possible, with the reconstruction of bone stock. Concomitantly, it allows the correct alignment of the prosthetic and limb components, as well as restoring the height of the joint interline and, thus, restoring the tension of soft parts and load distribution to the host bone, generating a joint reconstruction with good function, stable, and painless. There are several options for the management of these bone defects, among them: bone cement with or without reinforcement with screws, modular metallic augmentations, impacted bone graft, structural homologous graft and, more recently, metal metaphyseal cones, and metaphyseal sleeves. The objective of the present article was to gather classic information and innovations about the main aspects related to the treatment of bone defects during revision surgeries for total knee arthroplasty.

Keywords

- arthroplasty, replacement, knee
- bone defects
- homologous grafts
- review

Resumo

O aumento do número de cirurgias de revisão de artroplastia total do joelho tem sido observado nos últimos anos, em todo o mundo, por diversas causas. Nos Estados Unidos, é estimado um aumento de 601% no número de artroplastias totais do joelho entre 2005 e 2030. Dentre os enormes desafios dessa cirurgia complexa, o adequado tratamento dos defeitos ósseos é essencial para a obtenção de resultados satisfatórios e duradouros. O adequado tratamento dos defeitos ósseos objetiva construir uma plataforma de suporte estável e duradoura para a implantação dos componentes protéticos definitivos e, se possível, com recomposição do estoque ósseo. Concomitantemente, possibilita o correto alinhamento dos componentes protéticos e do membro, assim como permite restabelecer a altura da interlinha articular e, dessa

received
January 5, 2020
accepted
April 15, 2020
published online
March 29, 2021

DOI https://doi.org/10.1055/s-0040-1713392.
ISSN 0102-3616.

Thieme Revinter Publicações Ltda., Rua do Matoso 170, Rio de Janeiro, RJ, CEP 20270-135, Brazil

Palavras-chave
- artroplastia do joelho
- defeitos ósseos
- enxertos homólogos
- revisão

forma, restaurar a tensão de partes moles e distribuição de carga ao osso hospedeiro, gerando uma reconstrução articular com boa função, estável e indolor. Diversas são as opções para manejo dessas falhas ósseas, entre elas: cimento ósseo com ou sem reforço com parafusos, aumentos metálicos modulares, enxerto ósseo impactado, enxerto estrutural homólogo e, mais recentemente, cones metafisários de metal trabecular e *sleeve* metafisário. O objetivo do presente artigo foi reunir informações clássicas e inovações dos principais aspectos relativos ao tratamento das falhas ósseas durante as cirurgias de revisão de artroplastia total do joelho.

Introduction

The increase in the number of revision total knee arthroplasty (rTKA) surgeries can be related not only to the increase in the absolute number of primary surgeries performed, but also to several other factors such as the expansion of primary implant indications, including younger and more active patients, as well as factors related to surgical technique and implant durability.[1–5] In the United States, a 601% increase in the number of rTKAs is estimated between 2005 and 2030.[1] In Brazil, there is a lack of reliable data on the increase in the number of rTKAs.

Among the enormous challenges of this complex surgery, the adequate treatment of bone defects is essential to obtain satisfactory and lasting results.[6–8] The cause of bone deficiency is usually multifactorial; however, aspects such as previous pathology, the design of primary implants, the occurrence of osteolysis, possible technical errors in the realization of the primary prosthesis or during the removal of fixed implants and, also, the failure mechanism are frequently identified.[9–12]

Assessment of Bone Defects

Anteroposterior (AP) and lateral radiographs of the knee make it possible to assess the design and size of prosthetic components, to analyze the type and quality of implant-host fixation, to infer possible causes of failure, and to estimate the extent of bone loss. Axial radiography of the patella allows the assessment of patellar alignment, as well as the presence or absence of patellar component and/or bone defect.[13] Oblique radiographs can be useful in showing osteolysis, especially in implants with a posterior-stabilized box. Panoramic views allow to analyze the limb alignment, the presence of extra articular bone deformities, and the presence of possible synthesis materials as well as the condition of the other joints.[12–14]

However, standard radiographs of the knee often underestimate, especially in the femur,[9,13] the extent of the bone defect identified intraoperatively after removal of implants and debridement of fibrosis and necrotic tissues.[11,15] Computed tomography (CT) images show greater sensitivity and specificity in diagnosing bone defects and osteolytic lesions that are difficult to observe on radiographs due to the overlap of images of metallic components; however, due to the increased cost and exposure to ionizing radiation, the routine use of CT is not recommended.[11–13,16]

The adequate treatment of bone defects aims to build a stable and lasting support platform for implantation of the definitive prosthetic components and, if possible, the restoration of bone stock. Concomitantly, it allows the correct alignment of the prosthetic and limb components, as well as reestablishing the height of the joint interline, thus restoring the tension of soft parts and load distribution to the host bone and generating a joint reconstruction with good and stable function, and painless too.[6,7,9,11]

Classification and Management Options for Bone Defects

Several distinct bone defect classification systems have been proposed to assist in decision making. However, subjectivity and, therefore, low interobserver agreement and limited accuracy in correctly estimating the size of bone defect are the main criticisms of most classifications.[11,12,17]

The most widely used classification is that of the Anderson Orthopedic Research Institute (AORI),[18] which describes the defects according to size, location, and impairment of soft-tissue structures after the removal of components and debridement of devitalized tissues. Defects in the femur and tibia are analyzed separately in three categories:

Type 1: it includes contained defects limited to the cancellous bone, without compromise or cortical bone failure. It presents intact metaphyseal bone and, therefore, does not compromise the stability of the revision components. In selected cases, revisions can be effectively performed with primary implants,[19] although standard revision implants associated with the use of intramedullary nails are the recommendation of most authors. Thus, this type of defect can be effectively treated by filling with bone cement, sometimes associated with reinforcement with screws. Bone grafting may represent a management option in this type of bone failure. Metallic augmentations can also be an option to restore the joint interline.[6,10–12,15,19]

Type 2: it is characterized by considerable loss of metaphyseal bone, which will need to be filled in during revision surgery. Defects can occur in only one femoral condyle or tibial plateau and are referred to as type 2A. These defects are most often managed with bone cement reinforced with a screw or non-porous metallic augmentations (wedge or

block) or, still, bone grafting and standard revision components with intramedullary nails.[20] However, bone defects that affect both condyles or plateaus are classified as type 2B. In these more severe defects, more complex treatment and fixation options are recommended. Thus, options with metaphyseal fixation, such as highly porous metal cones (tantalum cones), or metaphyseal sleeves, or even homologous structural bone grafting, are the most recommended options.[6–8,10–12,19–22]

Type 3: it has completely deficient metaphyseal bone, characterized by severe bone loss that compromises the largest portion of the femoral condyle or tibial plateau. These defects are often associated with detachments of the epicondyles and, consequently, collateral ligaments, or even the patellar ligament. Normally, for appropriate treatment, these defects require prosthetic implants with long intramedullary nail with diaphyseal fixation, and options for defect management with metaphyseal fixation, such as trabecular metal cones, or metaphyseal sleeve or, still, structural homologous graft. In cases with detachment of the epicondyle and ligament insufficiency, blocked implants are normally necessary. Customized implants, non-conventional or tumor prostheses can be indicated for the management of large defects in which reconstruction is not possible.[6–8,10–12,19,21–23]

Thus, for an adequate treatment of bone defects during the performance of rTKA, the accurate analysis of the quality of the host bone, the configuration (whether contained or not contained), the size and location of the bone defect must be carefully analyzed. However, currently, there is no option for managing bone failure that is ideal in all circumstances. Therefore, several other factors, such as functional demand, presence of comorbidities, life expectancy and experience of the surgeon must be evaluated in the decision-making process and in the individual choice of the option employed. However, restoration of bone stock is preferable in patients with the possibility of future revisions.[24]

Bone Cement with or without Reinforcement with Screws

Bone defects involving less than 50% of the cancellous bone surface (ideally, less than 10% of peripheral deficiency) and with a depth of less than 5 mm are traditionally managed with methyl methacrylate. In short, this technique is best suited for small bone defects, mainly, those contained.[17]

The use of bone cement is also advocated for the handling of defects with a depth between 5 and 10 mm; however, the use one or more screws from 4.5 to 6.5 mm is recommended to reinforce the construction, aiming to provide greater mechanical resistance to the cement column and improve the load distribution to the host bone. In this case, attention must be paid so that the screws do not remain in direct contact with the definitive implant. Therefore, this technique can be indicated in the management of AORI type-1 defects and, eventually, in selected cases AORI type 2A.[6,11,12,15,17]

Satisfactory results, in medium-term follow-up, in the treatment of bone defects in the tibia, using cement reinforced with screws, were demonstrated by Ritter et al.,[25] although with a high incidence of non-progressive radiolucent lines. Therefore, this technique was more often indicated for older patients with less functional demand, due to the questioning regarding the long-term conservation of the biomechanical properties.[6,11,24] Posteriorly, Berend et al.[26] demonstrated high implant survival in patients with 20 years of surgery who underwent primary arthroplasty with significant bone defects managed with methyl methacrylate reinforced with screws. Additionally, the same authors evaluated patients who underwent rTKA surgeries and demonstrated that the use of bone cement reinforced with screws as well as the use of revision implants had the ability to restore knee biomechanics and a 98.5% survival rate after 15 years. Thus, the authors guide the possibility of using this technique to reduce costs without compromising the survival of the prosthesis.[27]

Modular Metallic Augmentation (Blocks and Wedges)

Modular metallic augmentations is indicated in the management of uncontrolled bone defects, compromising more than 25% of the cortical contour and with a depth between 5 and 20 mm, or even when more than 40% of the implant surface is not supported by the host bone.[11,12,15,28] In summary, modular metallic augmentations are most often indicated in the management of AORI type 2 bone defects[11] and also employed in selected AORI type 3 cases in elderly patients with low physical demand.[15,17]

The various revision implant systems present metallic augmentations of varying thicknesses, sizes and shapes. They can be added to both the femoral and tibial components to fill the bone defect in one or both tibial condyles or plateaus.

The metallic augmentations for the management of tibial defects are presented in wedge or block form. In both options, it is usually necessary to prepare and remove additional host bone for correct adaptation of the metal augmentation. Although there is a lesser removal of additional bone with the use of metal wedges, the sheer force at the implant-bone interface is greater and, consequently, more susceptible to mechanical failure. When using block augmentation, bone removal is usually greater; however, it presents a better load distribution to the host bone.[11,24,29] The possible bone loss after the use of modular augmentations must be filled in with methyl methacrylate or by bone grafting.[15]

The use of symmetric metallic augmentation extensions in both the distal femur and the proximal tibia frequently contribute to the restoration of the height of the joint interline and, consequently, soft-tissue tensioning and equilibrium of the flexion-extension balance. Posterior femoral augments are particularly useful in restoring the anteroposterior dimension of the component and, consequently, in the stability of the flexion space; however, the use of asymmetric posterior femoral augments may be necessary to ensure proper external rotation of the component.[6,11]

The main advantages of using metallic extensions are the immediate load-bearing capacity, it helps the rotational

stability of the component, the reduction of surgical time and presents less complications. The disadvantages, however, refer to the increased costs with the implant, sometimes the need for additional resection of the host bone and the fact of not restoring the bone stock. Other potential disadvantages refer to the possibility of corrosion and the formation of wear debris at the modular augmentation interface and prosthetic component, in addition to the possibility of the occurrence of the stress shielding phenomenon due to the difference between the elasticity modules of the metal and the host bone.[10,15,24,30,31]

Failures of metallic augmentations in performing adequate treatment of defects, most often, occur when the surgeon underestimates the severity of bone deficiency and does not identify the need to use defect treatment options with metaphyseal fixation.[11] Therefore, the tendency of modern modular augmentations is to use metals in highly porous configuration, between 70 and 80%, given the benefits of having an elasticity module closer to the host bone, greater friction and fixation capacity, in addition to enabling bone growth and biological fixation.

Good or excellent results with the use of metallic augmentations to treat bone deficiencies during the revision have been reported to vary from 84 to 98%,[15,31] although the effectiveness and durability of the technique is contested.

In a prospective medium to long follow-up of 79 patients with AORI defects, two treated with metallic augmentations, although Patel et al.[31] have observed incidence of non-progressive radiolucent lines in 14% of cases, they found durability of 92% after 11 years. Favorable results, with no complications or loosening in 3 years, were also reported by Werle et al.,[32] with the use of 30 mm femoral metallic augmentation to treat femoral defects AORI 3. Contrarily, Hockman et al.[33] identified that even using modular augmentations in 89% of rTKA cases, structural grafts were necessary in 48% of cases to effectively treat bone deficiency. They also observed a greater number of failures in patients treated only with metallic augmentations, resulting in a 79.4% durability in 8 years.

Impaction Bone Graft

The use of impaction bone graft is an effective option for the management and restoration of bone stock in defects of various sizes and shapes, especially for those contained, although good and durable results have also been demonstrated for not contained defects.[30,34,35] Autologous graft has osteoinduction, osteoconduction, and osteogenic capacity and can be used, above all, in small disabilities due to limited availability and risk of pain and complications at donor sites. Due to greater quantitative availability, the homologous graft is the most frequently used, although it presents a potential risk of disease transmission, fracture of the host bone during impaction and, also the possibility of graft absorption with loss of support capacity.[12,17,30,34,35] Increased risk for infection and concern about immunological reaction are also related to the homologous graft.[17]

The surgical technique requires careful debridement of the bone defect with the use of a burr drill to remove the sclerotic bone from the periphery of the defect, thus forming a viable bed for osteointegration. The initial stability of components with the use of impacted bone graft is worrisome and is also influenced by the integrity of the cortex, the size of the defect and the type of implanted intramedullary nail. Contained defects can be treated without major difficulties; however, for non-contained defects, a shaped plate or metal mesh should be used to avoid graft leakage and to increase the stability of the construction.[17,30,34] The intramedullary nail test must be properly positioned before the impaction of bone particles between 3 and 5 mm in size to provide greater initial stability.[17,30,34] The test implants are removed, and the final intramedullary nail must be inserted. The use of long press-fit nails can add initial stability to the system; however, it can over-protect the load transmission graft and, consequently, there is a concern to inhibit early incorporation. Therefore, many authors recommend the preferential use of a cemented nail.[30,34]

In a study of 42 rTKAs, with an average follow-up of 3.8 years, treated with impacted homologous graft, Lotke et al.[34] identified graft incorporation in all cases without failure of the implants. Similar results were found by Naim et al.[36] by treating large tibial bone losses with impacted graft and short cemented nail and demonstrating favorable clinical results and durability in the short-term. Conversely, poor results with long-term follow-up (10 years) are demonstrated by Hilgen et al.[37] In this study, of the 29 patients treated with impacted graft and constricted implants, 14 required revision due to mechanical failure at a mean time of 5 years, and in all these cases a lack of graft incorporation and reabsorption was observed during the operation.

Structural Homologous Bone Graft

Structural bone graft from a tissue bank represents a cost-effective option for the treatment of types 2 and 3 AORI bone defects, of varying shapes and sizes, in patients with greater physical demand and future possibility of a new rTKA.[17]

The advantages of using the homologous graft consists of the capacity to restore bone stock and provides adequate initial support to the implants, allows the reinsertion of the epicondyles and avoids additional removal of the host bone.[17] However, in addition to the limited availability in our midst, this technique presents the risk of non-union, resorption and graft fracture, long surgical time, as well as the risk of disease transmission.[12]

The femoral head is the most widely used homologous graft, possibly because of its ability to adapt to various formats of bone defects; however, segmental parts of the distal femur and proximal tibia are also widely used. All the cartilaginous tissue of the graft must be removed, as well as the cortical bone, with preference being given to the use of cancellous bone. The part must be prepared with abundant irrigation to remove the bone marrow components. Acetabular milling cutter is used to remove sclerotic bone in order to potentiate graft-bone host contact and promote its

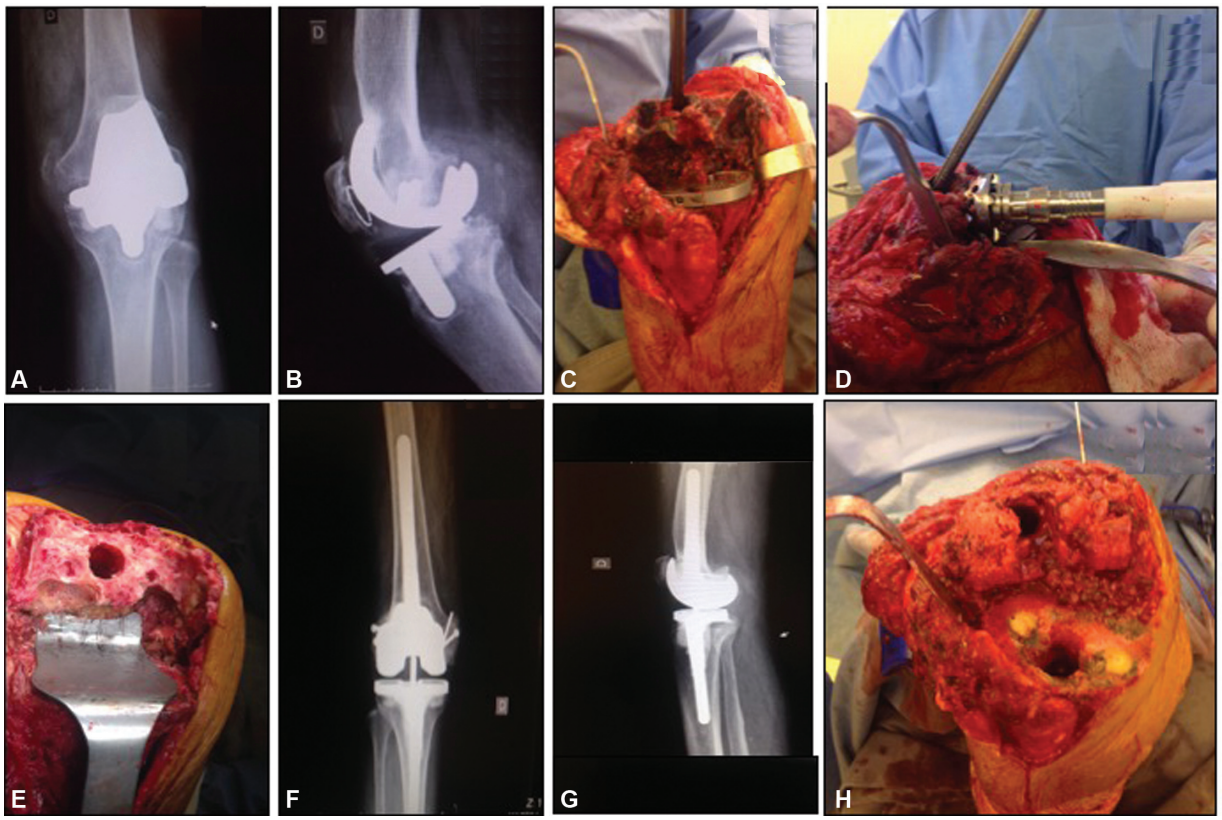

Fig. 1 (A) and (B) anteroposterior radiographs and aseptic loosening profile of total knee prosthesis with marked osteolysis in the distal femur; (C) Intraoperative aspect of the femoral bone defect; (D) Preparation of the graft with an acetabular cutter; (E) Intraoperative appearance after debridement; (F) and (G) Postoperative radiographs of the structural homologous graft fixed with screws in both condyles of the distal femur and revision semi-constricted implants; (H) Intraoperative appearance after using homologous bone graft.

incorporation. Provisional fixation is performed with Kirschner wires to continue making bone cuts with an oscillatory saw. The structural graft is customized to the bone defect. The final fixation, if necessary, can be carried out with screws. The definitive implants are cemented on the homologous graft[12,38] (►**Figure 1**).

In 46 rTKAs using homologous structural graft, Engh and Ammem[38] reported 91% of 10-year survival. Of these patients, four required a new surgical approach. In two of them the graft was incorporated and in two others the graft was removed due to infection. Similarly, Wang et al.[39] studied 30 reviews in which an average of 1.7 homologous femoral heads were used, with an average follow-up of 76 months, and they did not observe graft failure at the end of the evaluation. Conclusions favorable to the capacity of the homologous graft as an adequate option for durable support were obtained by Chun et al.[40] when evaluating the clinical and radiographic results, with an 8-year follow-up of 27 patients, 26 of whom showed no fractures or graft collapses or disease transmission. Similarly, we did not observe fracture or collapse of the homologous graft in a short-term assessment of 26 rTKAs with AORI types 2B and 3 defects; however, in three cases we noticed mild-to-moderate graft absorption without compromising the support function or implant failure, and one patient observed a non-union of segmental graft from the distal femur, but without loss of structural function.[23]

However, doubts and concerns about the durability and maintenance of the structural function of the graft in the long term are not completely clarified. Several studies report the 10-year survival rate of revisions with a structural graft with a mean of 74%.[6,41,42] Unsatisfactory results, however, have been reported by Bauman et al.[41] When evaluating 70 rTKAs, they found survival of 80.7% and 75.9% at, respectively, 5 and 10 years after surgery. Of the 16 cases of failure described, 8 cases were attributed to graft failure, which occurred on average 42 months after surgery. In a systematic review, evaluating 551 rTKAs with homologous graft and mean follow-up of 5.9 years, the reported incidence of any type of graft failure was 6.5%. Deep infection occurred in 5.5% of cases and aseptic loosening in 3.4%.[8]

Trabecular Metal Metaphyseal Cones and Metaphyseal Sleeves

Metaphyseal cones and sleeves represent a modern option for the management of large bone defects, providing immediate structural support and potential biological fixation. Metaphyseal cones come in a variety of sizes and models, allowing the treatment of lesions of varying sizes and configurations. In short, they are indicated for the treatment of AORI types 2 and 3 defects.[6,17,22] The lack of restoration of the bone stock, the need for additional removal of the host bone for correct accommodation of the cones or sleeves and, if necessary, the

difficulty of removal due to biological fixation are the main disadvantages attributed to this option.[6,11,22,43,44]

Proper implantation of both the tantalum cone and the sleeve require the preparation of the host bone. Initially, the metaphysical cones were symmetrical and did not have side specificity; however, with the evolution of the designs, the current cones are asymmetric and can be metaphyseal or diaphyseal. A variety of implant systems can be used with metaphyseal cones, but sleeves are specific implants.[6,7,12,17,45]

It is recommended that the intramedullary test nail be used to obtain correct alignment and direction of the specific cutters to prepare the bed and better adaptation of the cone or sleeve. A burr drill may also be necessary in this debridement. After positioning the metaphyseal cone and repairing the defect, reconstruction proceeds with the placement of prosthetic components. It is noteworthy that the rotation of the cones should favor the better filling of defects and greater contact with the host bone and, thus, they are independent of the rotation of the implants. Eventual non-contact areas from the metaphyseal cone to the host bone should be grafted to favor biological integration. The inner portion of the cones allows cementation of the definitive prosthetic components. However, care should be taken with the use of an offset stem for some systems, given the possibility of difficulties in fitting to the metaphyseal cone (►**Figures 2** e **3**).

The metaphyseal sleeve fits the revision component, and the construction allows limited internal or external rotation to adjust the rotation of the tibial tray and the metaphyseal component. The definitive components are implanted with cement on the surface of the tibial tray, leaving the spinal canal free of cement for biological integration. Eventual removal of these porous devices can be quite difficult.[7,12,43,45,46]

Several clinical studies using tantalum cones for the management of bone defects during rTKA have shown favorable initial results in a short follow-up, with the need for reoperation in only about 1.1%.[43,44,47–51]

In a meta-analysis, evaluating 8 studies with 196 revision surgeries using 233 tantalum cones, with a follow-up of up to 40 months, the authors identified only two cases of aseptic

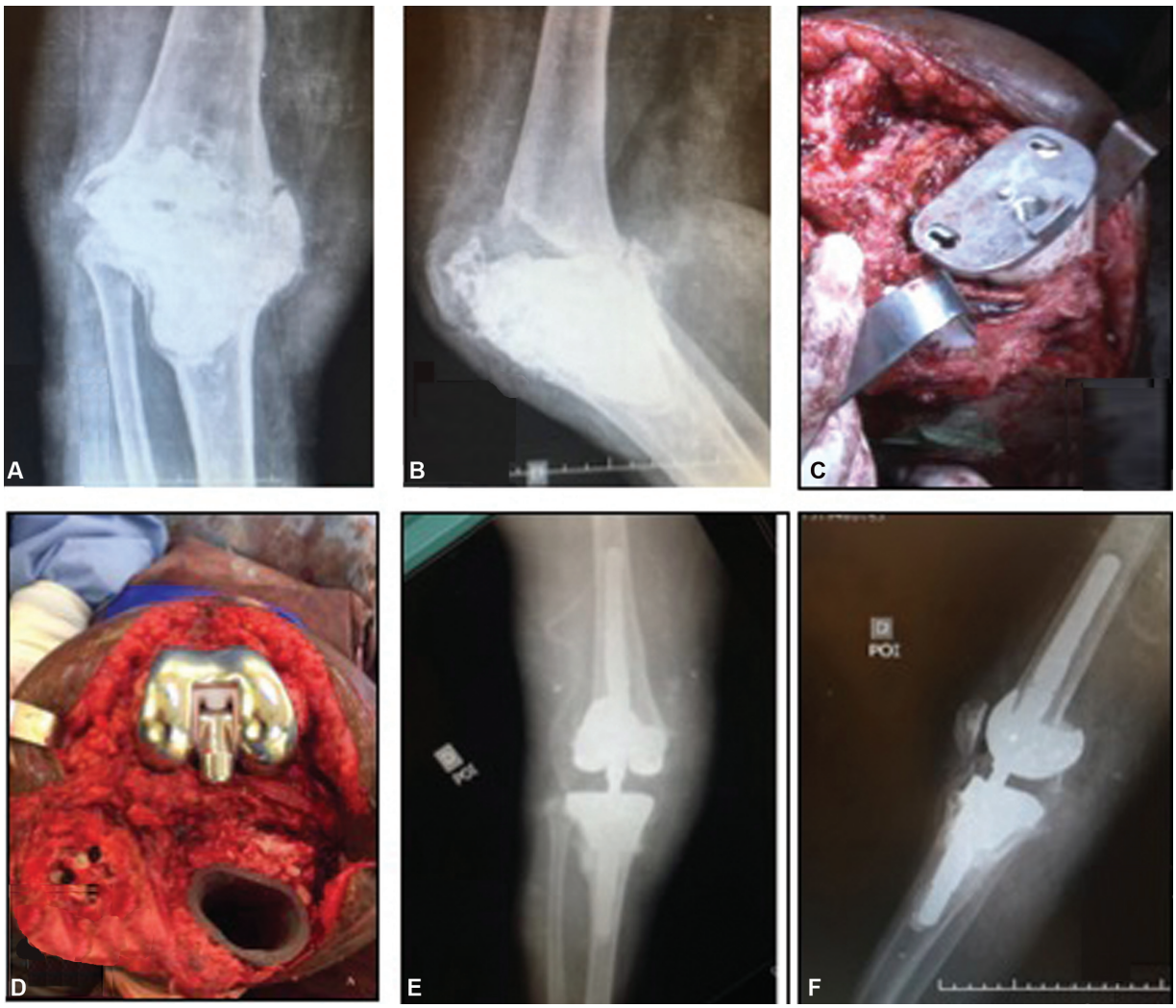

Fig. 2 (A) and (B) Preoperative radiographs of the 2nd revision total knee arthroplasty due to septic failure, with severe bone defect, especially in the proximal tibia; (C) Intraoperative appearance with the test components of the metaphyseal cone and tibial tray; (D) Intraoperative appearance with the tantalum cone implanted in the tibia and with maximum contact with the host bone; (E) and (F) Postoperative radiographs of the revision with contrite implants and metaphyseal cone in proximal tibia.

loosening. The recurrence of infection after a two-stage exchange was the main cause of reoperation.[20]

Systematic review of 20 studies including 812 metaphyseal cones was performed by Divano et al.,[21] showing 94.55% survival in the short-to-medium-term follow-up. The incidence of infection was 7.1%, while the rates of reoperation and revision were, respectively, 16.19% and 8.19%.

Kamath et al.[52] studied 66 reviews using tantalum cones in types 2 and 3 AORI defects, with minimum follow-up between 5 and 9 years, and identified that 23% of the cones had incomplete and non-progressive radiolucent lines and that 3% (two cones) had aseptic loosening. Therefore, the revision-free survival was over 96%, thus demonstrating the maintenance of favorable results in the medium and long terms.[52] Favorable medium-term results were also corroborated by Potter et al.[53]

These favorable results, however, were contested by Bohl et al.,[22] who compared reviews with the use of tantalum cones with the results of rTKA with conventional implants without the use of cones, and concluded that there was no evidence of superiority with the use of metaphyseal cones.

Similarly, Beckmann et al.[8] conducted a systematic review that compared 10 studies with 233 revisions managed using tantalum cones with 17 studies involving 476 revisions that performed large structural grafts. The authors pointed out that, although the results should not be considered conclusive, there are strong indications of better results favorable to the use of trabecular metal.

Short-term assessments of cementless metaphyseal sleeves have been studied by Alexander et al.;[54] these proved to be a promising option for the treatment of types 2B and 3 bone defects, being able to provide stable construction for fixation of implants.

In a prospective study, with a short-term follow-up of 83 rTKA, using 36 femoral and 83 tibial sleeves, 2 patients (2.7%) required revision for aseptic loosening on the tibial side.[46] Satisfactory results, with osteointegration of all sleeves in

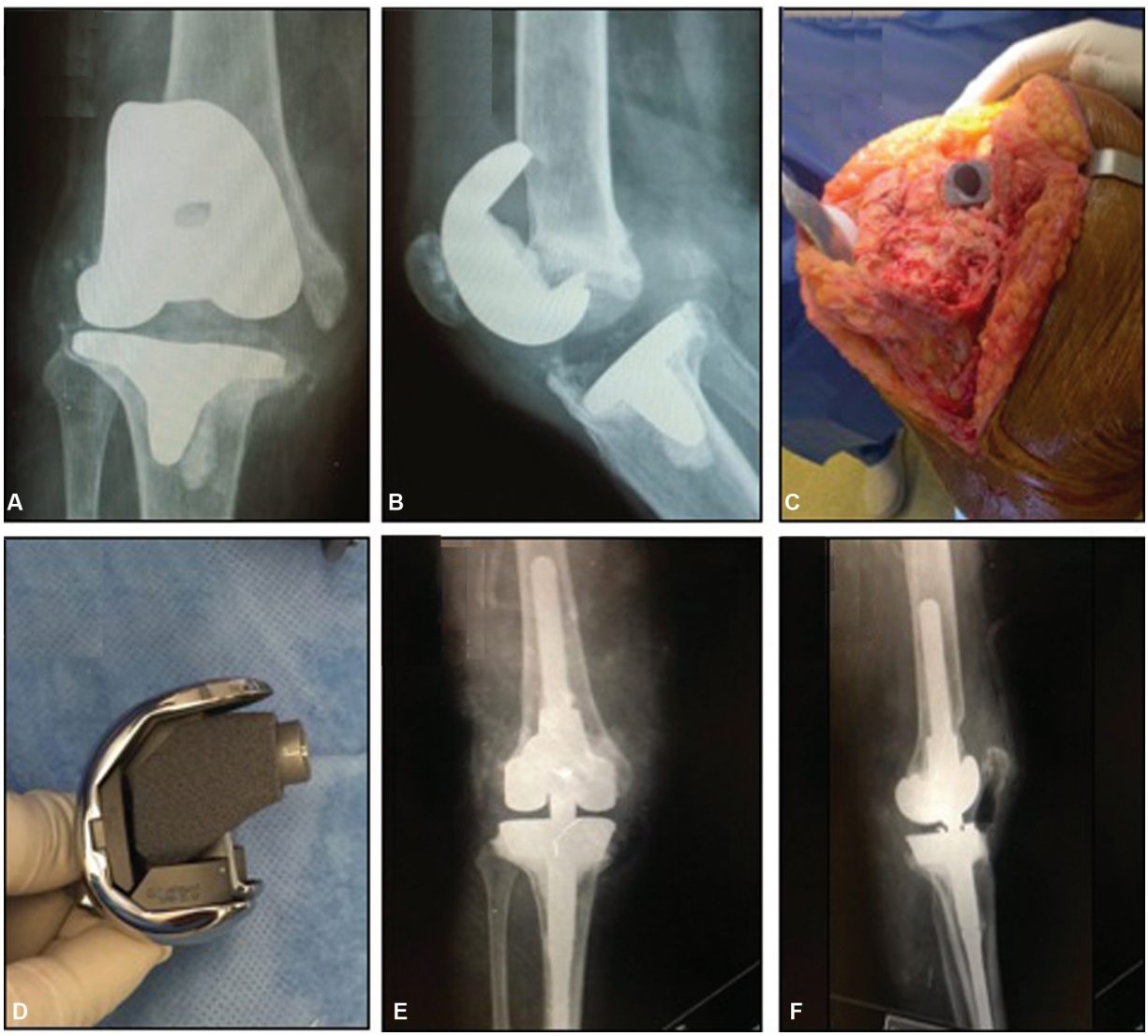

Fig. 3 (A) and (B) Preoperative radiographs of aseptic total knee arthroplasty failure with severe distal femoral defect; (C) metaphyseal tantalum cone positioned to treat bone defect; (D) Profile image of the definitive femoral component plus a tantalum cone and distal and posterior femoral wedges; (E) and (F) Postoperative radiographs.

the short term, were also identified on the tibial side by Barnett et al.[45]

Non-Conventional Prostheses and Customized Mega Prostheses

Unconventional or tumoral prostheses and customized megaprostheses are generally used to replace the entire distal femur or the entire proximal tibia. Thus, they are usually used in oncology, or to treat severe bone loss that is typically found in chronic infection, or after multiple joint reconstruction surgeries, so they are usually atypical indications.[12,17]

Customized implants are usually expensive, require a long time to produce, and often have a high risk of infectious and mechanical complications.[17]

Fraser et al.[55] studied 247 patients treated with hinged megaprostheses for the treatment of severe bone defects, demonstrating revision-free survival, after 8 years, of only 58%. Similarly, Holl et al.[56] identified a high incidence of complications in 11 out of 20 patients who underwent the placement of this type of implant, however without the need for amputation. These results were corroborated by Barry et al.,[57] who demonstrated a high number of complications and reoperations with this treatment, although, according to the authors, it is a viable option for salvage of the limb.

Final Considerations

Proper treatment of bone defects during TKA revisions is a fundamental principle for obtaining satisfactory and long-lasting results. There are several management options with their respective advantages and disadvantages, and there is no option for treating bone failure that is ideal in all circumstances. Therefore, decision making and choice of the method employed is individualized; however, the procedure should focus on the objective of restoring bone stock in patients with the possibility of future revisions.

Conflict of Interests

The authors declare that there is no conflict of interests.

References

1 Kurtz S, Ong K, Lau E, Mowat F, Halpern M. Projections of primary and revision hip and knee arthroplasty in the United States from 2005 to 2030. J Bone Joint Surg Am 2007;89(04):780–785
2 Bozic KJ, Kurtz SM, Lau E, et al. The epidemiology of revision total knee arthroplasty in the United States. Clin Orthop Relat Res 2010;468(01):45–51
3 Bozic KJ, Kamath AF, Ong K, et al. Comparative Epidemiology of Revision Arthroplasty: Failed THA Poses Greater Clinical and Economic Burdens Than Failed TKA. Clin Orthop Relat Res 2015;473(06):2131–2138
4 Delanois RE, Mistry JB, Gwam CU, Mohamed NS, Choksi US, Mont MA. Current Epidemiology of Revision Total Knee Arthroplasty in the United States. J Arthroplasty 2017;32(09):2663–2668
5 Chalmers BP, Pallante GD, Sierra RJ, Lewallen DG, Pagnano MW, Trousdale RT. Contemporary Revision Total Knee Arthroplasty in Patients Younger Than 50 Years: 1 in 3 Risk of Re-Revision by 10 Years. J Arthroplasty 2019;34(7S):S266–S270
6 Sculco PK, Abdel MP, Hanssen AD, Lewallen DG. The management of bone loss in revision total knee arthroplasty: rebuild, reinforce, and augment. Bone Joint J 2016;98-B(1, Suppl A)120–124
7 Chalmers BP, Desy NM, Pagnano MW, Trousdale RT, Taunton MJ. Survivorship of Metaphyseal Sleeves in Revision Total Knee Arthroplasty. J Arthroplasty 2017;32(05):1565–1570
8 Beckmann NA, Mueller S, Gondan M, Jaeger S, Reiner T, Bitsch RG. Treatment of severe bone defects during revision total knee arthroplasty with structural allografts and porous metal cones-a systematic review. J Arthroplasty 2015;30(02):249–253
9 Huten D. Femorotibial bone loss during revision total knee arthroplasty. Orthop Traumatol Surg Res 2013;99(1, Suppl)S22–S33
10 Vasso M, Beaufils P, Cerciello S, Schiavone Panni A. Bone loss following knee arthroplasty: potential treatment options. Arch Orthop Trauma Surg 2014;134(04):543–553
11 Mancuso F, Beltrame A, Colombo E, Miani E, Bassini F. Management of metaphyseal bone loss in revision knee arthroplasty. Acta Biomed 2017;88(2S):98–111
12 Sheth NP, Bonadio MB, Demange MK. Bone Loss in Revision Total Knee Arthroplasty: Evaluation and Management. J Am Acad Orthop Surg 2017;25(05):348–357
13 Dalling JG, Math K, Scuderi GR. Evaluating the progression of osteolysis after total knee arthroplasty. J Am Acad Orthop Surg 2015;23(03):173–180
14 Nadaud MC, Fehring TK, Fehring K. Underestimation of osteolysis in posterior stabilized total knee arthroplasty. J Arthroplasty 2004;19(01):110–115
15 Panegrossi G, Ceretti M, Papalia M, Casella F, Favetti F, Falez F. Bone loss management in total knee revision surgery. Int Orthop 2014; 38(02):419–427
16 Minoda Y, Yoshida T, Sugimoto K, Baba S, Ikebuchi M, Nakamura H. Detection of small periprosthetic bone defects after total knee arthroplasty. J Arthroplasty 2014;29(12):2280–2284
17 Lei PF, Hu RY, Hu YH. Bone Defects in Revision Total Knee Arthroplasty and Management. Orthop Surg 2019;11(01):15–24
18 Engh GA, Parks NL. The management of bone defects in revision total knee arthroplasty. Instr Course Lect 1997;46:227–236
19 Burastero G, Cavagnaro L, Chiarlone F, Alessio-Mazzola M, Carrega G, Felli L. The Use of Tantalum Metaphyseal Cones for the Management of Severe Bone Defects in Septic Knee Revision. J Arthroplasty 2018;33(12):3739–3745
20 Lachiewicz PF, Watters TS. Porous metal metaphyseal cones for severe bone loss: when only metal will do. Bone Joint J 2014;96-B (11, Supple A)118–121
21 Divano S, Cavagnaro L, Zanirato A, Basso M, Felli L, Formica M. Porous metal cones: gold standard for massive bone loss in complex revision knee arthroplasty? A systematic review of current literature. Arch Orthop Trauma Surg 2018;138(06):851–863
22 Bohl DD, Brown NM, McDowell MA, et al. Do Porous Tantalum Metaphyseal Cones Improve Outcomes in Revision Total Knee Arthroplasty? J Arthroplasty 2018;33(01):171–177
23 Cobra HAAB, Junior MCNP, Mozella AP. Homologous structural graft for treatment of bone defect during knee revision arthroplasty. Rev Bras Ortop 2013;48(04):341–347
24 Whittaker JP, Dharmarajan R, Toms AD. The management of bone loss in revision total knee replacement. J Bone Joint Surg Br 2008; 90(08):981–987
25 Ritter MA, Keating EM, Faris PM. Screw and cement fixation of large defects in total knee arthroplasty. A sequel. J Arthroplasty 1993;8(01):63–65
26 Berend ME, Ritter MA, Keating EM, Jackson MD, Davis KE. Use of screws and cement in primary TKA with up to 20 years follow-up. J Arthroplasty 2014;29(06):1207–1210
27 Berend ME, Ritter MA, Keating EM, Jackson MD, Davis KE, Malinzak RA. Use of screws and cement in revision TKA with primary or revision specific prosthesis with up to 17 years followup. J Arthroplasty 2015;30(01):86–89

28 Backstein D, Safir O, Gross A. Management of bone loss: structural grafts in revision total knee arthroplasty. Clin Orthop Relat Res 2006;446(446):104–112
29 Chen F, Krackow KA. Management of tibial defects in total knee arthroplasty. A biomechanical study. Clin Orthop Relat Res 1994; (305):249–257
30 Qiu YY, Yan CH, Chiu KY, Ng FY. Review article: Treatments for bone loss in revision total knee arthroplasty. J Orthop Surg (Hong Kong) 2012;20(01):78–86
31 Patel JV, Masonis JL, Guerin J, Bourne RB, Rorabeck CH. The fate of augments to treat type-2 bone defects in revision knee arthroplasty. J Bone Joint Surg Br 2004;86(02):195–199
32 Werle JR, Goodman SB, Imrie SN. Revision total knee arthroplasty using large distal femoral augments for severe metaphyseal bone deficiency: a preliminary study. Orthopedics 2002;25(03):325–327
33 Hockman DE, Ammeen D, Engh GA. Augments and allografts in revision total knee arthroplasty: usage and outcome using one modular revision prosthesis. J Arthroplasty 2005;20(01):35–41
34 Lotke PA, Carolan GF, Puri N. Technique for impaction bone grafting of large bone defects in revision total knee arthroplasty. J Arthroplasty 2006;21(04, Suppl 1):57–60
35 Lotke PAP, Carolan GF, Puri N. Impaction grafting for bone defects in revision total knee arthroplasty. Clin Orthop Relat Res 2006; 446(446):99–103
36 Naim S, Toms AD. Impaction bone grafting for tibial defects in knee replacement surgery. Results at two years. Acta Orthop Belg 2013;79(02):205–210
37 Hilgen V, Citak M, Vettorazzi E, et al. 10-year results following impaction bone grafting of major bone defects in 29 rotational and hinged knee revision arthroplasties: a follow-up of a previous report. Acta Orthop 2013;84(04):387–391
38 Engh GA, Ammeen DJ. Use of structural allograft in revision total knee arthroplasty in knees with severe tibial bone loss. J Bone Joint Surg Am 2007;89(12):2640–2647
39 Wang JW, Hsu CH, Huang CC, Lin PC, Chen WS. Reconstruction using femoral head allograft in revision total knee replacement: an experience in Asian patients. Bone Joint J 2013;95-B(05):643–648
40 Chun CH, Kim JW, Kim SH, Kim BG, Chun KC, Kim KM. Clinical and radiological results of femoral head structural allograft for severe bone defects in revision TKA–a minimum 8-year follow-up. Knee 2014;21(02):420–423
41 Bauman RD, Lewallen DG, Hanssen AD. Limitations of structural allograft in revision total knee arthroplasty. Clin Orthop Relat Res 2009;467(03):818–824
42 Clatworthy MG, Ballance J, Brick GW, Chandler HP, Gross AE. The use of structural allograft for uncontained defects in revision total knee arthroplasty. A minimum five-year review. J Bone Joint Surg Am 2001;83(03):404–411
43 Meneghini RM, Lewallen DG, Hanssen AD. Use of porous tantalum metaphyseal cones for severe tibial bone loss during revision total knee replacement. Surgical technique. J Bone Joint Surg Am 2009; 91(Suppl 2 Pt 1):131–138
44 Howard JL, Kudera J, Lewallen DG, Hanssen AD. Early results of the use of tantalum femoral cones for revision total knee arthroplasty. J Bone Joint Surg Am 2011;93(05):478–484
45 Barnett SL, Mayer RR, Gondusky JS, Choi L, Patel JJ, Gorab RS. Use of stepped porous titanium metaphyseal sleeves for tibial defects in revision total knee arthroplasty: short term results. J Arthroplasty 2014;29(06):1219–1224
46 Huang R, Barrazueta G, Ong A, et al. Revision total knee arthroplasty using metaphyseal sleeves at short-term follow-up. Orthopedics 2014;37(09):e804–e809
47 Schmitz HC, Klauser W, Citak M, Al-Khateeb H, Gehrke T, Kendoff D. Three-year follow up utilizing tantal cones in revision total knee arthroplasty. J Arthroplasty 2013;28(09):1556–1560
48 Rao BM, Kamal TT, Vafaye J, Moss M. Tantalum cones for major osteolysis in revision knee replacement. Bone Joint J 2013;95-B (08):1069–1074
49 Mozella AdeP, Olivero RR, Alexandre H, Cobra AB. Use of a trabecular metal cone made of tantalum, to treat bone defects during revision knee arthroplasty. Rev Bras Ortop 2014;49(03):245–251
50 Girerd D, Parratte S, Lunebourg A, et al. Total knee arthroplasty revision with trabecular tantalum cones: Preliminary retrospective study of 51 patients from two centres with a minimal 2-year follow-up. Orthop Traumatol Surg Res 2016;102(04):429–433
51 Villanueva-Martínez M, De la Torre-Escudero B, Rojo-Manaute JM, Ríos-Luna A, Chana-Rodriguez F. Tantalum cones in revision total knee arthroplasty. A promising short-term result with 29 cones in 21 patients. J Arthroplasty 2013;28(06):988–993
52 Kamath AF, Lewallen DG, Hanssen AD. Porous tantalum metaphyseal cones for severe tibial bone loss in revision knee arthroplasty: a five to nine-year follow-up. J Bone Joint Surg Am 2015;97 (03):216–223
53 Potter GD III, Abdel MP, Lewallen DG, Hanssen AD. Midterm Results of Porous Tantalum Femoral Cones in Revision Total Knee Arthroplasty. J Bone Joint Surg Am 2016;98(15):1286–1291
54 Alexander GE, Bernasek TL, Crank RL, Haidukewych GJ. Cementless metaphyseal sleeves used for large tibial defects in revision total knee arthroplasty. J Arthroplasty 2013;28(04):604–607
55 Fraser JF, Werner S, Jacofsky DJ. Wear and loosening in total knee arthroplasty: a quick review. J Knee Surg 2015;28(02): 139–144
56 Höll S, Schlomberg A, Gosheger G, et al. Distal femur and proximal tibia replacement with megaprosthesis in revision knee arthroplasty: a limb-saving procedure. Knee Surg Sports Traumatol Arthrosc 2012;20(12):2513–2518
57 Barry JJ, Thielen Z, Sing DC, Yi PH, Hansen EN, Ries M. Length of Endoprosthetic Reconstruction in Revision Knee Arthroplasty Is Associated With Complications and Reoperations. Clin Orthop Relat Res 2017;475(01):72–79

Update on Patellar Instability

Atualização em instabilidade patelar

Nilson Roberto Severino[1] Fabrício Roberto Severino[1] Osmar Pedro Arbix de Camargo[1] Luiz Gabriel Betoni Guglielmetti[1] Victor Marques de Oliveira[1] Ricardo de Paula Leite Cury[1]

[1] Knee Group, Department of Orthopedics and Traumatology, Faculty of Medical Sciences, Irmandade da Santa Casa de Misericórdia de São Paulo, Santa Casa de São Paulo, São Paulo, SP Brazil

Address for correspondence Nilson Roberto Severino, Rua Dr. Cesário Motta Júnior, 112, Vila Buarque, SãoPaulo, SP, 01221-020, Brazil (e-mail: nrseverino@uol.com.br).

Rev Bras Ortop 2021;56(2):147–153.

Abstract

Patellar instability is a multifactorial clinical condition that affects a significant number of patients and occurs due to morphological variations of the joint and patellofemoral alignment. The present literature review study aimed to identify and summarize current concepts on patellar instability, in relation to associated risk factors, diagnostic criteria, and the benefits and risks of conservative and surgical treatments. For this purpose, a search was conducted in the following electronic databases: MEDLINE (via Pubmed), LILACS and Cochrane Library. It is concluded that the accurate diagnosis depends on the detailed clinical evaluation, including the history and possible individual risk factors, as well as imaging exams. The initial treatment of patellar instability is still controversial, and requires the combination of conservative and surgical interventions, taking into consideration both soft tissues and bone structures, the latter being the most common reason for choosing surgical treatment, especially lateral patellar instability.

Keywords
- patella
- patellofemoral joint
- joint instability
- patellar dislocation

Resumo

A instabilidade patelar é uma condição clínica multifatorial, que acomete um número expressivo de pacientes, ocorrendo devido a variações anatômicas, morfológicas da articulação e do alinhamento patelofemoral. O presente estudo de revisão e atualização da literatura teve como objetivos identificar e sumarizar os conceitos atuais sobre instabilidade patelar em relação aos fatores de risco associados, os critérios diagnósticos e os benefícios e riscos dos tratamentos conservador e cirúrgico. Para tanto, foi realizado um levantamento nas bases de dados eletrônicas MEDLINE (via Pubmed), LILACS e Cochrane Library. Conclui-se que o diagnóstico preciso depende da avaliação clínica detalhada, incluindo o histórico e possíveis fatores de risco individuais, além de exames de imagem. O tratamento inicial da instabilidade patelar é ainda controverso, e requer a combinação de intervenções conservadoras e cirúrgicas, levando em consideração tanto os tecidos moles quanto as estruturas ósseas, sendo estas últimas a razão mais comum para a escolha do tratamento cirúrgico, principalmente instabilidade patelar lateral.

Palavras-chave
- patela
- articulação patelofemoral
- instabilidade articular
- luxação patelar

received
September 10, 2019
accepted
March 17, 2020
published online
November 2, 2020

DOI https://doi.org/10.1055/s-0040-1713389.
ISSN 0102-3616.

Thieme Revinter Publicações Ltda., Rua do Matoso 170, Rio de Janeiro, RJ, CEP 20270-135, Brazil

Introduction

Patellar instability is a common and disabling clinical condition that mainly affects young individuals. Anatomical factors such as trochlear dysplasia, patellar morphology, tibial tuberosity localization, and soft tissue rupture have been associated with primary dislocation and recurrent secondary instability.[1] Patellofemoral dislocation is a disabling lesion that represents ~ 2 to 3% of all traumatic knee injuries and affects 5 to 43 cases per 100,000 young people and adolescents per year.[2–4] This condition can cause significant morbidity since it is associated with high recurrence rates, lesions and fractures of the patellofemoral cartilage, injury of adjacent soft tissues, which result in pain, decreased function and possible development of patellofemoral arthrosis.[2,5]

Patellofemoral joint instability is multifactorial, the presence of predisposing factors such as femoral anteversion, external tibial torsion, internal femoral torsion, geno valgus, patellar dysplasia, trochlear dysplasia, high patella, oblique medial vastus atrophy, flat foot, and generalized hyperlaxity may influence the occurrence of recurrent dislocations.[6,7]

Patellar dislocations are mainly lateral, and the main mechanism of injury during physical activity is the internal rotation of the femur with the foot planted, valgus component and a sudden lateral displacement of the patella, or a direct impact that displaces the patella from the joint. However, they can also occur after low-energy trauma in people with predisposing factors.[8,9] About 93% of traumatic patellar dislocations occur during flexion with valgus movement of the knee without direct contact, while medial dislocations are exclusively traumatic or iatrogenic.[9]

The clinical picture consists of complaints of feeling of falsehood, severe pain and secondary effusion. According to Sillanpaa et al.,[9] in 2008, conditions such as hemarthrosis, medial facet fracture and medial patellofemoral ligament (MPFL) injury occur in almost all patients after traumatic patellar dislocation, in addition, osteochondral fracture can be observed in 25% of the cases.

Treatment of acute primary patellar dislocation aims to reduce the risk of recurrence or painful subluxation and prevent secondary osteoarthrosis.[5] Historically, the initial therapeutic choice is conservative for patients who have had an episode of acute dislocation, with the exception of cases of associated osteochondral lesions or fractures, where early surgical treatment is indicated.[10] According to studies of the natural history of the disease, 50 to 70% of patients are free of recurrent dislocations after conservative treatment.[11–14] On the other hand, some recent publications suggest high rates of recurrent instability for both operated and nonoperated patients.[2,15]

The long-term consequences of primary acute patellar dislocation include recurrent dislocations, patellar instability, cartilage injury, pain, limitation of activities of daily living, and secondary patellofemoral osteoarthrosis, with a six-fold increased risk of dislocation recurrence in patients with a history of contralateral patellar dislocation. In cases where ≥ 2 episodes of dislocation occur, the risk of recurrence is ~ 50% if there was an injury to the MPFL.[9,16] However, recurrence rates and residual symptoms of instability after conservative treatment consequently lead to surgical indication. Despite the high incidence rates of patellofemoral instability, the management of patients with this condition is complex and remains variable in the literature.[2,8] Thus, the present study of review and updating of the literature aimed to identify and summarize the current concepts about patellar instability in relation to the associated risk factors, diagnostic criteria and the benefits and risks of conservative and surgical treatments. A survey was conducted in the electronic databases: MEDLINE (via Pubmed), LILACS and Cochrane Library, and included only studies with good methodological quality and high level of evidence such as systematic reviews, randomized clinical trials and prospective observational studies. The keywords (MeSH terms) used in the strategies were *Patella* or *Patellar Dislocation*, adapted for each database searched.

Risk Factors

Studies report that > 60% of patellar dislocations occur during physical activity. It is estimated that women have an approximate risk 33% higher than men,[3,17,18] although some studies do not find differences between genders for the occurrence of primary dislocation.[5,18,19] Age is another relevant risk factor, since most acute patellar dislocations occur in adolescents and young adults, especially between 10 and 17 years old.[3,17]

Anatomical and structural risk factors for patellar instability were identified, such as: high patella, abnormal patellar morphology, trochlear dysplasia, patellar hypermobility, variations in the anatomy of the MPFL, generalized ligament hyperlaxity, hypoplasia of the oblique medial vastus, increased Q-angle, increased femoral anteversion, valgus alignment, and external tibial rotation.[7,8,20]

Dejour et al.,[21] in 1994, considered four factors predisposing to dislocation: 1) trochlear dysplasia; 2) lateral inclination of the patella, interpreted as dysplasia of the vastus oblique medial; 3) high patella and 4) lateralization of the anterior tuberosity of the tibia (ATT) (increased Q angle). A prospective observational study analyzed the patellofemoral morphology in skeletally immature children with and without primary patellar dislocation and found significant differences in measurements related to trochlear dysplasia such as greater groove angle and lower trochlear depth (< 3 mm), which result in increased central condylar height.[19] Another prospective study[18] analyzed the same risk factors in children and adults and showed similar findings, that is, trochlear dysplasia and excessive patellar height were the most common factors, with no differences in skeletal maturity. The combination of two or more associated risk factors is present in most patients who progress to primary patellar dislocation.[3] According to Santos Neto et al.,[22] in 2012, the morphology of the MPFL varies with the interepicondylar distance and the lateral condyle, and with the age of the patient.

The recurrence of patellar dislocation was investigated by prospective cohort studies that showed a total cumulative

incidence of ipsilateral recurrence between 36[23] and 54%[24] after 15 to 20 years, being significantly higher in patients < 18 years old at the first dislocation, presence of trochlea dysplasia, high patella and greater distance between the tibia tuberosity and the trochlear sulcus (TA-GT). Most events occurred within 5 years of the initial injury. Furthermore, approximately half of the patients who suffered lateral patellar dislocation present symptoms and radiographic alterations compatible with osteoarthrosis on average 25 years after the injury.[25] Thus, failures in the treatment of patellar dislocation can lead to recurrent patellar instability, persistent knee pain, and even patellofemoral osteoarthrosis.[26]

Diagnostic Criteria

Although physical examination is the main diagnostic tool for patellar instability, imaging exams are used to assist in the clinical decision-making and differential diagnosis, and include conventional radiographs, magnetic resonance imaging (MRI), computed tomography (CT) and ultrasonography (US).[1,27] Radiological evaluation is often the first imaging examination to be requested, including incidences: a) anteroposterior, to evaluate the joint alignment and symmetry of bone structures; b) absolute profile at 30 degrees of flexion, which allows the measurement of patellar height from the relationship between the patella and tibia using indices such as: Insall-Salvatti,[28] Blackburne-Peel[29] and Caton-Deschamps,[30] in addition to the measurement of the plateau-patella angle [31]; (c) axial, to evaluate the angle of the trochlear groove and the shape and positioning (inclination) of the patella.

A systematic review showed that radiographic measurement of patellar height using the Insall-Salvatti and Caton-Deschamps methods, and MRI by the Insall-Salvatti method, presented good validity, with significant difference between samples of healthy patients and of those with patellar instability ($p < 0.0001$). The measurement of the TA-GT distance evaluated by CT also demonstrated good intra- and interexaminer validity. The measurements of patellar inclination (patellar tilt) and the angles of the trochlear and lateral patellar groove also showed good discrimination validity between individuals with patellar instability and the control group ($p < 0.0001$). For the measurements of the congruence angle and height of the lateral and medial condyles, there was low validity beyond the substantial heterogeneity among the analyzed studies. Finally, there is insufficient evidence to determine the reliability and validity of patellar height using the Blackburne-Peel method, the angle of congruence by MRI, lateral patellar displacement by MRI, femoral anteversion by CT, the depth of the trolley, the crossing signal and Wiberg patellar classification. There was low reliability for the evaluation of trochlear dysplasia and groove angle by US.[1,32]

Treatment

Conservative treatment

The treatment of patellar instability and dislocation remains a challenge for surgeons due to the complexity of the procedures and the unsatisfactory results. Historically, conservative treatment (pharmacological, physiotherapy and immobilization) has been considered as the first option for primary patellar dislocations, except in the presence of osteochondral fracture [15] and MPFL avulsion.[33] However, there are still controversies in the literature regarding the indication for conservative or surgical treatment. Some studies have found high recurrence rates and residual symptoms of instability associated with conservative treatment (up to 44%),[13,14,26,34] and for this reason, surgical treatment has been recommended, but also has high recurrence rates (10 to 35%).[26]

A Cochrane[4] systematic review published in 2015 showed that although there is some evidence to support surgical treatment in primary patellar dislocation, the quality of evidence is very low due to the high risk of bias and inaccuracy in the effect estimates of the included studies. Therefore, new randomized clinical trials of better methodological quality have been recommended. ►**Table 1–**[4,8,26,35,36] shows the results of systematic reviews with meta-analysis comparing conservative with surgical treatment for primary patellar dislocation.

In general, the goals of conservative treatment after primary dislocation of the patella are to reduce swelling, strengthen the knee muscles and improve joint range of motion.[33] Physiotherapy for patients with patellar instability should focus on strengthening the closed kinetic chain of the quadriceps and gluteus muscles, and sensory-motor training. Closed kinetic chain exercises involving the gluteal musculature tend to force the external rotation of the femur and consequently decrease the Q angle during the gait cycle. Strengthening the quadriceps musculature with emphasis on the vastus oblique medial (VOM) helps in the proper positioning of the patella in the trochlear groove.[33,34,37,38] The period of immobilization after dislocation episode varies in the literature between 2 and 6 weeks.[8]

Surgical treatment

The selection of the appropriate surgical procedure depends on the individual pathophysiology of patellar instability, which, for the most part, is anatomical in nature. For this reason, surgical techniques aim to restore normal anatomy, and there is an association between lateral patellar dislocations and medial soft tissue lesions.[15] Indications for surgical treatment are also related to pain and patient function. In many cases, patients have minimal symptoms at rest, but significantly limit their functional activities due to apprehension and instability. Therefore, the risk of recurrence is an important element to be considered in treatment.[6] The objective of surgical treatment of patellar instability is to stabilize it, restore normal kinematics and optimize the transmission of loads through the joint. Surgical techniques include bone procedures, such as osteotomy of the tibial tuberosity, with medialization and/or distalization, and trochleoplasty; soft tissue interventions, such as reconstruction of the medial patellofemoral ligament (MPFL).[39,40] Arthroscopic and minimally invasive techniques, such as medial plication and retinacular releases, are typically

Table 1 Results of systematic reviews with meta-analysis on conservative versus surgical treatment for primary patellar dislocation

Study/Year	Included and participating studies	Quality of studies included (GRADE)	Results
Yang et al.,[35] 2019	16 ECRs/observational studies N = 918 participants 23 to 36 years old Follow up: 1 to 5 years	Low	*Significant difference in favor of surgery:* - Kujala: DMP 0.79 [0.30 to 1.28] - Relapse: OR 0.44 [0.30 to 0.63]
			There was no significant difference between the groups: - Pain (EAV): DMP 0.84 [0.36 to 9.03]
Lee et al.,[26] 2018	4 ECRs N = 275 participants 23 to 36 years old Follow up: 1 to 5 years	Moderate to low	*There was no significant difference between the groups:* - Recidivism: RR 1.33 [0.89 to 2.00] - Alley: DM 1.76 [- 2.02 a 5.54] - Instability: RR 1.11 [0.89 to 1.40] - Pain: DM - 0.39 [- 6.97 to 6.20] - Tegner: DM 0.63 [- 0.32 to 1.58]
Longo et al.,[36] 2017	17 ECRs/observational studies N = 2,086 (2,134 knees) Average 20.3 years old *Follow up*: average 5 years	NA	*Significant difference in favor of surgery:* - Relapse: OR 0.54 [0.40 to 0.70] (36.4% conservative x 25% surgical)
Saccomano et al.,[8] 2016	9 ECRs N = 430 knees 13 to 36 years old *Follow up*: 2 to 14 years	Moderate to low	*Significant difference in favor of surgery:* - Recurrence: RR 0.62 [0.39 to 0.98] - Pain: DMP - 0.32 [- 0.61 to - 0.03]
			There was no significant difference between the groups: - Kujala: DMP 0.74 [0.08 to 1.40] - Lysholm: DMP - 0.10 [- 0.45 to 0.26] - Tegner: DMP – 0.61 [- 1.25 to 0.02]
Smith et al.,[4] 2015	6 ECRs N = 344 participants 19 to 27 years old Follow up: up to 2 years	Too low	*Significant difference in* favor of surgery (after 2 to 5 years)*:* - Recurrence: RR 0.53 [0.33 to 0.87] - Alley: DM 13.93 [5.33 a 22.53] - Instability: RR 0.44 [0.27 to 0.72]
			There was no significant difference between the groups: Recidivism: after 6 to 9 years: RR 0.67 [-0.42 to 1.08] after 14 years RR 0.93 [-0.67 to 1.30] - Kujala: after 6 to 9 years: RR -0.35 [-10.61 to 4.11] after 14 years RR -1.00 [-8.60 to 6.60]

Abbreviations: DM, mean difference; DMO, standardized mean difference; EAV, visual analogue pain scale; RCT, randomized clinical trial; GRADE, The Grading of Recommendations Assessment, Development and Evaluation; NA, not evaluated; OR, odds ratio; RR, Relative risk.

recommended for patients with minimal bone misalignment or trochlear dysplasia, or as adjuvants to provide additional soft tissue balance in patients undergoing bone repair procedures.[41] However, isolated arthroscopic lateral retinacular release may result in increased lateral mobility of the patella and medial instability, and is not recommended.[6]

Reconstruction of the medial patellofemoral ligament

Among the surgical techniques for recurrent patellar dislocation, the restoration of the function of the MPFL is one of the most important factors. The MPFL is the main restrictor to lateral translation of the patella and contributes with 50 to 60% of the medial containment force against lateral patellar translation. However, comparing the techniques of reconstruction of the MPFL, the choice of graft, the positioning of this graft or its tension, is difficult, given the scarcity of clinical evidence of comparative studies. [26,42] Medial patellofemoral ligament reconstruction is indicated for patients with MPFL lesions or deficiency and who present recurrent instability without evidence of bone malalignment. Arthroscopic diagnosis can also be made prior to MPFL reconstruction to identify any osteochondral lesions or free bodies.[43] The reconstructive techniques of the MPFL involve autologous graft of the flexor tendons (gravitis or semitendinous), passed through a patellar bone tunnel in the femur or fixed to the patella with suture anchors. The quadriceps tendon can also be used as a graft for the MPFL.[43] The knee flexion angle during MPFL graft fixation ranges from 20° to 90°. Graft fixation at smaller and larger knee flexion angles during MPFL reconstruction showed satisfactory results reported by the patients and low recurrence rates.[44] Regarding the comparison between single-band or double band graft, there

seems to be no differences regarding the improvement of knee function, recurrence rate and occurrence of complications. The single band technique may present a higher risk of postoperative apprehension, and the double band may cause greater joint stiffness, but there is insufficient evidence in the literature to support or refute these findings.[45,46]

Most studies on MPFL reconstruction, alone or combined with other techniques, show positive results, with improvement of pain and physical function and low incidence of recurrent dislocations. A systematic review[47] analyzed the effects of this surgery on skeletally immature patients (mean 13.2 years old and 4.8 years postoperatively, autologous flexor graft). There was a significant improvement in the Kujala questionnaire from 59.1 to 84.6 points before and after surgery. The complication rate was 25%, 3.8% redislocation and 11.4% subluxation. The systematic review by Lee et al.,[26] in 2018, compared the techniques of medial realignment and reconstruction of the MPFL and observed a significant difference in favor of reconstruction in physical function evaluated by the Kujala questionnaires (mean difference [DM] - 8.91 [- 14.05 to - 3.77]) and Lysholm (DM - 13.51 [- 21.35 to - 5.68]).

A combined surgical approach appears to be indicated for patients with increased tuber-trochlear tibiasule (TAS-GT) or severe trochlear dysplasia. The indication for the reconstruction of the MPFL combined with a bone procedure such as osteotomy is influenced by individual anatomical changes.[38]

Osteotomy of the anterior tuberosity of the tibia

Osteotomy of the tibial tuberosity is another treatment option for patients with patellofemoral instability. It refers to the alteration of the position of the tibial tuberosity, realignment of the knee extensor mechanism and correction of misalignment and instability. This procedure is indicated in patients with recurrent instability, increased TA-GT distance, high patella, or high-grade osteochondral lesions in the patellofemoral joint.[33,40,43] One of the most common techniques is the anteromedialization osteotomy described by Fulkerson et al.,[48] which involves the transfer of the tibial tuberosity anteromedially, and is indicated for patients with increased TA-GT distance, high patella, or osteochondral lesions. The medialization of the ATT, also known as the Elmslie-Trillat procedure, is an option to treat patellar malalignment in patients without high patella. [43] The results after the transfer of the ATT have shown good results. A systematic review analyzed 38 studies with a total of 1,182 surgeries, and reported a recurrence rate of dislocation of 7%.[49]

Trochleoplastia

Patellar instability with severe trochlear dysplasia is the main indication for trochleoplasty, a surgical technique capable of correcting and remodeling the bone architecture of the femoral trochlea. [50] Specific indications for trochleoplasty include patients with extreme patellar malalignment (identified by the "J" sign on clinical examination and TA-GT distance $>$ 10 mm), abnormal trochlear morphology in the presence of normal or almost normal articular cartilage.[15,51]

Different techniques for surgical correction of trochlear dysplasia were described:1) elevation of the lateral facet; 2) deepening of the groove with or without subchondral trochlear removal, followed by fixation of the corrected trochlear cartilage; and 3) resection of a subchondral cartilaginous flap, remodeling of the trochlea andre-fixation of the cartilage.[50,52]

Trochleoplasty is contraindicated for patients with open epiphyseal plaque or diagnosed with diffuse patellofemoral arthrosis. Complications associated with trochleoplasty include arthritis as a result of damage to the cartilage of the trochlea, and arthrofibrosis.[53] Given the technical requirements and potential complications, the clinical outcomes after trochleoplasty present satisfaction rates between 67 and 95%.[15,52]

According to Banke et al.,[52] trochleoplasty combined with MPFL reconstruction has shown good results for the treatment of chronic patellar instability. This concept of associated treatment is a safe option, not only as rescue therapy, but also as a primary procedure in relation to the treatment of patients with important anatomical changes, such as severe trochlear dysplasia. Isolated reconstruction of the MPFL, for these cases, according to the authors, can lead to 46% of recurrent dislocation.

Angular deformities

According to Zhang et al.,[54] femoral deformities, such as valgus or rotary, can lead to patellar dislocation and sometimes must be corrected. Distal varization osteotomy and external femoral derotation osteotomy can often prevent further dislocations of the patella, without the need for other corrective associations. According to the authors, the internal rotation of the femur should be excessive for osteotomy, citing 4 cases with 30°, 45° and 60° of internal rotation of the femur, in which they performed external derotation osteotomy and dislocations no longer occurred.

Conclusion

The available scientific evidence regarding the treatment of patellar instability is still controversial and of low to moderate methodological quality. However, updating regarding treatment and diagnosis strategies and knowledge of the risk factors of this injury are important to assist the decision-making of the surgeon. It is essential to understand the importance of the surgical technique regarding the individual anatomical alterations involved. Future studies with greater methodological rigor are still needed to address topics that remain uncertain.

Conflict of Interests

The authors have no conflict of interests to declare.

References

1 Smith TO, Davies L, Toms AP, Hing CB, Donell ST. The reliability and validity of radiological assessment for patellar instability. A systematic review and meta-analysis. Skeletal Radiol 2011;40 (04):399–414

2 Liu JN, Steinhaus ME, Kalbian IL, et al. Patellar Instability Management: A Survey of the International Patellofemoral Study Group. Am J Sports Med 2018;46(13):3299–3306

3 Fithian DC, Paxton EW, Stone ML, et al. Epidemiology and natural history of acute patellar dislocation. Am J Sports Med 2004;32 (05):1114–1121
4 Smith TO, Donell S, Song F, Hing CB. Surgical versus non-surgical interventions for treating patellar dislocation. Cochrane Database Syst Rev 2015;(02):CD008106
5 Arendt EA, Fithian DC, Cohen E. Current concepts of lateral patella dislocation. Clin Sports Med 2002;21(03):499–519
6 Koh JL, Stewart C. Patellar instability. Clin Sports Med 2014;33 (03):461–476
7 Franco BAFM, Sadigursky D, Daltro GC. Patellar position in patients with patellofemoral syndrome as characterized by anatomo-radiographic study. Rev Bras Ortop 2018;53(04):410–414
8 Saccomanno MF, Sircana G, Fodale M, Donati F, Milano G. Surgical versus conservative treatment of primary patellar dislocation. A systematic review and meta-analysis. Int Orthop 2016;40(11): 2277–2287
9 Sillanpää P, Mattila VM, Iivonen T, Visuri T, Pihlajamäki H. Incidence and risk factors of acute traumatic primary patellar dislocation. Med Sci Sports Exerc 2008;40(04):606–611
10 Panni AS, Vasso M, Cerciello S. Acute patellar dislocation. What to do? Knee Surg Sports Traumatol Arthrosc 2013;21(02):275–278
11 Cofield RH, Bryan RS. Acute dislocation of the patella: results of conservative treatment. J Trauma 1977;17(07):526–531
12 Hawkins RJ, Bell RH, Anisette G. Acute patellar dislocations. The natural history. Am J Sports Med 1986;14(02):117–120
13 Mäenpää H, Huhtala H, Lehto MU. Recurrence after patellar dislocation. Redislocation in 37/75 patients followed for 6-24 years. Acta Orthop Scand 1997;68(05):424–426
14 Mäenpää H, Lehto MU. Patellar dislocation. The long-term results of nonoperative management in 100 patients. Am J Sports Med 1997;25(02):213–217
15 Weber AE, Nathani A, Dines JS, et al. An Algorithmic Approach to the Management of Recurrent Lateral Patellar Dislocation. J Bone Joint Surg Am 2016;98(05):417–427
16 Duthon VB. Acute traumatic patellar dislocation. Orthop Traumatol Surg Res 2015;101(01):S59–S67
17 Seitlinger G, Ladenhauf HN, Wierer G. What is the chance that a patella dislocation will happen a second time: update on the natural history of a first time patella dislocation in the adolescent. Curr Opin Pediatr 2018;30(01):65–70
18 Arendt EA, England K, Agel J, Tompkins MA. An analysis of knee anatomic imaging factors associated with primary lateral patellar dislocations. Knee Surg Sports Traumatol Arthrosc 2017;25(10): 3099–3107
19 Askenberger M, Janarv PM, Finnbogason T, Arendt EA. Morphology and Anatomic Patellar Instability Risk Factors in First-Time Traumatic Lateral Patellar Dislocations: A Prospective Magnetic Resonance Imaging Study in Skeletally Immature Children. Am J Sports Med 2017;45(01):50–58
20 Balcarek P, Oberthür S, Hopfensitz S, et al. Which patellae are likely to redislocate? Knee Surg Sports Traumatol Arthrosc 2014; 22(10):2308–2314
21 Dejour H, Walch G, Nove-Josserand L, Guier C. Factors of patellar instability: an anatomic radiographic study. Knee Surg Sports Traumatol Arthrosc 1994;2(01):19–26
22 Santos Netto A, Brito MB, Severino FR, et al. Estudo da articulação patelofemoral por ressonância magnética: a variação da morfologia do ligamento patelofemoral medial. Rev Bras Ortop 2012;47 (02):204–209
23 Christensen TC, Sanders TL, Pareek A, Mohan R, Dahm DL, Krych AJ. Risk Factors and Time to Recurrent Ipsilateral and Contralateral Patellar Dislocations. Am J Sports Med 2017;45(09): 2105–2110
24 Sanders TL, Pareek A, Hewett TE, Stuart MJ, Dahm DL, Krych AJ. High rate of recurrent patellar dislocation in skeletally immature patients: a long-term population-based study. Knee Surg Sports Traumatol Arthrosc 2018;26(04):1037–1043
25 Sanders TL, Pareek A, Johnson NR, Stuart MJ, Dahm DL, Krych AJ. Patellofemoral Arthritis After Lateral Patellar Dislocation: A Matched Population-Based Analysis. Am J Sports Med 2017;45 (05):1012–1017
26 Lee DY, Park YJ, Song SY, Hwang SC, Park JS, Kang DG. Which Technique Is Better for Treating Patellar Dislocation? A Systematic Review and Meta-analysis. Arthroscopy 2018;34(11):3082–3093. e1
27 Souza PME, Gabetto MSS, Serrão MG, Vieira LAM, Oliveira DC. Patellofemoral Instability: Evaluation by Magnetic Resonance Imaging. Rev Bras Ortop 2013;48(02):159–164
28 Insall J, Salvati E. Patella position in the normal knee joint. Radiology 1971;101(01):101–104
29 Blackburne JS, Peel TE. A new method of measuring patellar height. J Bone Joint Surg Br 1977;59(02):241–242
30 Caton J. [Method of measuring the height of the patella]. Acta Orthop Belg 1989;55(03):385–386
31 Portner O, Pakzad H. The evaluation of patellar height: a simple method. J Bone Joint Surg Am 2011;93(01):73–80
32 Haj-Mirzaian A, Thawait GK, Tanaka MJ, Demehri S. Diagnosis and Characterization of Patellofemoral Instability: Review of Available Imaging Modalities. Sports Med Arthrosc Rev 2017;25(02):64–71
33 Koh JL, Stewart C. Patellar instability. Orthop Clin North Am 2015; 46(01):147–157
34 Lewallen LW, McIntosh AL, Dahm DL. Predictors of recurrent instability after acute patellofemoral dislocation in pediatric and adolescent patients. Am J Sports Med 2013;41(03):575–581
35 Yang F, Guo W, Wang Q, et al. Surgical versus nonsurgical treatment of primary acute patellar dislocation: A systematic review and meta-analysis. Medicine (Baltimore) 2019;98(29): e16338
36 Longo UG, Ciuffreda M, Locher J, Berton A, Salvatore G, Denaro V. Treatment of Primary Acute Patellar Dislocation: Systematic Review and Quantitative Synthesis of the Literature. Clin J Sport Med 2017;27(06):511–523
37 Dolak KL, Silkman C, Medina McKeon J, Hosey RG, Lattermann C, Uhl TL. Hip strengthening prior to functional exercises reduces pain sooner than quadriceps strengthening in females with patellofemoral pain syndrome: a randomized clinical trial. J Orthop Sports Phys Ther 2011;41(08):560–570
38 Cowan SM, Bennell KL, Crossley KM, Hodges PW, McConnell J. Physical therapy alters recruitment of the vasti in patellofemoral pain syndrome. Med Sci Sports Exerc 2002;34(12):1879–1885
39 Longo UG, Berton A, Salvatore G, et al. Medial Patellofemoral Ligament Reconstruction Combined With Bony Procedures for Patellar Instability: Current Indications, Outcomes, and Complications. Arthroscopy 2016;32(07):1421–1427
40 Dejour D, Le Coultre B. Osteotomies in Patello-Femoral Instabilities. Sports Med Arthrosc Rev 2018;26(01):8–15
41 Fonseca LPRMD, Kawatake EH, Pochini AC. Lateral patellar retinacular release: changes over the last ten years. Rev Bras Ortop 2017;52(04):442–449
42 Baumann CA, Pratte EL, Sherman SL, Arendt EA, Hinckel BB. Reconstruction of the medial patellotibial ligament results in favorable clinical outcomes: a systematic review. Knee Surg Sports Traumatol Arthrosc 2018;26(10):2920–2933
43 Buchanan G, Torres L, Czarkowski B, Giangarra CE. current concepts in the treatment of gross patellofemoral instability. Int J Sports Phys Ther 2016;11(06):867–876
44 Patel NK, de Sa D, Vaswani R, Kay J, Musahl V, Lesniak BP. Knee Flexion Angle During Graft Fixation for Medial Patellofemoral Ligament Reconstruction: A Systematic Review of Outcomes and Complications. Arthroscopy 2019;35(06):1893–1904
45 Kang H, Zheng R, Dai Y, Lu J, Wang F. Single- and double-bundle medial patellofemoral ligament reconstruction procedures result in similar recurrent dislocation rates and improvements in knee function: a systematic review. Knee Surg Sports Traumatol Arthrosc 2019;27(03):827–836

46 Sadigursky D, de Melo Laranjeira SM, Nunes M, Caneiro RJ, Colavolpe PO. Reconstruction of the medial patellofemoral ligament by means of the anatomical double-bundle technique using metal anchors. Rev Bras Ortop 2016;51(03):290–297
47 Shamrock AG, Day MA, Duchman KR, Glass N, Westermann RW. Medial Patellofemoral Ligament Reconstruction in Skeletally Immature Patients: A Systematic Review and Meta-analysis. Orthop J Sports Med 2019;7(07):2325967119855023
48 Fulkerson JP. Anteromedialization of the tibial tuberosity for patellofemoral malalignment. Clin Orthop Relat Res 1983;(177): 176–181
49 Longo UG, Rizzello G, Ciuffreda M, et al. Elmslie-Trillat, Maquet, Fulkerson, Roux Goldthwait, and Other Distal Realignment Procedures for the Management of Patellar Dislocation: Systematic Review and Quantitative Synthesis of the Literature. Arthroscopy 2016;32(05):929–943
50 Nolan JE III, Schottel PC, Endres NK. Trochleoplasty: Indications and Technique. Curr Rev Musculoskelet Med 2018;11(02): 231–240
51 Carstensen SE, Menzer HM, Diduch DR. Patellar Instability: When is Trochleoplasty Necessary? Sports Med Arthrosc Rev 2017;25 (02):92–99
52 Banke IJ, Kohn LM, Meidinger G, et al. Combined trochleoplasty and MPFL reconstruction for treatment of chronic patellofemoral instability: a prospective minimum 2-year follow-up study. Knee Surg Sports Traumatol Arthrosc 2014;22(11):2591–2598
53 LaPrade RF, Cram TR, James EW, Rasmussen MT. Trochlear dysplasia and the role of trochleoplasty. Clin Sports Med 2014; 33(03):531–545
54 Zhang X, Attenello J, Safran MR, Lowenberg DW. Congenital internal rotation deformity of the distal femur presenting as patellofemoral instability and pain. J ISAKOS 2019;4:93–97

Brazilian authors don't cite Brazilian authors: Nothing has changed since 1994*

Os Autores brasileiros não citam os autores brasileiros: Nada mudou desde 1994

Vincenzo Giordano[1,2] Juliana Lyra[3] João Artur Bonadiman[4] Osvandré Lech[5]

[1] Orthopedics and Traumatology Service Prof. Nova Monteiro, Hospital Municipal Miguel Couto, Rio de Janeiro, RJ, Brazil
[2] Clínica São Vicente, Rede D'or São Luiz, Rio de Janeiro, RJ, Brazil
[3] Orthopedics and Traumatology Program, Orthopedics and Traumatology Service Prof. Nova Monteiro, Hospital Municipal Miguel Couto, Rio de Janeiro, RJ, Brazil
[4] Orthopedics and Traumatology Institute, Hospital São Vicente de Paulo, Passo Fundo, RS, Brazil
[5] Shoulder and Elbow Surgery Service, Orthopedics and Traumatology Institute, Hospital São Vicente de Paulo, Passo Fundo, RS, Brazil

Address for correspondence Vincenzo Giordano, Rua Mário Ribeiro, 117/2° floor, Leblon, 22430-160, Rio de Janeiro, RJ, Brazil (e-mail: v_giordano@me.com).

Rev Bras Ortop 2021;56(2):154–160.

Abstract

Objective To outline the profile of self-citations from Revista Brasileira de Ortopedia (Rev Bras Ortop) and citations of this journal in other medical orthopaedic journals with general or specific content in a knowledge area of the specialty.

Methods This is an observational cross-sectional study of the frequency of self-citations and citations from Rev Bras Ortop in five other medical orthopaedic journals from different countries, all published in English. The last 15 articles published in 2020 in each of the six journals were analyzed. The references used in each of them were evaluated to identify the journal in which they were originally published. The frequency of distribution of the four main journals cited, their position, and the relative percentage to the total number of citations were observed and recorded in each of the six journals. The number of times that the Rev Bras Ortop was cited in each of the selected foreign journals was assessed using its absolute and relative frequencies.

Results The total number of citations evaluated in this study was 2,527 (ranging from 386 to 486 per magazine). Rev Bras Ortop showed a low rate of self-citation (2.6%), being the sixth journal cited in the journal itself (10 out of a total of 386 references).

Keywords
- journal article
- journal impact factor
- peer review
- research
- database

* Work developed by the Department of Orthopedics and Traumatology Prof. Nova Monteiro, Hospital Municipal Miguel Couto, Rio de Janeiro, RJ and Hospital São Vicente de Paulo, Institute of Orthopedics and Traumatology, Passo Fundo, RS, Brazil.

received
February 7, 2021
accepted
February 19, 2021

DOI https://doi.org/10.1055/s-0041-1728702.
ISSN 0102-3616.

Thieme Revinter Publicações Ltda., Rua do Matoso 170, Rio de Janeiro, RJ, CEP 20270-135, Brazil

Moreover, Rev Bras Ortop was not mentioned in any of the other five medical journals included in the study (absolute frequency 0, relative frequency 0).
Conclusion Rev Bras Ortop has a low reference of itself, with a self-citation rate of 2.6% in the studied period, showing that the Brazilian orthopaedic surgeons do not mention the Brazilian orthopaedic surgeon who publishes in the journal. We suggest the elaboration and implementation of strong strategies to improve the journal's visibility in the world academic-scientific scenario. In addition, it is essential that Brazilian orthopaedic surgeons understand this reality and assist directly and effectively to change this scenario.

Resumo

Objetivo Observar o perfil de autocitações da Revista Brasileira de Ortopedia (Rev Bras Ortop) e de citações deste periódico em outras revistas médicas de ortopedia de conteúdo geral ou específico de uma determinada área de conhecimento da especialidade.
Métodos Trata-se de estudo observacional transversal da frequência de autocitações e citações da Rev Bras Ortop em outros cinco periódicos médicos de ortopedia de diferentes países, todas publicadas em língua inglesa. Foram analisados os 15 últimos artigos publicados em 2020 em cada uma das seis revistas estudadas. As referências usadas em cada um delas foi avaliada para identificação do periódico em que foram publicadas originalmente. A distribuição de frequência dos quatro principais periódicos citados, sua posição e o percentual relativo ao total de citações foram observados e registrados em cada uma das seis revistas. O número de vezes em que a Rev Bras Ortop foi citada em cada um dos periódicos estrangeiros selecionados foi avaliado por meio de suas frequências absoluta e relativa.
Resultados O total de citações avaliadas neste estudo foi de 2527 (variando de 386 a 486 por revista). A Rev Bras Ortop apresentou baixa taxa de autocitação (2,6%), sendo citada na própria revista na sexta posição (10 de um total de 386 referências). No período estudado, a Rev Bras Ortop não foi citada em nenhum dos outros cinco periódicos médicos incluídos no estudo (frequência absoluta 0, frequência relativa 0).
Conclusão Observou-se que a Rev Bras Ortop apresenta baixa referência de si própria, com taxa de autocitação de 2,6% no período estudado, mostrando que de fato o ortopedista brasileiro não cita o ortopedista brasileiro que publica na revista. Sugerimos a elaboração e a implementação de estratégias fortes de melhora da visibilidade do periódico no cenário acadêmico-científico mundial. Além disso, é fundamental que os ortopedistas brasileiros entendam esta realidade e auxiliem direta e efetivamente em sua mudança.

Palavras-chave
- artigo de revista
- fator de impacto de revistas
- revisão da pesquisa por pares
- base de dados

Introduction

Researching, writing, and disseminating the findings of scientific research are important means of communication in the academic environment.[1] In general, the role of publication has both academic function of informing and communicating the results of the research, and professional function, democratically providing a structured area for the debate of the study findings.[1,2] In this context, the main function of medical journals is to transmit information that improves health care, publishing scientific articles that focus on issues of great relevance in health practice.[3] However, despite the growing number of scientific publications, allowing to reach a wider audience of readers, the authors face an unprecedented challenge when selecting which journal is the ideal journal to publish their research.[3–5]

In this difficult decision-making, the impact factor (IF) of the journal has been one of the most widely used factors to evaluate its quality, importance, and penetration in the academic environment.[6,7] The IF is calculated by dividing the number of citations of a journal in the Journal Citation Reports (JCR) in one year by the total number of articles published in the same discipline in the journal evaluated in the previous two years.[8] Some authors have suggested the choice of scientific journals owned by an association of health professionals or publications that allow free access to the reader, potentially increasing the visibility of the study.[9,10]

In Brazil, Revista Brasileira de Ortopedia (Rev Bras Ortop) is the scientific publishing body of Sociedade Brasileira de Ortopedia e Treaumatologia (SBOT).[11] The journal does not receive funding money from funding agencies and is fully supported by SBOT, without charging a fee for submission and publication of its articles. Since 2009 it is indexed in PubMed, PubMed Central, Scopus, SciELO (Scientific Electronic Library On-Line) and LILACS (Latin American Literature in Health Sciences) databases, ensuring good visibility in the world orthopedic scenario. Nevertheless, Lech, in an editorial published in the journal itself in 1994, drew attention to the fact that national authors do not mention national authors, demonstrated by the low rate of self-citation within the journal.[12] Among the causes pointed out, we highlight the need to use international references to "confer veracity" to the study and the phenomena of "third-worldism" and "implicit competition" among the authors.

Interestingly, despite having increased its exposure in databases of excellence in medical research, since 1994 little has changed in this poor scenario of citations of the journal itself.[13] But do Brazilian authors actually mention less the journal of their professional association than foreign authors do for their societies or medical associations? Our hypothesis is that little has changed since 1994, keeping the journal's number of self-citations low. The aim of this study is to observe the profile of self-citations of Rev Bras Ortop and citations of this journal in other medical journals of orthopedics.

Material and Methods

This is a cross-sectional observational study of the frequency of self-citations and citations of Rev Bras Ortop in other orthopedic medical journals. In addition to Rev Bras Ortop, four other magazines of general scope were chosen within the specialty (*The Journal of Bone & Joint Surg American* [J Bone Joint Surg Am], *Bone & Joint Journal* [Bone Joint J], *Acta Orthopaedica et Traumatologica Turcica* [Acta Orthop Traumatol Turc] and *Der Unfallchirurgie* [Unfallchirurg]) and a journal specific to a knowledge area (*Journal of Shoulder & Elbow Surgery* [J Shoulder Elbow Surg]).

J Bone Joint Surg Am is a peer-reviewed fortnightly medical journal published by *The Journal of Bone and Joint Surgery, Inc.* (Massachusetts, USA). It is indexed in PubMed, Scopus, CrossRef, Portico and Web of Science, with 4.57 IF 2019.[14] Bone Joint J, formerly known as *The Journal of Bone & Joint Surgery British,* is a monthly peer-reviewed medical journal published by *The British Editorial Society of Bone & Joint Surgery* (London, United Kingdom). It is indexed in PubMed, with 4.30 IF 2019.[15] Acta Orthop Traumatol Turc is the official journal of the Turkish Association of Orthopedis and Traumatology (*Türk Ortopedi ve Travmatoloji Derneği* - TOTDER) and the Turkish Society of Orthopedics and Traumatology (*Türk Orthopedi ve Travmatoloji Birliği Derneği* - TOTBID). It is a peer-reviewed open-access scientific journal published bimonthly in English. It is indexed in the *Science Citation Index Expanded*, PubMed, PubMed Central, Scopus, DOAJ, Index Copernicus and TUBITAK ULAKBIM TR Index, with 1.21 IF 2019.[16] Unfallchirurg is the official medical journal of the German Society of Trauma Surgery (*Deutschen Gesellschaft für Unfallchirurgie*), of monthly periodicity, offering some open access articles and others only by subscription. The articles are peer-reviewed and originally published in German, with abstract in English. It is indexed in the *Science Citation Index* (SCI) *Expanded,* PubMed, EMBASE and Scopus, with 0.67 IF 2019.[17] J Shoulder Elbow Surg is the official publication of several medical societies, including *Sociedad Latinoamericana de Hombro y Codo*. It has monthly periodicity, and its articles are peer reviewed. It offers open access articles and other articles by subscription only. It is indexed in PubMed, EMBASE and Scopus, with 2.81 IF 2019.[18] ►**Table 1** provides information from selected journals.

The last 15 articles published in 2020 were selected in each of the six journals. All references were evaluated to identify the journal in which they were originally published. The distribution of punctual frequency of the four main journals mentioned, their position and the percentage relative to the total number of citations were observed in each of the journals. The number of times Rev Bras Ortop was mentioned in each of the selected journals was evaluated using its absolute and relative frequencies.

Results

The total number of citations in this study was 2527, ranging from 386 (Rev Bras Ortop) to 486 (J Shoulder Elbow Surg) per journal. Three journals presented high frequency and three journals presented low sel-citation frequency. It was observed that The J Shoulder Elbow Surg, Bone Joint J and J Bone Joint Surg Am present firstly citations of themselves, with 22.2%, 13.7% and 11.9% of the citations, respectively, in relation to the total researched in the journal. Rev Bras Ortop, Acta Orthop Traumatol Turc and Unfallchirurg presented low self-references, with 2.6%, 1.0% and 2.2% of citations, respectively, in relation to the total surveyed in the journal. Acta Orthop Traumatol Turc cited itself four times in a total of 391 references and Unfallchirurg 10 times out of a total of 456 referrals. Rev Bras Ortop is sel-f-mentioned in the sixth position (10 out of a total of 386 references used during the study period), however it was not mentioned in any of the other five medical journals included in the study (absolute frequency 0, relative frequency 0).

►**Table 2** shows the six orthopedic journals analyzed in the study, with its four main citations, in addition to the number of times Rev Bras Ortop was mentioned in each of the journals.

Discussion

It was observed that, in general, there is a low frequency of rev bras ortop citations both in the journal itself and in the other journals researched in this study. In the evaluation of the last 15 articles published in Rev Bras Ortop in 2020, only 10 were from the journal itself, while in the other five journals included in the study the journal was not mentioned at all. The magnitude of the problem is enormous, since it is the main vehicle for disseminating scientific evidence of

Table 1 Information from orthopedic medical journals used in the study

Main Journal	Who publishes	Periodicity	Indexing	IF 2019
Rev Bras Ortop	SBOT	Monthly	PubMed, PubMed Central, Scopus, SciELO and LILACS	0.69
J Bone Joint Surg Am	The Journal of Bone and Joint Surgery, Inc.	Biweekly	PubMed, Scopus, CrossRef, Portico and Web of Science	4.57
Bone Joint J	The British Editorial Society of Bone & Joint Surgery	Monthly	Pubmed	4.30
Acta Orthop Traumatol Turc	TOTDER / TOTBID	Bimonthly	Science Citation Index Expanded, PubMed, PubMed Central, Scopus, DOAJ, Index Copernicus and TUBITAK ULAKBIM TR Index	1.21
Unfallchirurg	Deutschen Gesellschaft für Unfallchirurgie	Monthly	Science Citation Index Expanded, PubMed, EMBASE and Scopus	0.67
J Shoulder Elbow Surg	Various medical specialty societies [#]	Monthly	PubMed, EMBASE and Scopus	2.81

Abbreviations: IF, impact factor.
Source: SOT Prof. Nova Monteiro–Hospital Municipal Miguel Couto / IOT Passo Fundo, 2021.
Labels:
Rev Bras Ortop – Revista Brasileira de Ortopedia
J Bone Joint Surg Am – The Journal of Bone & Joint Surgery American
Bone Joint J – The Bone & Joint Journal
Acta Orthop Traumatol Turc – Acta Orthopaedica et Traumatologica Turcica
Unfallchirurg – Der Unfallchirurgie
J Shoulder Elbow Surg – The Journal of Shoulder & Elbow Surgery
SBOT – Sociedade Brasileira de Ortopedia e Traumatologia
TOTDER – Türk Ortopedi ve Travmatoloji Derneği
TOTBID – Türk Ortopedi ve Travmatoloji Birliği Derneği
[#]– American Shoulder and Elbow Surgeons, European Society for Surgery of Shoulder and Elbow, Japan Shoulder Society, Shoulder and Elbow Society of Australia, Sociedad Latinoamericana de Hombro y Codo, South African Shoulder and Elbow Surgeons, Asian Shoulder Association, Korean Shoulder and Elbow Society, International Congress of Shoulder and Elbow Surgery e American Society of Shoulder and Elbow Therapists.

Brazilian orthopedists. Although it was not our objective to evaluate the reasons that lead the Brazilian orthopedist to cite their own journal so little, our findings suggest the need to elaborate and implement strategies to encourage the citation of their scientific journal.

There are two ways to deal with this sad reality. One of them is, in a simplistic way, to seek a "culprit," whether this is the "third-worldist" phenomenon, the search for a "good" foreign periodical or the Brazilian orthopedists themselves cious of "their" discovery. However, it should be in mind that there is no reliable list of good and bad journals, and that the sharing of evidence through scientific publications contributes greatly to minimizing the importance of borders and contributing to the use of evidence in the global health field.[1,5] In addition, there is no "local" or "very specific" knowledge that is not of interest to any medical journal that seeks quality and transparency.[19]

The other way to deal with the problem of Rev Bras Ortop's low self-citation is to improve its reputation, which includes indexing in more bibliographic databases, the perception of "prestige" of the journal and the increase of its IF, widely used in the selection of which journal to send the scientific study.[2,3,20,21] It is interesting to note that of the three journals with the highest number of self-citations, the lowest IF 2019 is 2.81,[18] while the highest IF 2019 of the journals with the lowest number of self-citations is 1.21.[16] Currently Rev Bras Ortop's FI 2019 is 0.69.[11] Interestingly, of the three journals of lesser self-citation, all are of official organs of their medical specialty societies. Despite the potential increase in the visibility of the study among a greater number of professionals in the field when it is published in the journal of their own professional medical association,[9,10] Morley and Urquhart[2] observed that this link was pointed out as of low importance among professionals of a university hospital of the United Kingdom's National Health System.

Although IF is is an important criterion for choosing which journal to submit a scientific study, several authors have pointed out limitations in its use, especially for incorrect manipulation and application of self-citations.[7,8,22] Moreover, its usefulness does not extend to individual articles, suggesting that there is objectively no correlation between the frequency of citation of an individual article and the IF of a given publication.[19,22,23] Finally, it is important to note that the IF does not reflect the quality and transparency in the peer review process to which a journal submits its articles.[3,5,24] In the study by Morley and Urquhart,[2] peer review was considered a very important factor in the choice of journal for publication. Reputable journals should fully disclose their peer review process in printed content or on their official Website, and their reviewers should understand the importance of their work in legitimizing publication.[5,24–26] The lack of peer review leads to unethical practices such as plutogism, publication of unscientific falsified data, and unsafe clinical practices.[25] In 2018, more than 42,000 academic journals

Table 2 Main citations in the six orthopedic journals included in the study

Main Journals	Main citations	Position	Absolute frequency	Frequency relative to total citations (%)
Rev Bras Ortop				
Total citations searched: 386	Knee Surg Sports Traumatol Arthrosc	First	90	23.3
	Am J Sports Med	Second	29	7.5
	J Bone Joint Surg Am	Third	28	7.3
	Spine	4th	20	5.2
	Rev Bras Ortop – ***self-cit***	6th	10	2.6
	PARTIAL TOTAL		177	45.9
J Bone Joint Surg Am				
Total citations searched: 420	J Bone Joint Surg Am - ***self-cit***	First	50	11.9
	Clin Orthop Rel Res	Second	28	6.7
	Am J Sports Med	Third	22	5.2.
	J Arthroplasty	4th	17	4.0
	Rev Bras Ortop	N/C	0	0
	PARTIAL TOTAL		117	27.9
Bone Joint J				
Total citations searched: 388	Bone Joint J - ***self-cit***	First	53	13.7
	J Bone Joint Surg Am	Second	44	11.3
	Spine	Third	34	8.8
	Clin Orthop Rel Res	4th	16	4.1
	Rev Bras Ortop	N/C	0	0
	PARTIAL TOTAL		147	37.9
Acta Orthop Traumatol Turc				
Total citations searched: 391	J Bone Joint Surg Am	First	24	6.1
	Clin Orthop Rel Res	Second	23	5.9
	J Hand Surg Am	Third	17	4.3
	J Shoulder Elbow Surg	4th	15	3.8
	Acta Orthop Traumatol Turc - ***self-cit***	19th	4	1.0
	Rev Bras Ortop	N/C	0	0
	PARTIAL TOTAL		83	21.2
Unfallchirurg				
Total citations searched: 456	Am J Sports Med	First	33	7.2
	J Bone Joint Surg Am	Second	27	5.9
	J Shoulder Elbow Surg	Second	27	5.9
	Bone Joint J	4th	15	3.3
	Unfallchirurg - ***self-cit***	6th	10	2.2
	Rev Bras Ortop	N/C	0	0
	PARTIAL TOTAL		112	24.6
J Shoulder Elbow Surg				
Total citations searched: 486	J Shoulder Elbow Surg - ***self-cit***	First	108	22.2
	J Bone Joint Surg Am	Second	49	10.1
	Arthroscopy	Second	19	3.9
	Am J Sports Med	4th	18	3.70
	Rev Bras Ortop	N/C	0	39.9
	PARTIAL TOTAL		194	

Abbreviation: N/C, not cited.
Source: SOT Prof. Nova Monteiro–Hospital Municipal Miguel Couto / IOT Passo Fundo, 2021.
Subtitles:
Rev Bras Ortop – Revista Brasileira de Ortopedia
J Bone Joint Surg Am – The Journal of Bone & Joint Surgery American
Bone Joint J – The Bone & Joint Journal
Acta Orthop Traumatol Turc – Acta Orthopaedica et Traumatologica Turcica
Unfallchirurg – Der Unfallchirurgie
J Shoulder Elbow Surg – The Journal of Shoulder & Elbow Surgery
Knee Surg Sports Traumatol Arthrosc – Knee Surgery, Sports Traumatology, Arthoscopy
Am J Sports Med – The American Journal of Sports Medicine
Clin Orthop Rel Res – Clinical Orthopaedics and Related Research
J Arthroplasty – The Journal of Arthroplasty
J Hand Surg Am – The Journal of Hand Surgery American volume

reviewed by active peers were published, with an accelerated growth of more than 5% in recent years.[27]

The influence of Latin American studies in the orthopedic literature has been limited, with a small number of publications conducted in the region.[28,29] In 2014, Latin American countries produced only 1% of all published orthopedic articles.[29] Of the 50 most cited articles, 20 were by Brazilian authors, but no national journal was used as a reference. In this context, what is necessary for Brazilian orthopedists to recognize the importance of Rev Bras Ortop and choose it to publish their studies? Moreover, how to motivate the citation to the national authors who publish in the journal? Understanding the characteristics that make the articles cited by other scientists can help researchers, institutions and governments promote quality research that could become more influential to the international orthopedic scientific community.[29]

This challenge does not seem to be exclusive to Rev Bras Ortop. In our study, we observed that of the four journals published by their professional specialty associations, only Bone Joint J self-cited first. Certainly, this finding reflects the diversity of subjects covered by Bone Joint J, but also its reputation and credibility built over years. Chomsky-Higgins et al.[28] highlighted the need for strong policies to encourage scientific production, such as support for multicenter projects and clinical studies that benefit the local population, encouraging residents and young orthopedists to produce quality research and improvement of hospital infrastructure. Thus, as the largest professional and educational entity of Brazilian orthopedics, SBOT needs to foster training and obtain the necessary funding to develop national data that can be published in its own journal, increasing the visibility of Brazilian research and researchers on the world stage. In parallel, there is a need for this and other professional medical associations to act with government institutions, such as CAPES, in order to reduce bureaucratic pressure, characterized by arbitrary elevation of cutting levels for financing purposes, which leads national authors to try to publish their manuscripts in journals with higher IF in their field of research, instead of seeking a Brazilian journal, such as Rev Bras Ortop.[30]

Among the limitations of the study, we highlight mainly the short period of data collection (last 15 articles published in 2020) and the lack of investigation of the reasons that lead the Brazilian orthopedist to cite so little of their own journal. Because this is a cross-sectional observational study, we examined the self-citation rate at a given time, evaluating the strength of the relationship between the exposure factor and bibliometric variables taken into account in scientific journals, such as IF, peer review and main editorial source. Cross-sectional studies are known to have an inherent temporal dimension, as they verify the prevalence of the exposure factor at present time.[31] Thus, we observed that Rev Bras Ortop showed a low self-citation rate, suggesting the need to implement specific strategies to reverse the current scenario. Understanding the reasons for the low self-citation rate is fundamental, but the fact that this was not the focus of the present study does not make it impossible to take actions that improve the visibility of the main scientific publication of SBOT.

Conclusion

It was observed that Revista Brasileira de Ortopedia has a low self-citation rate, showing that Brazilian orthopedists do not mention Brazilian orthopedists who publish in the journal. We suggest the development and implementation of strong strategies to improve the visibility of the journal in the world academic-scientific scenario. It is essential that Brazilian orthopedists understand this reality and help directly and effectively in their change.

Conflict of Interest

The authors declare that there is no conflict of interest.

References

1 Asnake M. The importance of scientific publication in the development of public health. Cien Saude Colet 2015;20(07):1972–1973
2 Morley P, Urquhart C. Publishing trends in medical journal literature: the views of medical staff in an NHS teaching hospital in the United Kingdom. Health Info Libr J 2004;21 (02):121–124
3 Hudzik B. What makes a good medical journal great? CMAJ 2016; 188(07):531
4 Garba S, Ahmed A, Mai A, Makama G, Odigie V. Proliferations of scientific medical journals: a burden or a blessing. Oman Med J 2010;25(04):311–314
5 Suiter AM, Sarli CC. Selecting a journal for publication: criteria to consider. Mo Med 2019;116(06):461–465
6 Not-so-deep impact. Nature 2005;435(7045):1003–1004
7 Sundaram K, Warren J, Anis HK, Klika AK, Piuzzi NS. Publication integrity in orthopaedic journals: the self-citation in orthopaedic research (SCOR) threshold. Eur J Orthop Surg Traumatol 2020;30 (04):629–635
8 Garfield E. The history and meaning of the journal impact factor. JAMA 2006;295(01):90–93
9 Björk BC, Solomon D. Open access versus subscription journals: a comparison of scientific impact. BMC Med 2012;10:73
10 Suzuki K, Edelson A, Iversen LL, Hausmann L, Schulz JB, Turner AJ. A learned society's perspective on publishing. J Neurochem 2016; 139(Suppl 2):17–23
11 Revista Brasileira de Ortopedia. [Last accessed in January 2021] from https://www.scielo.br/revistas/rbort/iaboutj.htm
12 Lech O. Os autores brasileiros não citam os autores brasileiros. [Editorial]Rev Bras Ortop 1994;29(09):
13 Lech O. Autores nacionais não citam os autores nacionais–parte 2. Comunicação Pessoal; 2020
14 The Journal of Bone & Joint Surgery. [Last accessed in January 2021] from https://www.ovid.com/product-details.11933.html
15 The Bone & Joint Journal. [Last accessed in January 2021] from: https://online.boneandjoint.org.uk/journal/bjj
16 Acta Orthopaedica et Traumatologica Túrcica. [Last accessed in January 2021] from https://www.aott.org.tr/
17 Der Unfallchirurg. [Last accessed in January 2021] from https://www.springer.com/journal/113
18 Journal of Shoulder and Elbow Surgery. Last accessed in January 2021 from https://www.jshoulderelbow.org/
19 Marusić M Why physicians should publish, how easy it is, and how important it is in clinical work. Arch Oncol 2003;11(02): 59–64
20 Balhara YP. Indexed journal: What does it mean? Lung India 2012; 29(02):193

21 Seglen PO. Citation rates and journal impact factors are not suitable for evaluation of research. Acta Orthop Scand 1998;69 (03):224–229
22 Kurmis AP. Understanding the limitations of the journal impact factor. J Bone Joint Surg Am 2003;85(12):2449–2454
23 Whitehouse GH. Impact factors: facts and myths. Eur Radiol 2002; 12(04):715–717
24 Chloros GD, Giannoudis VP, Giannoudis PV. Peer-reviewing in surgical journals: revolutionize or perish? Ann Surg 2021
25 Rupp M, Anastasopoulou L, Wintermeyer E, Malhaan D, El Khassawna T, Heiss C. Predatory journals: a major threat in orthopaedic research. Int Orthop 2019;43(03):509–517
26 Smith R. The trouble with medical journals. J R Soc Med 2006;99 (03):115–119
27 Wilkinson J. How to find the right journal for your research (using actual data). [Last accessed in January 2021] from: https://clarivate.com/webofsciencegroup/article/how-to-find-the-right-journal-for-your-research-using-actual-data/
28 Chomsky-Higgins K, Miclau TA, Mackechnie MC, et al. Barriers to clinical research in Latin America. Front Public Health 2017;5:57
29 Urrutia J, Zamora T, Prada C. The fifty most cited Latin-American articles in the orthopaedic literature. Int Orthop 2014;38(08): 1723–1729
30 Metze K. Bureaucrats, researchers, editors, and the impact factor: a vicious circle that is detrimental to science. Clinics (Sao Paulo) 2010;65(10):937–940
31 Song JW, Chung KC. Observational studies: cohort and case-control studies. Plast Reconstr Surg 2010;126(06):2234–2242

Impact of the Strategies Adopted to Face the COVID-19 Pandemic in a Brazilian Reference Institute for High Complexity Surgery in Orthopedics and Traumatology*

Impacto das estratégias adotadas para enfrentar a pandemia de COVID-19 em um Instituto Brasileiro de referência em cirurgia de alta complexidade em Ortopedia e Traumatologia

Geraldo da Rocha Motta Filho[1] Ana Carolina Leal[2] Marcus Vinicius Galvão do Amaral[3] Phelippe Augusto Valente Maia[4] Maria Eugênia Leite Duarte[2] Germana Lyra Bähr[5]

[1] Division of Teaching and Research, Instituto Nacional de Traumatologia e Ortopedia, Rio de Janeiro, RJ, Brazil
[2] Teaching and Research Division, Instituto Nacional de Traumatologia e Ortopedia, Rio de Janeiro, RJ, Brazil
[3] Division of Orthopedics and Traumatology, Instituto Nacional de Traumatologia e Ortopedia, Rio de Janeiro, RJ, Brazil
[4] Hospital Unit, Instituto Nacional de Traumatologia e Ortopedia, Rio de Janeiro, RJ, Brazil
[5] Special Programs, Instituto Nacional de Traumatologia e Ortopedia, Rio de Janeiro, RJ, Brazil

Address for correspondence Geraldo da Rocha Motta Filho, MD, MSc, Rua Raimundo de Magalhães, 92, Rio de Janeiro, RJ, 22451-150, Brazil (e-mail: geraldomotta@terra.com.br).

Rev Bras Ortop 2021;56(2):161–167.

Abstract

COVID-19 pandemics required substantial reorganization and adaptation of healthcare services all over the world. This study aims to analyze the effect of operational strategies implemented in Brazil to manage the extra strain placed on healthcare services by the COVID-19 pandemic of 2020. In particular, this investigation examines the strategy to convert an institute specialized in elective orthopedic procedures of high complexity into a trauma unit for all musculoskeletal trauma patients of an entire federative unit. A retrospective study was conducted comparing hospital variables at the peak period of the pandemic (from March 16, 2020 to June 30, 2020) with the same period in 2019 as a comparative baseline. The variables analyzed included number of professionals away from work, surgeries performed, outpatient care, transfers, length

Keywords
- COVID-19
- coronavirus
- SARS-CoV-2
- trauma
- orthopedics
- surgery

* Work developed at the Teaching and Research Division, National Institute of Traumatology and Orthopedics, Rio de Janeiro, RJ, Brazil.

received
December 16, 2020
accepted
February 11, 2021

DOI https://doi.org/10.1055/s-0041-1728703.
ISSN 0102-3616.

Thieme Revinter Publicações Ltda., Rua do Matoso 170, Rio de Janeiro, RJ, CEP 20270-135, Brazil

of stay, number of patients diagnosed with COVID-19 and patient mortality. During the COVID-19 peak period, there was a 48.5% reduction in surgical productivity and 72.4% reduction in outpatient care compared with the same period in 2019. The number of transfers increased substantially (124.5%), while 94 confirmed cases and 77 suspected cases of COVID-19 were reported. The mortality rate increased by 245%. The present study highlighted the effect of COVID-19 on a tertiary orthopedic hospital. Despite the dramatic changes in hospital operations, due to the implementation of protocols to manage the pandemic, the results demonstrated the feasibility and efficiency of such protocols in prioritizing quality and safety for patients and the healthcare workforce.

Resumo

A pandemia de COVID-19 exigiu reorganização e adaptação substanciais dos serviços de saúde em todo o mundo. Este estudo tem como objetivo analisar o efeito das estratégias operacionais implementadas no Brasil em resposta à pressão extra imposta aos serviços de saúde pela pandemia de COVID-19 de 2020. Esta pesquisa examina principalmente a estratégia de conversão de um instituto especializado em procedimentos ortopédicos eletivos de alta complexidade em uma unidade de trauma para todos os pacientes com traumatismo musculoesquelético de toda uma unidade federativa. Um estudo retrospectivo comparou as variáveis hospitalares no período de pico da pandemia (de 16 de março de 2020 a 30 de junho de 2020) com o mesmo período de 2019, que representou os valores basais. As variáveis analisadas foram número de profissionais afastados do trabalho, cirurgias realizadas, atendimento ambulatorial, transferências, tempo de internação, número de pacientes com diagnóstico de COVID-19 e mortalidade dos pacientes. Durante o período de pico de COVID-19, houve uma redução de 48,5% na produtividade cirúrgica e de 72,4% no atendimento ambulatorial em comparação ao mesmo período de 2019. O número de transferências aumentou de maneira substancial (124,5%), com relato de 94 casos confirmados e 77 casos suspeitos de COVID-19. A taxa de mortalidade aumentou 245%. Este estudo destacou o efeito da COVID-19 em um hospital ortopédico terciário. Apesar das mudanças dramáticas no funcionamento do hospital devido à instituição de protocolos em resposta à pandemia, os resultados demonstraram a viabilidade e a eficiência de tais protocolos em priorizar a qualidade e a segurança dos pacientes e dos profissionais de saúde.

Palavras-chave
- COVID-19
- coronavírus
- SARS-CoV-2
- trauma
- ortopedia
- cirurgia

Introduction

On March 12, 2020, the World Health Organization (WHO) declared COVID-19—the disease caused by the SARS-CoV-2 virus—a global pandemic, resulting in many changes to diverse aspects of life worldwide.[1]

In Brazil, the first case of COVID-19 was confirmed in São Paulo on February 26, 2020. Soon after, Rio de Janeiro reported its first case on March 5, 2020 and by March 17, 2020, the state was already showing community transmission of the disease, prompting the declaration of a state of emergency and the introduction of measures to contain the progress of the disease. Despite these measures, the disease spread quickly, reaching its peak in May 2020, and sustaining a high national level of new cases and deaths. At the end of June, 1 408 485 cases and 59 656 deaths had been recorded, of which 10 080 confirmed cases were from the state of Rio de Janeiro.[2] All Brazilian states experienced a period of high demand for diagnostic tests, personal protective equipment (PPE) and hospital beds in the months of April and May 2020 but this demand was met with lack, despite the construction of field hospitals for the exclusive care of patients with COVID-19.

Although orthopedics and traumatology, as a medical specialty, does not directly deal with the effects caused by SARS-CoV-2, its performance has been profoundly affected due to the suspension of elective procedures by health authorities. This measure, adopted worldwide, was motivated by the high risk of exposing patients and health professionals to the virus and by the need to allocate resources and hospital infrastructure to the treatment of pandemic victims.[3–5]

Most Brazilian states have reorganized their health services to free up beds from general and emergency hospitals to prioritize patients with COVID-19. In a particular state, this resulted in the transfer of all cases of orthopedic trauma to a

single hospital specialized in elective orthopedic procedures of high complexity.

The aim of this study is to assess the effect of the operational strategies within the context of the pandemic, specifically, in converting an institute specialized in elective orthopedic procedures of high complexity into a unit to assist patients of musculoskeletal trauma. The protocols and strategies described in the article can be readily applied to other health units, being of great use in coping with the ongoing second wave of the disease.

Methods

This retrospective study assesses the effect that the measures taken to manage the COVID-19 pandemic had on the activities of a highly-complexity orthopedic hospital in Brazil. The data were collected from information contained in the institutional data management system (MV and MV Portal) and from the minutes of meetings of the institutional' Crisis Office. This study was approved by the institutional Ethics on Research Committee.

According to the guidelines of health authorities and control bodies, elective procedures were suspended, and only oncological, orthopedic trauma and treatment for infections and postoperative complications were performed. In addition, the hospital was responsible for treating all orthopedic trauma patients in the state where it is located. To adapt to the new routine, elaborate protocols and strategies were put in place and their implementation was coordinated by the Crisis Office through virtual meetings. Decisions were communicated to the workforce through reports conveyed through WhatsApp, on institutional television sets located in areas with high staff concentration and on the intranet, which all employees had access to. The new protocols which were implemented as of March 16, 2020 involved the reorganization of institutional activities; reception and referral of transferred patients; and reorganization of surgical procedures. These areas constitute the scope of this study.

Reorganization of Institutional Activities

The actions related to the reorganization of institutional activities covered both assistance and academic activities and are summarized in ►**Table 1**.

Reception and Referral of Transferred Patients

Due to the impossibility of performing polymerase chain reaction (PCR) in naso and/or oropharynx swabs for all patients, flows and entry protocols for transferred patients had to be defined. The first group, asymptomatic patients, were accommodated in a specific area. The second group consisting of suspected COVID-19 cases (i.e., those with a history of possible contagion or influenza like symptoms) were placed in a second area with 40 beds and the third group, transferees who were admitted with a confirmed COVID-19 diagnosis, were placed in a third area (►**Fig. 1**). All symptomatic patients or those with a history of contagion underwent screening for COVID-19 through PCR. The test result was made available within 72 hours.

In addition to the three different cohorts in the hospitalization area, in the ICU, 10 exclusive isolation beds were reserved for confirmed COVID-19 patients. Between these areas, safety barriers were set up, with transition limits. Access to the floor, where the isolated area for COVID-19 patients was located, was blocked for employees who were not part of the staff selected to work in the space.

Reorganization of Surgical Procedures

Surgical procedures were performed in two different surgical centers. Asymptomatic patients were referred to the main surgical center with 18 rooms. Positive or suspected COVID-19 patients were referred to another surgical center with three operating rooms on another floor, which was completely independent of the first.

The flow of care in these units was altered with restrictions placed on the number of professionals allowed during surgery. The surgical team involved in performing the procedure was only granted access to the operating room after the end of anesthesia.

Table 1 Reorganization of institutional activities

Welfare activities	Academic activities
• Release of professionals with a high COVID-19 risk for remote work. • Reduction of outpatient care, with suspension of care for new patients. • Separation of waiting areas in outpatient units and creation of a staggered system of attendance. • Definition of an exclusive area for the care of symptomatic patients and employees. • Relocation and training of professionals to work in the most critical areas—the Intensive Care Unit (ICU), Referenced Trauma Unit, and COVID-19 areas in the wards. • Making iPads available in the ICU and wards for patients to hold virtual meetings with their families. • Elaboration of the efficient use of PPE through a manual placed at the Hospital Infection Area.	• Suspension of face-to-face activities and adoption of a remote format for activities in various areas of specialization, such as master's classes and clinical sessions. • Use of mannequins and realistic simulation to train professionals, including professionals from other health units, on intubation, ventilator management and respiratory physiotherapy for COVID-19. • Organization of scales to maintain activities in research laboratories and vivarium.

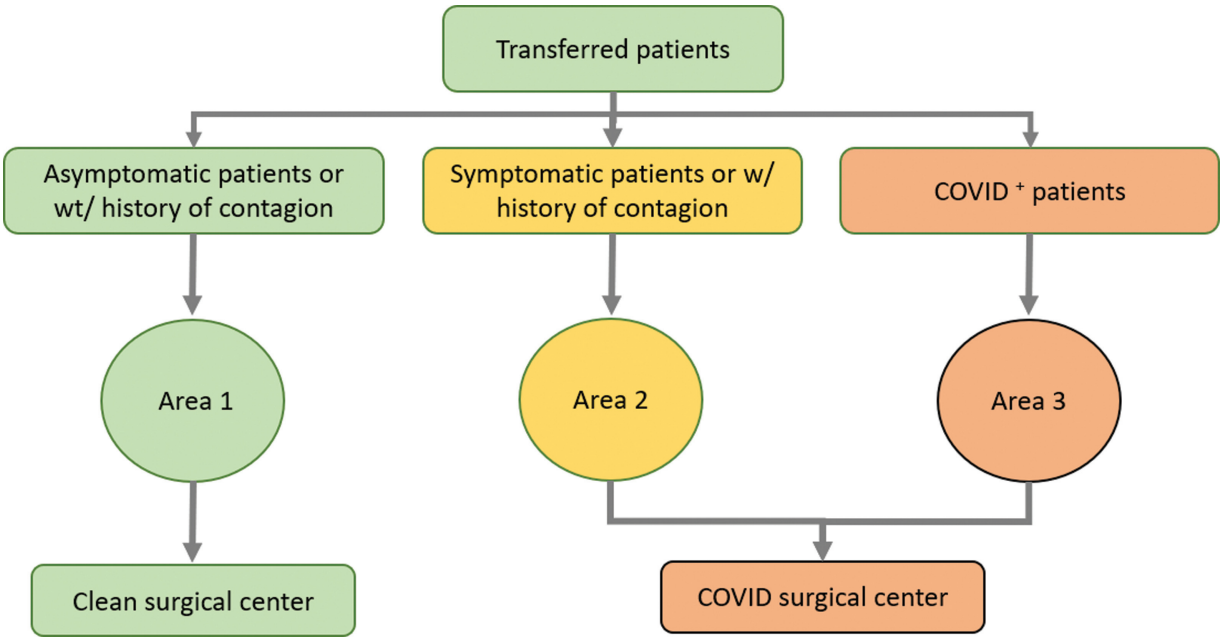

Fig. 1 Algorithm for reception and referral of transferred patients.

Data Analysis

The evaluation of the effect of the implementation of the described protocols was done by comparing hospital data from March 16, 2020 to June 30, 2020 with information from the same period in 2019. The variables analyzed were: (i) the number of professionals who were placed on leave, (ii) the number of surgeries performed, (iii) outpatient care, (iv) the number of transfers, (v) length of hospital stay, (vi) the number of patients diagnosed with COVID-19 and the origin of the infection, and (vii) the number of deaths. The criterion used to characterize the infection—as community infection or coming from another health unit—was the appearance of symptoms until the seventh day of hospitalization. After this period, the infection was classified as having been acquired at the institute.

Results

During the period studied, 231 employees—including 160 healthcare professionals—were placed on leave according to Ordinance No. 428 of the Ministry of Health, which allowed remote work for professionals over 60 years old, with chronic diseases and high-risk pregnant women.

The academic activities of stricto and lato sensu postgraduate courses were maintained, with classes, scientific meetings and dissertation defenses done through video conferences.

Comparing all data year over year (YOY), the restriction to performing elective procedures, both surgical and outpatient, resulted in a 48.5% reduction in surgical productivity (►**Fig. 2**) and in a 72.4% reduction in outpatient care compared with the same period in 2019 (►**Fig. 3**).

The new role assumed by the institute—to attend to all orthopedic trauma patients in the state in which it is located—resulted in an increase of 124.5% in the number of transfers (►**Fig. 4**). The increase in transfers was accompanied by an

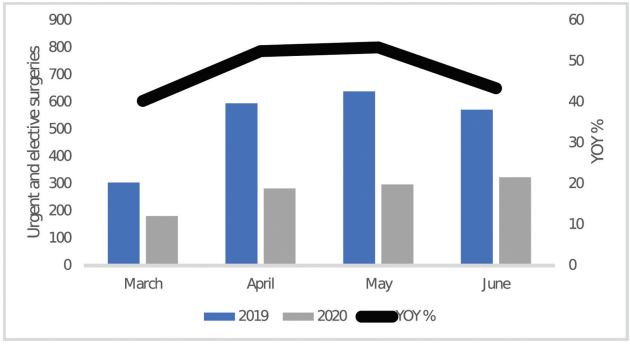

Fig. 2 Number of urgent and elective surgeries performed during the two periods evaluated. Blue: 2019. Gray: 2020. Black line: YOY%.

increase of 63% in the length of stay in April and an increase of more than 100% in May and June 2020 compared with 2019 (►**Table 2**).

The increase in the number of transfers also resulted in an increase in the number of inpatients diagnosed with COVID-19 and in cases of in-hospital contamination (►**Fig. 5**). In addition, due to the transmission of the virus among hospital professionals, there was an increase in the number of professionals on sick leave (►**Fig. 5**), which mainly affected nurses and nursing assistants in April (►**Table 3**).

In the period studied, 631 patients from other units were transferred to the institute, and 1087 surgical procedures were performed. Among the transferred patients, COVID-19 was confirmed in 94 of them, of which 46 patients had their diagnosis confirmed before transfer, 28 acquired COVID-19 at the institute, and the origin of infection could not be traced in the remaining 20 patients. In another 77 transferred patients, despite being suspected cases, a COVID-19 diagnosis was not confirmed by PCR.

In the period of this study, 38 deaths were recorded (11 in the same period of 2019), representing an increase of 245%.

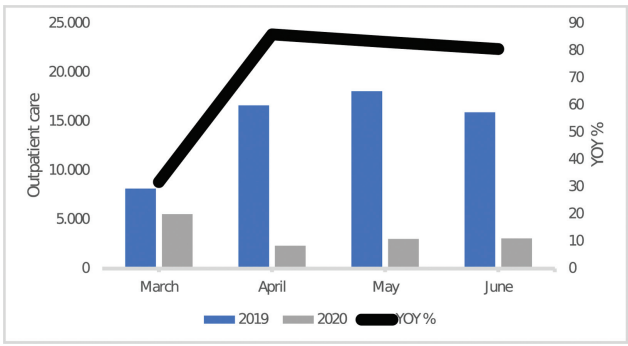

Fig. 3 Number of outpatient care performed during the two periods evaluated. Blue: 2019. Gray: 2020. Black line: YOY% .

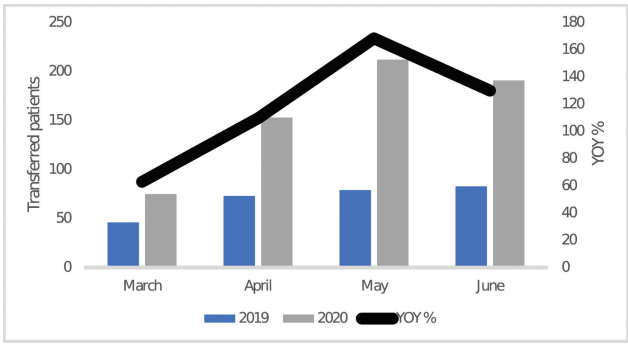

Fig. 4 Number of transferred patients in the two periods evaluated. Blue: 2019. Gray: 2020. Black line: YOY%.

Table 2 Length of hospital stay

	2019 Average number of days	2020 Average number of days	YOY % Increase / (Decrease)
March (March 16 to March 31)	8.2	8.5	3.6%
April	9.1	14.9	63.7%
May	7.8	16.3	108.9%
June	7.7	16.6	114.1%

Among the patients who died, 31 (or 81.5%) had a confirmed COVID-19 diagnosis.

Discussion

The spread of the SARS-CoV-2 virus was rapid and extensive in Brazil, especially in highly populated states such as Rio de Janeiro and São Paulo. This resulted in a need to reorganize healthcare systems to redirect resources and free up hospital beds for patients with COVID-19. With this new directive, it was necessary to implement new measures and strategies for patient reception routines, identification of COVID-19 carriers, making PPE available, controlling the movement of healthcare professionals and patients, and allocation of separated surgical rooms for COVID-19 and non-COVID-19 patients.[4–6] In addition to these strategies, it was necessary

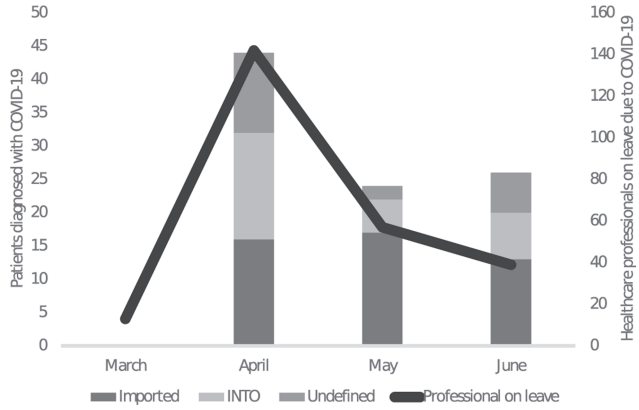

Fig. 5 Number of patients and professionals diagnosed with COVID-19 and number of healthcare professionals on leave. Bars represent the number of patients with COVID-19 classified according to the source of the infection. Line represents the number of professionals on leave due to the disease.

Table 3 Number of healthcare professionals diagnosed with COVID-19

	Physician	Nurse	Nursing assistant	Others
March (March 16 to March 31)	10	0	3	0
April	30	46	59	7
May	11	14	19	13
June	4	13	18	4
Total	55	73	99	24

to adopt measures to allow teaching and research activities to continue in the least disruptive way possible.[7–9]

Over the study period, 502 professionals were removed from their daily professional activities either because they belonged to a high-risk group or were diagnosed with COVID-19. This caused a 21.6% reduction in the workforce. Such a reduction led to a representative deficit of human resources in critical areas, mainly those who care for COVID-19. This resulted in a temporary reduction in the global availability of beds due to a shortage of these professionals. Approximately 11% of healthcare professionals were placed on leave due to a COVID-19 infection. This figure is comparatively lower than those reported in hospitals in Hong Kong and Italy, which stood at 22% and 20% respectively.[10] However, the number of healthcare professionals who were infected with COVID-19 may have been underestimated, as there were many cases which could not be diagnostically confirmed due to limitations in COVID-19 testing, particularly at the start of the pandemic.

The reduction in the number of outpatient visits and surgical operations were a direct reflection of the measures and protocols implemented by the Crisis Office. The reduction of these activities has also been adopted in other Brazilian and international services, highlighting their role in helping to mitigate the spread of the virus.[6,11]

The Institute's central role in taking over the care of all orthopedic trauma cases in the state has led to a substantial increase in the number of transfers and, consequently, in the admission of patients who already had the virus into its facility. In April 2020, 16 patients acquired COVID-19 during the hospitalization period. In the following months, with the reinforcement of safety and hygiene measures, it was observed that, although the number of infected patients transferred remained constant, there was a drastic drop in the number of patients who contracted the disease at the institute, showing the effectiveness of the protocols adopted.

The peak period of COVID 19's first wave in the State, coincided with the greater number of infected patients hospitalized and with the most reduced healthcare workforce, due to the virus. This observation suggests that the spread of the disease occurred not only among patients, but also among healthcare professionals. Several factors may have contributed to the rapid spread of the virus among healthcare professionals. In their study, Nguyen et al.[12] showed that despite using PPE, healthcare professionals' risk of contamination by the SARS-CoV-2 virus was three times greater, compared with the general population. In addition, a Chinese study by Guo et al.[13] on orthopedic surgeons reported physical tiredness as another risk factor for contracting COVID-19. This same study demonstrated that the most likely places of exposure to the virus were the wards, public spaces and surgical centers. Such studies emphasize the importance of adopting other measures for effective infection control and reinforce the importance of adequate management of scales and shifts to maintain healthcare professionals' mental balance.

During the study period, 94 transferred patients were diagnosed with COVID-19. It is important to note that in the initial months of the pandemic, there were not enough diagnostic tests available, and some suspected patients were discharged or died without diagnostic confirmation. This suggests that the number of COVID-19 cases was underreported at the unit. The incidence of COVID-19 in patients treated at the institute was higher in April, with a 50% reduction in subsequent months, mainly due to effective control of the spread of the disease.

In the same study period, 631 transfers and 1087 surgeries were performed with an average hospital stay of 16 days compared with eight days in the same period of 2019. At the institute, elective surgeries are usually performed preceded by rigorous preoperative preparation. During the pandemic, a change was noted in the profile of patients seen, and these were those who had serious clinical conditions. The care of these patients, who often needed urgent medical intervention, led to surgical procedures being performed without due control of the patient's comorbidities and clinical decompensations. Conversely, if these patients were diagnosed with COVID-19, it most likely led to the postponement of their surgery, which resulted in the procedure being performed after a longer wait than currently recommended in the literature. Both factors affect the patients' postoperative recovery and may have contributed to longer hospital stays, as previously demonstrated.[14–16] A COVID-19 diagnosis may have also contributed to the increase in the length of stay, either by aggravating the patient's clinical condition and prolonging his recovery or by the requirement to comply with quarantine requirements during the hospitalization period.

COVID-19 seems to be the main factor that contributed to the significant increase in the number of deaths (245%) since 31 of the 36 patients who died were confirmed COVID-19 cases. In our data, the mortality rate of patients with COVID-19 was 32.9%. In the literature, the mortality rate of patients undergoing orthopedic procedures with a perioperative diagnosis of COVID-19 is quite variable at 7.6% □ 43.7%.[17] Thus, there is still no consensus regarding the effect of COVID-19 on the mortality of patients undergoing urgent orthopedic procedures. While some studies claim that both the mortality rate and the number of complications are higher in patients with COVID-19 and therefore, surgical procedures should be postponed whenever possible,[18] another set of evidence suggests that in elderly patients with femoral fractures diagnosed with COVID-19, early performance of the surgical procedures would result in better outcomes, despite the high mortality rate.[16–19] Knowing the effect of surgical outcomes for patients with COVID-19 is of fundamental importance to doctors and managers since it will allow adequate management of patients who need urgent procedures and guide the development of protocols for reintroducing elective procedures safely.

Conclusions

Managing an unprecedented health crisis is a huge challenge for all healthcare service providers, but it also provides an invaluable learning opportunity. The strategy defined by the institute, with the support of control bodies, of transforming a center for highly-complex elective surgeries into a trauma hospital during the COVID-19 pandemic allowed operational and resilient systems to be maintained, ensuring safe and quality care for patients with orthopedic trauma from across the state.

Even though this study is limited by its retrospective design and the actions and protocols described are part of a broad set of measures aimed at reorganizing the healthcare system of a single federative unit during the COVID-19 pandemic, the results presented represent the reality of a single institution. However, further studies should be conducted to assess the effect of the protocols and strategies implemented by the Crisis Office on the activities of other hospitals in the region.

Conflict of Interests

The authors have no conflict interests to declare.

References

1 World Health Organization. WHO announces COVID-19 outbreak a pandemic? 2020. [Accessed 22 June 2020] from: http://www.euro.who.int/en/health-topics/healthemergencies/coronavirus-covid-19/news/news/2020/3/whoannounces-covid-19-outbreak-a-pandemic

2 Brazil. Ministry of Health Brazil confirms first case of the disease. 2020. [Accessed 2 August 2020] from: https://www.saude.gov.br/noticias/agencia-saude/46435-brasil-confirma-first-case-of-new-coronavirus
3 Iacobucci G. Covid-19: all non-urgent elective surgery is suspended for at least three months in England. BMJ 2020;368:m1106
4 Ruggieri P, Trovarelli G, Angelini A, Pala E, Berizzi A, Donato D. COVID-19 strategy in organizing and planning orthopedic surgery in a major orthopedic referral center in an area of Italy severely affected by the pandemic: experience of the Department of Orthopedics, University of Padova. J Orthop Surg Res 2020;15 (01):279
5 Casiraghi A, Domenicucci M, Cattaneo S, et al. Operational strategies of a trauma hub in early coronavirus disease 2019 pandemic. Int Orthop 2020;44(08):1511–1518
6 Lima EBS, Belangero PS, Falótico GG, Mansur NSB, Luzo MVM, Reis FBD. Intervention Protocol of the Orthopedics and Traumatology Department of a High-Complexity University Hospital to Cope with the COVID-19 Pandemic. Rev Bras Ortop (Sao Paulo) 2020;55 (03):269–277
7 Awad ME, Rumley JCL, Vazquez JA, Devine JG. Perioperative Considerations in Urgent Surgical Care of Suspected and Confirmed COVID-19 Orthopaedic Patients: Operating Room Protocols and Recommendations in the Current COVID-19 Pandemic. J Am Acad Orthop Surg 2020;28(11):451–463
8 Mavrogenis AF, Quaile A, Scarlat MM. The virus crisis affects Orthopaedic surgery and scientific activities worldwide. Int Orthop 2020;44(05):813–817
9 Kogan M, Klein SE, Hannon CP, Nolte MT. Orthopaedic Education During the COVID-19 Pandemic. J Am Acad Orthop Surg 2020;28 (11):e456–e464
10 Nagesh S, Chakraborty S. Saving the frontline health workforce amidst the COVID-19 crisis: Challenges and recommendations. J Glob Health 2020;10(01):010345
11 Nuñez JH, Sallent A, Lakhani K, et al. Impact of the COVID-19 Pandemic on an Emergency Traumatology Service: Experience at a Tertiary Trauma Centre in Spain. Injury 2020;51(07): 1414–1418
12 Nguyen LH, Drew DA, Joshi AD, et al. Risk of COVID-19 among frontline healthcare workers and the general community: a prospective cohort study. medRxiv 2020;2020:x
13 Guo X, Wang J, Hu D, et al. Survey of COVID-19 Disease Among Orthopaedic Surgeons in Wuhan, People's Republic of China. J Bone Joint Surg Am 2020;102(10):847–854
14 Gholson JJ, Noiseux NO, Otero JE, Gao Y, Shah AS. Patient Factors Systematically Influence Hospital Length of Stay in Common Orthopaedic Procedures. Iowa Orthop J 2017;37:233–237
15 Egol KA, Konda SR, Bird ML, et al; NYU COVID Hip Fracture Research Group. Increased Mortality and Major Complications in Hip Fracture Care During the COVID-19 Pandemic: A New York City Perspective. J Orthop Trauma 2020;34(08):395–402
16 Muñoz Vives JM, Jornet-Gibert M, Cámara-Cabrera J, et al; Spanish HIP-COVID Investigation Group. Mortality Rates of Patients with Proximal Femoral Fracture in a Worldwide Pandemic: Preliminary Results of the Spanish HIP-COVID Observational Study. J Bone Joint Surg Am 2020;102(13):e69
17 Kumar Jain V, Lal H, Kumar Patralekh M, Vaishya R. Fracture management during COVID-19 pandemic: A systematic review. J Clin Orthop Trauma 2020;11(Suppl 4):S431–S441
18 Doglietto F, Vezzoli M, Gheza F, et al. Factors Associated With Surgical Mortality and Complications Among Patients With and Without Coronavirus Disease 2019 (COVID-19) in Italy. [published online ahead of print, 2020 Jun 12]JAMA Surg 2020;155 (08):1–14
19 Sobti A, Memon K, Bhaskar RRP, Unnithan A, Khaleel A. Outcome of trauma and orthopaedic surgery at a UK District General Hospital during the Covid-19 pandemic. J Clin Orthop Trauma 2020;11(Suppl 4):S442–S445

Relationship between Knee Symptoms and Biological Features in Recreational Runners*

Relação entre sintomatologia no joelho e as características biológicas em corredores recreacionais

Paula Passuello Alves Ribeiro[1] Kelly Cristina dos Santos Berni[1]

[1] Department of Physicaltherapy, Faculdade de Americana, Americana, São Paulo, Brazil

Rev Bras Ortop 2021;56(2):168–174.

Address for correspondence Kelly Cristina dos Santos Berni, PhD, Faculdade de Americana (FAM), Av. Joaquim Boer, 733, Jardim Luciene, Americana, SP, 13477-360, Brazil (e-mail: kelly_ssantos@hotmail.com).

Abstract

Objective The main objective of the present study was to compare the subjective perception of pain and symptoms of anterior knee pain with the different body mass index (BMI) classifications. The secondary objective was to verify the association between biological and anthropometric variables with the results of subjective questionnaires.

Methods A total of 126 recreational runners from both genders, aged between 20 and 59 years old, were recruited. Data regarding the biological variable (age), anthropometric variables (weight, height), visual analog scale (VAS), and Lysholm and Kujala questionnaires scores were collected. Information was obtained with a digital platform, available through a single link, allowing volunteers to answer these questions using electronic devices. Normality was verified by the Shapiro-Wilk test. T-tests and Wilcoxon tests were used to compare mean values. The association between variables was determined by the Pearson linear correlation.

Results There were significant differences in height between overweight and grade 1 obesity subjects ($p = 0.029$), in weight and BMI comparing normal weight subjects and both overweight and grade 1 obesity subjects ($p < 0.001$ and $p < 0.05$, respectively). An unclear significant correlation was observed between BMI values and specific questionnaires and subjective scale scores ($p < 0.05$).

Conclusion Recreational runners who present high BMI values are more likely to experience knee pain than those with normal BMI values.

Keywords
- running
- Lysholm knee scoring scale
- body mass index
- sport-related injuries
- knee injuries
- patellofemoral pain syndrome

Resumo

Objetivo O principal objetivo do presente estudo foi comparar a percepção subjetiva de dor e sintomas de dor anterior no joelho com as diferentes classificações de índice de massa corporal (IMC). O objetivo secundário foi verificar a associação entre as variáveis

* *Study developed at Faculdade de Americana, Americana, São Paulo, Brazil.*

received
July 22, 2019
accepted
April 15, 2020
published online
October 29, 2020

DOI https://doi.org/10.1055/s-0040-1713758.
ISSN 0102-3616.

Thieme Revinter Publicações Ltda., Rua do Matoso 170, Rio de Janeiro, RJ, CEP 20270-135, Brazil

biológica e antropométrica com os resultados apresentados pelos sujeitos nos questionários subjetivos.

Métodos Foram recrutados 126 corredores recreacionais de ambos os gêneros, com idades entre 20 e 59 anos. Foram coletados dados referentes à variável biológica idade, e as variáveis antropométricas peso e altura, além da escala visual analógica (EVA) e os questionários Lysholm e Kujala. As informações foram obtidas por meio de plataforma digital, disponibilizado em um único link, para que fossem respondidos através de dispositivos eletrônicos pelos próprios voluntários. A normalidade foi verificada por meio do teste Shapiro-Wilk. Foi utilizado o teste-T e o teste de Wilcoxon para comparação das médias. A associação entre as variáveis foi determinada pela correlação linear de Pearson.

Resultados Houve diferença significativa entre a estatura do grupo sobrepeso e o grupo obesidade grau 1 ($p = 0{,}029$), e o peso do grupo peso normal para os grupos sobrepeso e obesidade grau 1 ($p < 0{,}001$), e entre as médias do IMC ($p < 0{,}05$). Foi observada correlação significativa não clara entre o IMC e os questionários específicos e a escala subjetiva ($p < 0.05$).

Conclusão Os corredores recreacionais que possuem IMC acima dos valores de normalidade estão mais predispostos a apresentar dor no joelho do que aqueles com IMC normal.

Palavras-chave
- corrida
- escala de Lysholm para joelho
- índice de massa corporal
- lesões esportivas
- lesões do joelho
- síndrome da dor patelofemoral

Introduction

Running is the sport that most contributes to the occurrence of injuries in physically active adult individuals.[1] The incidence of lower limb injuries in runners ranges from 19.4 to 92.4%, affecting mainly the knees, with a specific incidence from 7.2 to 50%;[2] 30 to 70% of these injuries require training reduction and > 79% require medical attention.[3] Anterior knee pain, also called patellofemoral pain (PFP),[5] is a frequent cause for medical care.[4]

Short and long distance recreational runners report mainly knee injuries,[6] with 50% of them resulting from excessive use.[3] In addition, these lesions may be associated with risk factors, such as body mass index (BMI)[7] and advanced age.[2,3,8] Since injuries are multifactorial, studies on running-related risk factors must present a high quality to allow precise conclusions.[9] For Powers et al.,[10] failure to treat this lesion is constant, and it can be attributed to the lack of understanding of its causes.

The diagnosis is based on the history and physical examination of the patient, since imaging tests, including radiography and magnetic resonance imaging (MRI), do not provide specific findings.[11] As such, qualitative and quantitative assessment tools are required.[12] These tools include the Lysholm questionnaire, due to its reliability and validity in athletes and patients with joint cartilage conditions,[13,14] and the Patellofemoral Disorders Scale (Kujala Anterior Knee Pain Scale), which is a specific tool for anterior knee pain evaluation.[15–17]

Due to the diverse etiology, the diagnosis is complex and susceptible to interpretation errors.[18] Therefore, the Lysholm and Kujala questionnaires can provide additional information to the history and physical examination of the patient, reducing the inaccuracy in clinical evaluation; in addition, these are easily applied, low-cost tools. The main objective of the present study was to compare the subjective perception of pain and anterior knee pain symptoms in people with different BMI classifications. The secondary objective was to verify the association between biological and anthropometric variables with subjective questionnaires scores. Our initial hypothesis is the existence of an association between biological (age) and anthropometric (BMI) variables with pain perception and PFP symptoms.[7,8]

Material and Methods

Study Design

The sample consisted of 126 recreational runners of both genders, aged between 20 and 59 years old. All volunteers were recruited by invitation and declared they did not run competitively. An Informed Consent Form (ICF) was signed; this document provided the telephone number of the researchers in charge to resolve possible doubts, since there was no direct contact with the volunteers. The document was in a digital format, according to a project approved by the Research Ethic Committee (CEP, in the Portuguese acronym) under the number 2.774.475/2018.

The study was conducted through questionnaires digitally available on a single link, via the internet; a brief explanatory text about these tools was also provided. In addition, data regarding age, knee pain intensity according to the visual analog scale (VAS), weight and height for BMI calculation were collected. Next, recruited individuals were encouraged to answer the Lysholm and Kujala questionnaires on their computers, notebooks, cell phones, tablets, or other electronic devices.

Body mass index

Body mass index was used to assess the subject's weight in relation to height, with the following classification: < 18.5, low weight; from 18.5 to 24.9, normal weight; from 25 to 29.9, overweight; ≥ 30, obesity. The BMI was calculated by dividing the body mass in kilograms (kg) by the squared height (m^2). Data were provided by the subjects, who were instructed to weight themselves on a digital or analogic scale, and to measure their heights before answering the online questionnaires.

Lysholm questionnaire

The Lysholm questionnaire is a specific knee questionnaire, which was translated and validated in Portuguese.[19] The questionnaire was answered by the volunteers, who chose only one answer per item. Items are divided into limping, support, locking, instability, pain, swelling, climbing stairs and squatting. The score 5 refers to the maximum in the items support, limping and squatting, the score 10 refers to the maximum in the items swelling and climbing stairs, the score 15 refers to the maximum in the item locking and the score 25 refers to if the maximum in the items instability and pain. The total score is classified as excellent ($\geq$ 95 points), good (94 to 84 points), fair (83 to 65 points) and poor ($\leq$ 64 points).[20]

Kujala questionnaire

The Kujala questionnaire (Patellofemoral Disorders Scale) is used to assess anterior knee pain and functional limitations. It was validated and translated into Portuguese, and it is the only questionnaire that concomitantly evaluates anterior knee pain, patellofemoral joint function and patellar alignment.[12] It scores from 0 to 100 points, where 0 represents the absence of pain and/or functional limitations, and 100 points corresponds to constant pain and several functional limitations. It consists of 13 multiple choice items, and 1 answer per item is allowed. Items are divided into limping, supporting body weight, walking, going up and down stairs, squatting, running, jumping, sitting for a long time with bent knees, pain in the affected knee, swelling, subluxations, loss of muscle mass and difficulty flexing the injured knee. A maximum score of 5 points is attributed to limping, sustaining body weight, walking, squatting, loss of muscle mass and difficulty flexing the injured knee, while a maximum score of 10 points is given to going up and down stairs, running, jumping, sitting for a long time with bent knees, pain in the affected knee, swelling and subluxations. Scores are classified as excellent ($\geq$ than 95 points), good (94 to 85 points), fair (84 to 65 points) and poor ($\leq$ 64 points).[15]

Visual analog scale

The VAS was used to subjectively measure the level of knee pain in recreational runners. The classification goes from 0 to 10 points, where 0 to 2 corresponds to mild pain, 3 to 7 equates to moderate pain and 8 to 10 represents severe pain. The VAS was answered according to current pain during the application of the questionnaire.[21]

Statistical analysis

Descriptive data were presented as mean $\pm$ standard deviation (SD). Data normality was examined using the Shapiro-Wilk test. A paired sample t-test compared mean values from parametric data, while the Wilcoxon test was used for non-parametric data. Variables were analyzed by Pearson linear correlation. The 95% confidence interval (CI) for variables association was calculated. The magnitudes of the correlation adopted were (r): Trivial when less than or equal to 0.1; small when greater than 0.1 to 0.3; moderate when greater than 0.3 to 0.5, large when greater than 0.5 to 0.7, very large when greater than 0.7 to 0.9 and almost perfect when greater than 0.9 to 1.0. In case of 95%CI overlapping, small positive and negative magnitude values were considered unclear; otherwise, the observed magnitude was considered.[22] Significance was adopted at $p \leq 0.05$. Analyzes were performed using IBM SPSS Statistics for Windows, Version 22 (IBM Corp., Armonk, NY, USA). Figures were generated with GraphPad Prism software, version 6.0 (San Diego, CA, USA).

Results

A total of 138 questionnaires were responded, with 126 considered viable and included in the analyzes. Twelve questionnaires were excluded: 5 due to the duplicate participation, 2 from subjects younger than the age stipulated by our study, 1 from a volunteer older than required, and 4 for not fully completing the questionnaire.

Descriptive data regarding age, height and body mass from recreational runners are presented in ►**Table 1**. A significant height difference was observed between overweight and grade 1 obesity subjects ($p = 0.029$) (►**Table 1**); body mass was significantly different when comparing the normal weight group to the overweight ($p < 0.001$) and grade 1 obesity groups ($p < 0.001$) (►**Table 1**).

The mean BMI values from overweight subjects were significantly different to those from normal weight subjects; the mean BMI values from grade 1 obesity subjects were significantly different from normal weight and overweight subjects (►**Figure 1A**). The VAS, Kujala and Lysholm mean scores presented no significant difference between groups (►**Figure 1B**, **1C**, **1D**).

Table 1 Characterization of recreational runners divided into groups according by body mass index

	Normal weight group	Overweight group	Grade 1 obesity group
Age (years old)	33.83 ± 7.98	34.10 ± 8.23	39.22 ± 8.84
Height (m)	1.67 ± 0.08	1.71 ± 0.09	$1.68 \pm 0.08^{**}$
Weight (kg)	63.26 ± 8.22	$78.64 \pm 9.48^{*}$	$91.55 \pm 11.87^{*}$

Abbreviations: m, meters; kg, kilograms.
*Significant difference, normal weight group, $p < 0.05$.
**Significant difference, overweight group, $p < 0.05$.

Significant correlations between BMI and the VAS ($r = 0.18$; $p = 0.04$), Kujala score ($r = -0.17$; $p = 0.05$) and Lysholm score ($r = -0.22$; $p = 0.01$) were observed (►**Figure 2**); however, there were no significant correlations between age and specific questionnaires and VAS scores (►**Figure 3**).

The virtual questionnaire inquired the running experience of participants, with three possible answers: 1 - < 6 months; 2 - > 6 months; 3 - ≥ 1 year. The weekly frequency, referring to how many times a week the subject does street running, was also questioned, with three possible answers: 1 - Once a week; 2 - Twice a week; 3 - ≥ 3 times a week. Regardless of their nature, all answers were included in our analysis; this information was collected to better understand the characteristics from our volunteers.

Discussion

Our main findings were the following: 1-) There is a significant difference between mean BMI values. 2-) BMI has a significant correlation with the VAS, Kujala and Lysholm scores. 3-) There is no significant correlation between age, subjective pain scale and specific questionnaires. The significant difference observed between BMI classifications (►**Figure 1A**) is due to the difference between the body weight from normal weight, overweight and grade 1 obesity subjects (►**Table 1**) and the height difference between the overweight and grade 1 obesity groups (►**Table 1**).

Our data suggest that the BMI is associated with the level of pain and PFP symptoms (►**Figure 2**). Linton et al.[7] observed that injured subjects have a higher BMI compared with non-injured individuals, so BMI can be a risk factor for running injuries; in addition, runners from the injured group reported both a knee injury in the previous 12 months and a current lesion. Kastelein et al.[23] detected an association between persistent knee pain in subjects with BMI values > 25 kg/m^2 during the 1st year of follow-up; those same patients, at a 6-year follow-up, presented bilateral symptoms, including reports of knee swelling and locking sensation in the Lysholm questionnaire. Similarly, Nielsen et al.[24,25] highlighted that an increased BMI consequently increases the risk of running-related injuries, and that BMI values < 20 kg/m^2 are considered protective factors for the development of lesions.[24]

Neal et al.,[26] demonstrated that BMI is not a risk factor for injuries in runners since the evaluated papers show evidence that subjects both above or within an ideal weight are predisposed to PFP development; furthermore, these authors state that the risk of having this type of pain is present regardless of the type of runner. Nevertheless, these results are not yet fully elucidated in the literature. Vitez et al.[8] and Linton et al.[7] observed that overweight runners are more susceptible to injuries than those with normal weight, corroborating our findings, which demonstrate an unclear significant correlation between BMI and VAS, Kujala and Lysholm scores.

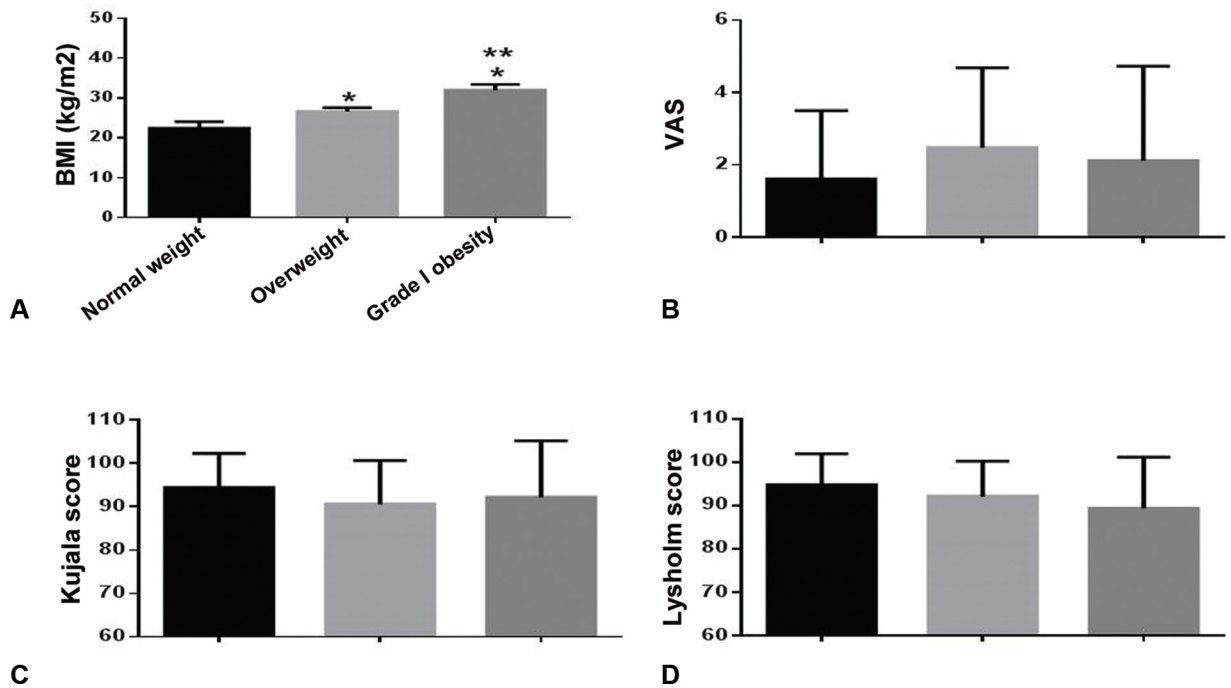

Fig. 1 (**A**) The black bar refers to the average body mass index (BMI) of normal weight subjects, the light gray bar represents the average BMI of overweight subjects, and the dark gray bar indicates the average BMI grade 1 obesity subjects. (**B**) The black bar corresponds to the average visual analog scale (VAS) score of normal weight subjects, the light gray bar shows the average VAS score of overweight participants, and the dark gray bar corresponds to the average VAS score of grade 1 obesity patients. (**C**) The black bar symbolizes the average Kujala score of normal weight subjects, the light gray bar refers to the average Kujala score of overweight subjects, and the dark gray bar represents the average Kujala score of grade 1 obesity individuals. (**D**) The black bar refers to the average Lysholm score of normal weight participants, the light gray bar refers to the average Lysholm score of overweight subjects, and the dark gray bar represents the average Lysholm score of with grade 1 obesity individuals. *, significant difference compared with normal weight subjects, $p \leq 0.05$; **, significant difference compared with overweight subjects, $p \leq 0.05$.

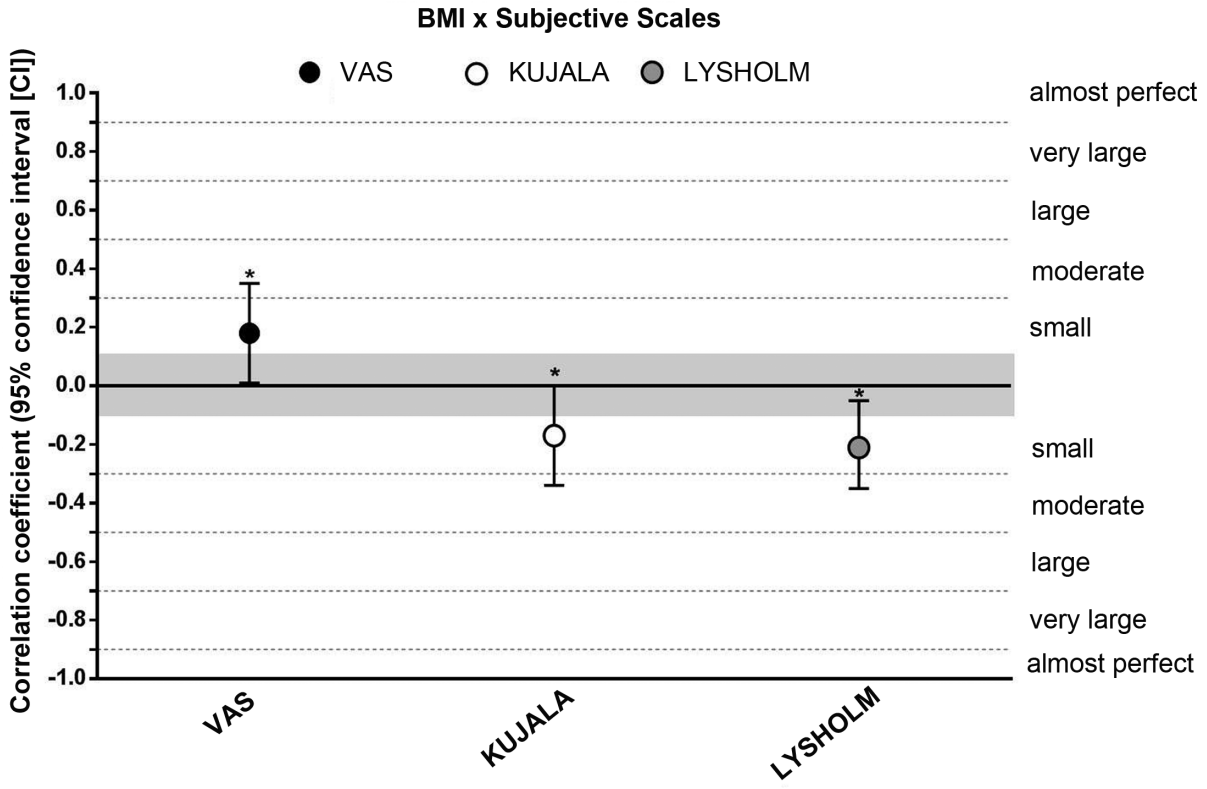

Fig. 2 Correlation between body mass index (BMI) and subjective scales scores. The black circle corresponds to the correlation with the visual analog scale (VAS), the white circle represents the correlation to the Kujala score, and the gray circle shows the correlation with the Lysholm score. The black line represents the limit between positive or negative correlation. The gray area shows the trivial correlation threshold, while the dotted lines represent small, moderate, large, very large or almost perfect correlation thresholds. *, significant difference, $p \leq 0.05$.

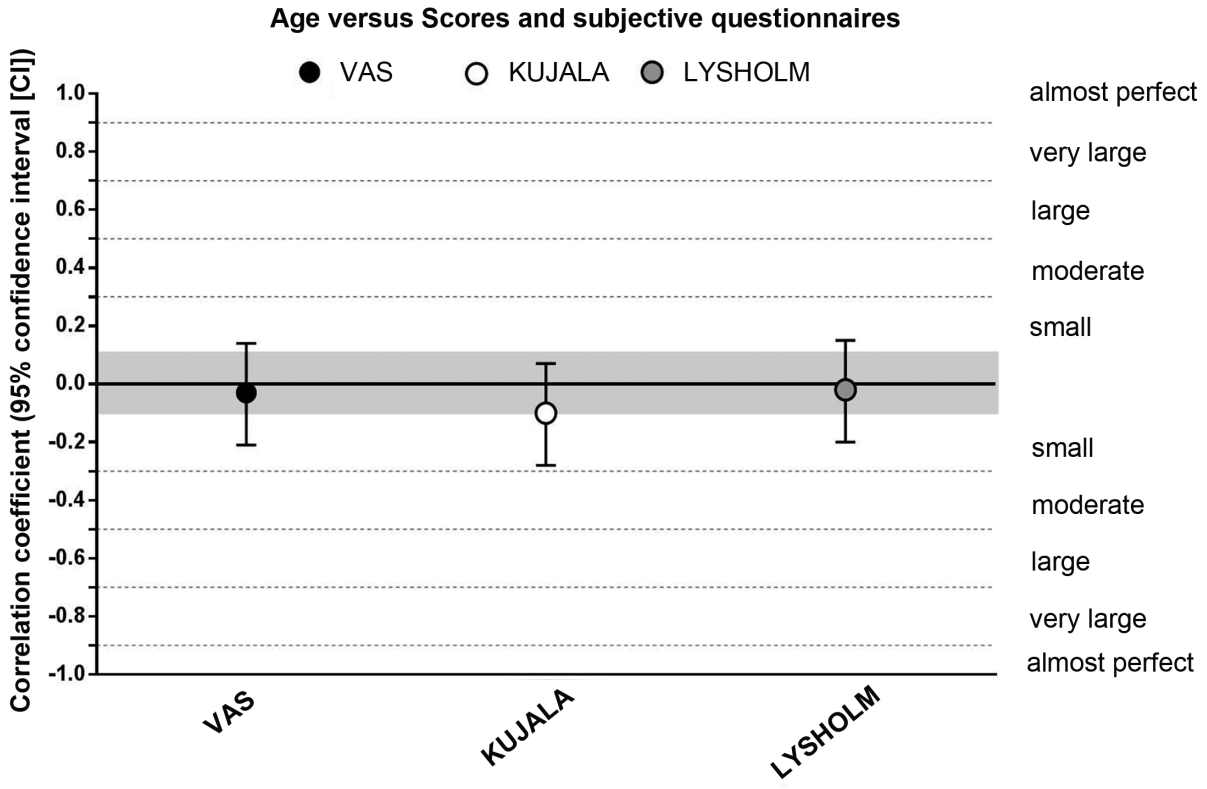

Fig. 3 Correlation between participants' age and subjective scales scores. The black circle corresponds to the correlation with the visual analog scale (VAS), the white circle represents the correlation to the Kujala score, and the gray circle shows the correlation with the Lysholm score. The black line represents the limit between positive or negative correlation. The gray area shows the trivial correlation threshold, while the dotted lines represent small, moderate, large, very large or almost perfect correlation thresholds. *, significant difference, $p \leq 0.05$.

Our results indicate that age has a trivial correlation with specific knee and pain questionnaires. On the contrary, Gionnogueron et al.,[3] Van Gent et al.,[2] and Vitez et al.[8] pointed out that advanced age is a risk factor for lower limb injury. A recent systematic review and meta-analysis found moderate evidence that age is not a risk factor for patellofemoral pain in runners, including recreational runners.[26] According to Nielsen et al.,[24] middle-aged runners between 45 and 65 years old are more susceptible to running-related injuries. This observation justifies the trivial correlation found by our study, in which most volunteers were young adults (►**Table 1**), since few symptoms are reported by this age group.

Our study had two main limitations: Indirect contact with volunteers and the lack of distinction between pain and injury, mainly due to the difficulty in diagnosing and controlling the injury factor. Future studies must attempt to control variables that the literature proposes as risk factors for PFP, including sport experience, flexibility, patellar alignment, quadriceps muscles strength, weekly training volume, running speed, running shoes and mileage covered with them, step type, guidance and periodization by a professional, as well as face-to-face questionnaire application and the differentiation between pain and injury.

Conclusion

We conclude that a high BMI value can be a causative factor for knee pain in recreational runners; therefore, the weight of such subjects must be controlled to minimize the occurrence of injuries. Lysholm and Kujala questionnaires can be used to assess knee symptoms in this population, providing additional information to the physical evaluation and assisting in preventive strategies, as they enable the characterization of current symptoms.

Conflict of Interests
The authors have no conflict of interests to declare.

Acknowledgements
We are grateful to all the volunteers included in the present study.

References

1 Bueno AM, Pilgaard M, Hulme A, et al. Injury prevalence across sports: a descriptive analysis on a representative sample of the Danish population. Inj Epidemiol 2018;5(01):6
2 van Gent RN, Siem D, van Middelkoop M, van Os AG, Bierma-Zeinstra SM, Koes BW. Incidence and determinants of lower extremity running injuries in long distance runners: a systematic review. Br J Sports Med 2007;41(08):469–480, discussion 480
3 Gijon-Nogueron G, Fernandez-Villarejo M. Risk factors and protective factors for lower-extremity running injuries a systematic review. J Am Podiatr Med Assoc 2015;105(06):532–540
4 Sanchis-alfonso V, Mcconnell J, Monllau JC, Fulkerson JP. Diagnosis and treatment of anterior knee pain. Jt Disord Orthop Sport Med 2016;1(03):161–173
5 Crossley KM, Stefanik JJ, Selfe J, Collins NJ, Davis IS, Powers CM, et al. Patellofemoral pain consensus statement from the 4th International Patellofemoral Pain Research Retreat, Manchester. Part 1: Terminology, de fi nitions, clinical examination, natural history, patellofemoral osteoarthritis and patient-reported outcome measures.2016:839–843
6 van Poppel D, Scholten-Peeters GG, van Middelkoop M, Verhagen AP. Prevalence, incidence and course of lower extremity injuries in runners during a 12-month follow-up period. Scand J Med Sci Sports 2014;24(06):943–949
7 Linton L, Valentin S. Running with injury: A study of UK novice and recreational runners and factors associated with running related injury. J Sci Med Sport 2018;21(12):1221–1225
8 Vitez L, Zupet P, Zadnik V, Drobnič M. Running injuries in the participants of ljubljana marathon. Zdr Varst 2017;56(04): 196–202
9 van der Worp MP, ten Haaf DS, van Cingel R, de Wijer A, Nijhuis-van der Sanden MW, Staal JB. Injuries in runners; a systematic review on risk factors and sex differences. PLoS One 2015;10(02): e0114937
10 Powers CM, Bolgla LA, Callaghan MJ, Collins N, Sheehan FT. Patellofemoral pain: proximal, distal, and local factors, 2nd International Research Retreat. J Orthop Sports Phys Ther 2012; 42(06):A1–A54
11 van der Heijden RA, Oei EH, Bron EE, et al. No difference on quantitative magnetic resonance imaging in patellofemoral cartilage composition between patients with Patellofemoral pain and healthy controls. Am J Sports Med 2016;44(05): 1172–1178
12 Aquino VS, Falcon SF, Neves LM, Rodrigues RC, Sendín FA. Translation and Cross-cultural adaptation of the Scoring of Patellofemoral Disorders into Portuguese?: Preliminary study Acta Ortop Bras 2011;19(05):273–279
13 Kocher MS, Steadman JR, Briggs KK, Sterett WI, Hawkins RJ. Reliability, validity, and responsiveness of the Lysholm knee scale for various chondral disorders of the knee. J Bone Joint Surg Am 2004;86(06):1139–1145
14 Marx RG, Jones EC, Allen AA, et al. Reliability, validity, and responsiveness of four knee outcome scales for athletic patients. J Bone Joint Surg Am 2001;83(10):1459–1469
15 Kujala UM, Jaakkola LH, Koskinen SK, Taimela S, Hurme M, Nelimarkka O. Scoring of patellofemoral disorders. Arthroscopy 1993;9(02):159–163
16 Paxton EW, Fithian DC, Stone ML, Silva P. The reliability and validity of knee-specific and general health instruments in assessing acute patellar dislocation outcomes. Am J Sports Med 2003;31(04):487–492
17 Rodriguez-Merchan EC. Knee instruments and rating scales designed to measure outcomes. J Orthop Traumatol 2012;13 (01):1–6
18 Nunes GS, Stapait EL, Kirsten MH, de Noronha M, Santos GM. Clinical test for diagnosis of patellofemoral pain syndrome: Systematic review with meta-analysis. Phys Ther Sport 2013;14 (01):54–59
19 Peccin MS, Ciconelli RM, Cohen M. Specific questionnaire for knee symptoms - the " Lysholm Knee Scoring Scale" - Translation and validation into portuguese. Acta Ortop Bras 2006;14(05): 268–272
20 Lysholm J, Gillquist J. Evaluation of knee ligament surgery results with special emphasis on use of a scoring scale. Am J Sports Med 1982;10(03):150–154
21 McCormack HM, Horne DJDEL, Sheather S. Clinical applications of visual analogue scales: a critical review. Psychol Med 1988;18 (04):1007–1019
22 Hopkins WG, Marshall SW, Batterham AM, Hanin J. Progressive statistics for studies in sports medicine and exercise science. Med Sci Sports Exerc 2009;41(01):3–13
23 Kastelein M, Luijsterburg PA, Heintjes EM, et al. The 6-year trajectory of non-traumatic knee symptoms (including patellofemoral pain) in adolescents and young adults in general

practice: a study of clinical predictors. Br J Sports Med 2015;49 (06):400–405
24 Nielsen RO, Buist I, Parner ET, et al. Predictors of Running-Related Injuries Among 930 Novice Runners: A 1-Year Prospective Follow-up Study. Orthop J Sports Med 2013;1(01): 2325967113487316
25 Nielsen RO, Buist I, Sørensen H, Lind M, Rasmussen S. Training errors and running related injuries: a systematic review. Int J Sports Phys Ther 2012;7(01):58–75
26 Neal BS, Lack SD, Lankhorst NE, Raye A, Morrissey D, van Middelkoop M. Risk factors for patellofemoral pain: a systematic review and meta-analysis. Br J Sports Med 2019;53(05):270–281

Dynamic Knee Alignment and Pelvic Balance: Comparison Regarding Gender in Young Soccer Athletes*

Alinhamento dinâmico do joelho e equilíbrio pélvico: Comparação entre os sexos em atletas de futebol de base

Flaviano Moreira da Silva[1] Denis Bordoni Canêz[1] Andressa Rodeghiero Madeira[1] Gustavo Dias Ferreira[2]

[1] Physical Therapy Course, Universidade Católica de Pelotas, Pelotas, Rio Grande do Sul, Brazil
[2] Physiology and Pharmacology Department, Universidade Federal de Pelotas, Pelotas, Rio Grande do Sul, Brazil

Address for correspondence Flaviano Moreira da Silva, Rua Barão de Santa Tecla, 1.160, apto 402, Centro, Pelotas, Rio Grande do Sul, Brazil (e-mail: flaviano.silva@ucpel.edu.br).

Rev Bras Ortop 2021;56(2):175–180.

Abstract

Objective To evaluate knee alignment in the frontal plane and pelvic balance during the step-down test in female and male soccer players.

Methods Cross-sectional study carried out with male and female soccer players from under-15 and under-17 teams of a professional club in Southern Brazil. The step-down test was performed, filmed with a video camera, and evaluated according to the angular measurements obtained during movement using the Kinovea software (open source), version 0.8.24.

Results The sample consisted of 38 individuals, 19 males and 19 females. Female athletes had a greater varus angle ($9.42^\circ \pm 1.65^\circ$) compared to male athletes ($3.91^\circ \pm 2.0^\circ$; $p = 0.04$). There was no difference regarding the unilateral pelvic drop between the groups. In addition, the association between the hip-related pelvic drop and the projection angle on the frontal plane of the knee was weak in both genders.

Conclusion Even though the pelvic drop was observed in both genders, young female athletes had greater varus knee angles on the step-down test, which require greater attention to minimize the risk of injury.

Keywords
- soccer
- genu valgum
- genu varum
- pelvis

Resumo

Objetivo Avaliar o alinhamento do joelho no plano frontal e o equilíbrio pélvico durante a descida de um degrau comparando atletas de futebol feminino e masculino.

Métodos Estudo transversal, realizado com atletas de futebol das categorias sub-15 e sub-17, de ambos os sexos, de um clube profissional do Sul do Brasil. Foi realizado o teste de descida de um degrau, o qual foi filmado por uma câmera de vídeo, e, em sua

* *Study developed at Universidade Católica de Pelotas, Pelotas, Rio Grande do Sul, Brazil.*

received
September 11, 2019
accepted
September 16, 2020

DOI https://doi.org/10.1055/s-0040-1721361.
ISSN 0102-3616.

Thieme Revinter Publicações Ltda., Rua do Matoso 170, Rio de Janeiro, RJ, CEP 20270-135, Brazil

avaliação, traçaram-se as medidas angulares durante o movimento por meio do software Kinovea (código aberto), versão 0.8.24.

Resultados A amostra foi composta por 38 indivíduos, 19 do sexo masculino e 19 do sexo feminino. As atletas do sexo feminino apresentaram maior ângulo em varo ($9{,}42° \pm 1{,}65°$) quando comparadas com os atletas masculinos ($3{,}91° \pm 2{,}0°$; $p = 0{,}04$). Não houve diferença em relação à queda unilateral da pelve (*drop* pélvico) entre os grupos, e a associação entre o *drop* pélvico do quadril e o ângulo de projeção no plano frontal do joelho foi fraca em ambos os sexos.

Conclusão Apesar de ambos os sexos terem apresentado queda pélvica, as atletas de base do sexo feminino apresentaram maior angulação do joelho em varo no teste de descida do degrau, e necessitam maior atenção para minimizar o risco de lesão.

Palavras-chave
- futebol
- genu valgum
- genu varum
- pelve

Introduction

At a high performance level, soccer is a physically complex, intense sport that may cause injuries, especially in the lower limbs.[1] A number of factors are related to non-contact injuries, including age, gender, body morphology, muscle strength, flexibility, and joint stability and alignment[2] Among the changes in dynamic joint alignment, the valgus or varus knee is associated with the highest risk of injury, since misaligned lower limbs increase the load imposed on the joint. As such, health professionals must identify and minimize this risk factors in soccer athletes.[3,4]

Excessive valgus during running subjects the knee to chronic tension on medial ligament structures, and results in an abnormal rigidity in the iliotibial tract; in contrast, the varus increases the load imposed on the lateral ligament complex of the knee.[5] The kinematics of the lower limbs is directly related to the pelvic girdle, and the weakening of the pelvic muscles, such as the abductors and external rotators of the hip, in addition to the delayed activation time of the hip musculature, can reflect in a dynamic knee misalignment.[6–8] Studies show that subjects with weakened pelvic muscles are more likely to develop patellofemoral pain;[9,10] in addition, the dynamic misalignment of the knee is related to more serious injuries which prevent athletic activities for long periods of time, such as injuries to the ankle ligament and rupture of the anterior cruciate ligament of the knee.[11–13]

Even though there is a trend to generalize pelvic muscle weakness in lower-limb injuries, other factors, including gender, must be considered.[14] More specifically, among athletes at the same level of activity, women are more susceptible to sports injuries, presenting them in a higher incidence and greater severity. This occurs because women have lower general stability and muscle strength, in addition to joint hypermobility resulting from hormonal factors, which can potentiate a biomechanical change during movement.[11,12,15–17] Women present increased angle of adduction and medial hip rotation due to weakness of the abductor and lateral hip rotator muscles; this fact led to the hypothesis that female athletes have greater dynamic misalignment of the knee and less movement control when compared to the male athletes since adolescence. Therefore, women require more attention regarding the risk of new injuries.[16]

As such, the present study aims to compare the relationship between knee alignment in the frontal plane and pelvic balance during the step-down test in young female and male soccer players.

Materials and Methods

Participants

The present is a cross-sectional study with young athletes from a professional soccer club in Southern Brazil. The study was approved by the Research Ethics Committee of Universidade Católica de Pelotas (opinion report number: 1.759.216), and the participants and their guardians respectively signed a consent form for underage participants and an informed consent form. The sample was selected per convenience, and all athletes from the club's youth ranks (under-17 and under-15), of both genders, were invited to participate in the study. The inclusion criterion consisted of playing soccer for the team during the season. The exclusion criteria were defined as the following: athletes submitted to lower-limb surgery within the previous 6 months, those absent due to injury during data collection, those who felt pain during test, athletes with discrepancy in the lower limbs, and those unable to perform the test without exacerbated postural compensations.

At the initial approach, 68 informed consent forms were retrieved; however, 22 athletes did not return to contact, and were considered lost. Another eight athletes were excluded from the study: one for having dropped out during the test, three due to knee pain, and four because they were unable to perform the step-down movement without exaggerated postural compensations. These last four subjects presented excessive trunk flexion that completely covered the markers positioned on the hip, increasing the chance of analytical error. As such, the final sample consisted of 38 athletes, 19 male and 19 female athletes.

Procedures

Investigators were previously trained and qualified regarding the location and demarcation of the landmarks for analysis. A pilot study was carried out with two volunteers for the adaptation of the method. All demarcations and software-based measurements were performed by a single evaluator to sustain the standardization of thr criteria.

Discrepancy and pain in the lower limbs

Lower-limb discrepancy was evaluated with the athletes in the supine position. Two points were marked, one on the anterosuperior iliac spine, and the other on the medial malleolus. A difference $\geq$ 1 cm between the limbs was considered a positive test. Pain was assessed withthea visual analog scale (VAS), which ranges from 0 to 10, with 0 indicating no pain, and 10, extreme pain.[18]

Pelvic drop and knee dynamic alignment

The unilateral pelvic drop and the frontal plane projection angle (FPPA) of the knee were evaluated during the step-down test by video recordings in 2D with a camera (AFC 183 14 megapixels, Kodak, Rochester, NY, US) 2 meters away from the athlete, fixed to a tripod at a height of 60 cm. For a better evaluation of the recordings, landmarks, including the anterosuperior iliac spines, the midpoint between the femoral epicondyles, and the midpoint between the malleoli, were identified with non-reflective adhesives.[7] The Kinovea software (open source), version 0.8.24, was used for the angular analysis of the in-motion data. The unilateral pelvic drop was defined by the inferior displacement of one of the hip demarcations, contralateral to the examined limb; it often results from weakness of the gluteus medius muscle of the supporting limb (►**Figure 1**); valgus misalignment was defined as the medial displacement of the knee marker (negative angular values in relation to the midline), whereas varus misalignment was determined by a lateral increase in the distal markers (positive angular values in relation to the midline) (►**Figure 2**).

The height of the step was standardized as 16 cm. The athletes were instructed to remain 15 cm away from the step. Subsequently, they were asked to climb on the step and remain as relaxed as possible for 10 seconds to capture a frontal image at the beginning of the test; next, they were asked to step down, touching the heel on the ground 5 cm in front of the step, on previously-made markings. Before the test, the athletes performed three rounds of rehearsal for adaptation; the mean values of the five consecutive tests were considered for analysis. The supporting limb was assessed during the movement.[6]

Statistical Analysis

The angles were analyzed using the Kinovea software, and the values are presented as means and standard deviations. The Shapiro-Wilk test was performed to verify data distribution. The Student *t*-test for independent samples was used for the comparative analysis of the mean pelvic drop and mean FPPA in athletes from both genders; the level of significance was set at 5%. The Pearson correlation was used to analyze the association between the pelvic drop and the FPPA. The r-value was interpreted as follows: r = 0 to 0.19, no association; 0.2 to 0.39, low association; 0.4 to 0.69, moderate association; 0.7 to 0.89, high association; and 0.9 to 1.0, strong association. All statistical analyses were performed using the STATA (StataCorp, College Station, TX, US) software, version 12.2.

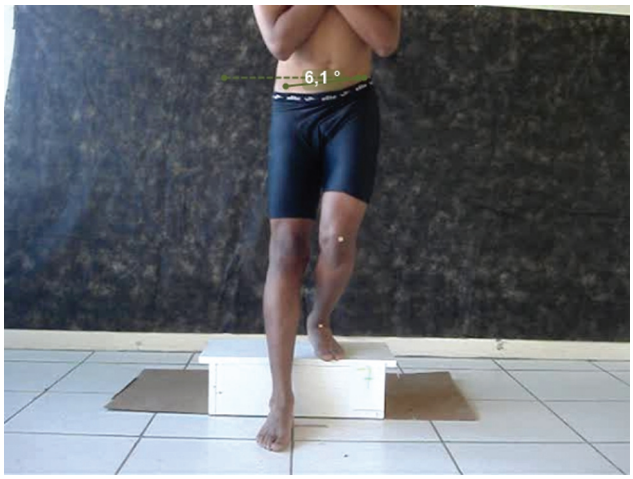

Fig. 1 Evaluation of the pelvic drop using the step-down test in young soccer players (Kinovea software, version 0.8.24).

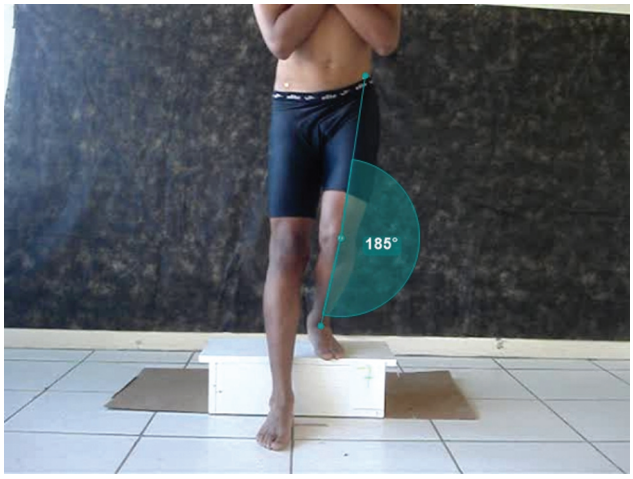

Fig. 2 Evaluation of the frontal plane projection angle(FPPA) of the knee using the step-down test in young soccer players (Kinovea software, version 0.8.24).

Results

The characteristics of the sample are presented in ►**Table 1**. There was a disparity between the male and female athletes regarding the time of soccer practice, and it must be highlighted that 89.5% of men had been playing for 5 years or more, compared to only 5.3% of women.

►**Table 2** compares the mean pelvic drop and mean FPPA in female and male athletes submitted to the step-down test. Although there is no significant difference regarding the pelvic drop, female athletes present, on average, a greater varus angle on the step-down test ($p = 0.04$).

►**Table 3** shows that the association between the pelvic drop and the varus angle of the knee is weak in both genders; as such, this is not the main factor for joint misalignment in our sample of young athletes.

Discussion

The main finding of the present study was that young female soccer athletes had lower knee alignment in the frontal plane

Table 1 Characteristics of the sample of young soccer players

	Gender	Under-15	Under-17	Total
Mean (standard deviation) age (in years)	Male	15 (0.00)	16.6 (0.51)	16.4 (0.69)
	Female	14.5 (1.07)	17 (0.00)	15.9 (1.43)
Time of practice				
Less than 1 year	Male	0%	0%	0%
	Female	50%	27.3%	36.8%
1 year	Male	0%	5.9%	5.25%
	Female	12.5%	18.2%	15.8%
2 years	Male	0%	0%	0%
	Female	25%	36.3%	31.6%
3 years	Male	0%	5.9%	5.25%
	Female	12.5%	9.1%	10.5%
5 years or more	Male	100%	88.2%	89.5%
	Female	0%	9.1%	5.3%
Guided soccer practice				
Once a week	Male	0%	0%	0%
	Female	37.5%	18.2%	26.3%
3 times a week	Male	50%	35.3%	36.8%
	Female	50%	54.5%	52.6%
More than 3 times a week	Male	50%	64.7%	63.2%
	Female	12.5%	27.3%	21.1%

Table 2 Comparison of the knee FPPA and pelvic drop using the step-down test in young soccer players

		Male			Female		
	N	Mean	Standard deviation	N	Mean	Standard deviation	*p*-value
FPPA (degrees)	19	3.91	2.00	19	9.42	1.65	0.04*
Pelvic drop (cm)	19	9.00	3.02	19	9.67	3.25	0.51

Abbreviation: FPPA, frontal plane projection angle.
Notes: Student *t*-test; *statistically-significant difference.

(varus deviation) during the step-down test. In addition, the pelvic drop was observed in both males and females, but it does not seem to be the main factor related to this misalignment.

Although pelvic muscle weakness is usually associated with dynamic valgus compensation, soccer athletes, like those in our sample, present a trend toward varus.[19] The varus is characterized by hip abduction and lateral rotation of the knee. Particularly in soccer, a change in the postural knee pattern to varus is common due to the greater use of hip abduction and flexion chains according to the specific sport movement.[7,20]

Our study dynamically evaluated the pelvic drop and frontal knee alignment of both male and female adolescent athletes using the step-down test. For weight-unloading activities in a closed kinetic chain, force results from a ground reaction medially to the knee joint, leading to a possible joint misalignment, which is resisted primarily by the collateral ligaments and adjoining musculature.[21] In fact, lower-limb misalignment occurs in sports,[22] and the female population apparently presents the greatest angular variations in the frontal plane due to lower joint stability and higher weakness in the pelvic girdle muscles.[9,23,24] However, other factors require further analysis.[7,25] In decelerating sport movements, women have lower knee flexion angles during the initial contact with the ground, because they

Table 3 Association between knee angle in the frontal plane and pelvic drop on the step-down test in young soccer players

	r-value*	*p*-value
Total (N = 38)	0.34	0.13
Male (N = 19)	0.31	0.19
Female (N = 19)	0.35	0.14

Note: *Pearson correlation.

present a biomechanical decrease in hip-flexion angles.[3] The muscles surrounding the hip joint play a key role in stabilization during movement, especially in the dynamic frontal knee alignment;[26] as such, weakened hip muscles can render women more susceptible to sports injuries, especially those with increased severity, including to the knee ligaments.[10,12,14,27,28]

Strengthening the trunk, pelvis and hip muscles can increase stability and decrease knee misalignment during the step-down test,[6] and this generally involves all lower-limb kinematics.[29,30] In addition to muscle strength, a greater range of motion also appears to be important. A study with 39 young female soccer players showed an inverse correlation between the range of motion of the hip and knee alignment, that is, a lower range of motion of the hip is associated with greater frontal misalignment;[20] pelvic girdle stability seems more complex than the mere analysis of its drop during movement.

In addition for a greater control of the pelvic and trunk muscles, programs and instructions for the control of knee alignment during movement can decrease pain and improve functional performance, especially in women.[10] In a study[31] carried out with 22 athletes, women had a higher electromyographic activation of the quadriceps and lower activation of the maximum gluteus during single-leg landing when compared to men. Therefore, increased quadriceps activity combined to lower gluteal activity can contribute to the altered energy absorption during landing by overloading other lower-limb muscle groups and increasing the risk of injury.[31] Programs guided by trained professionals can increase the activation of specific muscles, improving the quadriceps–hamstring ratio and the function of the hip adductor and abductor muscles. These programs are important for joint stability and alignment, and they benefit soccer athletes, especially females.[17]

It is also worth mentioning that, in addition to gender-related physiological differences, that is, the greater dynamic knee misalignment in women due to the lower muscle strength, greater widening of the pelvis and increased ligament laxity, resulting in an increased susceptibility to sports injuries compared to men, it is logical that long-term training facilitates the proper execution of sport movements, saving energy and potentially protecting the athlete from injuries. Regarding teenage soccer, males often play for a longer time and with higher frequency; this is consistent with our findings, in which almost 90% of the male participants had been playing for more than 5 years, compared to only 5% of the female athletes. As such, clinical care and injury prevention must be potentialized in females since their teen years.

Although the present is a cross-sectional study, which may limit conclusions about the cause–effect relationship in knee alignment, we believe that it is essential that health professionals working with athletes are be able to identify dynamic misalignments and institute specific injury-prevention protocols starting at the youth ranks, with special attention to the female population due to their physiological and biomechanical predisposition to a higher incidence and severity of injuries.

Conclusion

Even though both genders presented a pelvic drop, young female athletes had greater varus knee angles on the step-down test, and require greater attention to minimize the risk of injury.

Conflict of Interests
The authors have no conflict of interests to declare.

References

1 Abrahão GS, Caixeta LF, Barbosa LR, Siqueira dPP, Carvalho LC, Matheus JPC. Incidência das lesões ortopédicas por segmento anatômico associado à avaliação da frequência e intensidade da dor em uma equipe de futebol amador. Braz J Biomotr 2009;3(02): 152–158
2 Almeron MM, Pacheco AM, Pacheco I. Relação entre fatores de risco intrínsecos e extrínsecos e a prevalência de lesões em membros inferiores em atletas de basquetebol e voleibol. Rev Cienc Salud 2009;2(02):58–65
3 Tamura A, Akasaka K, Otsudo T, Shiozawa J, Toda Y, Yamada K. Dynamic knee valgus alignment influences impact attenuation in the lower extremity during the deceleration phase of a single-leg landing. PLoS One 2017;12(06):e0179810
4 Lima YL, Ferreira VMLM, de Paula Lima PO, Bezerra MA, de Oliveira RR, Almeida GPL. The association of ankle dorsiflexion and dynamic knee valgus: A systematic review and meta-analysis. Phys Ther Sport 2018;29:61–69
5 Schmitz RJ, Shultz SJ, Nguyen AD. Dynamic valgus alignment and functional strength in males and females during maturation. J Athl Train 2009;44(01):26–32
6 Araújo VL, Souza TR, Carvalhais VODC, Cruz AC, Fonseca ST. Effects of hip and trunk muscle strengthening on hip function and lower limb kinematics during step-down task. Clin Biomech (Bristol, Avon) 2017;44(01):28–35
7 Bittencourt NF, Ocarino JM, Mendonça LD, Hewett TE, Fonseca ST. Foot and hip contributions to high frontal plane knee projection angle in athletes: a classification and regression tree approach. J Orthop Sports Phys Ther 2012;42(12):996–1004
8 Snyder KR, Earl JE, O'Connor KM, Ebersole KT. Resistance training is accompanied by increases in hip strength and changes in lower extremity biomechanics during running. Clin Biomech (Bristol, Avon) 2009;24(01):26–34
9 Magalhães E, Fukuda TY, Sacramento SN, Forgas A, Cohen M, Abdalla RJ. A comparison of hip strength between sedentary females with and without patellofemoral pain syndrome. J Orthop Sports Phys Ther 2010;40(10):641–647
10 Emamvirdi M, Letafatkar A, Khaleghi Tazji M. The Effect of Valgus Control Instruction Exercises on Pain, Strength, and Functionality in Active Females With Patellofemoral Pain Syndrome. Sports Health 2019;11(03):223–237
11 Brophy RH, Chiaia TA, Maschi R, et al. The core and hip in soccer athletes compared by gender. Int J Sports Med 2009;30(09): 663–667
12 Larruskain J, Lekue JA, Diaz N, Odriozola A, Gil SM. A comparison of injuries in elite male and female football players: A five-season prospective study. Scand J Med Sci Sports 2018;28(01):237–245
13 Watson A, Mjaanes JMCOUNCIL ON SPORTS MEDICINE AND FITNESS. Soccer Injuries in Children and Adolescents. Pediatrics 2019;144(05):e20192759
14 Heiderscheit BC. Lower extremity injuries: is it just about hip strength? J Orthop Sports Phys Ther 2010;40(02):39–41
15 Sieńko-Awierianów E, Chudecka M. Risk of Injury in Physically Active Students: Associated Factors and Quality of Life Aspects. Int J Environ Res Public Health 2020;17(07):2564

16 Cesar GM. Influência do ciclo menstrual na atividade eletromiográfica e na cinemática do joelho durante a aterrissagem do salto [dissertação]. São Carlos: Programa de Pós Graduação em Fisioterapia, Universidade Federal de São Carlos; 2009
17 Rodríguez C, Echegoyen S, Aoyama T. The effects of "Prevent Injury and Enhance Performance Program" in a female soccer team. J Sports Med Phys Fitness 2018;58(05):659–663
18 Crossley KM, Bennell KL, Cowan SM, Green S. Analysis of outcome measures for persons with patellofemoral pain: which are reliable and valid? Arch Phys Med Rehabil 2004;85(05):815–822
19 de Rezende LFM, Santos M, Araújo TL, Matsudo VKR. A prática do futebol acentua os graus de geno varo? Rev Bras Med Esporte 2011;14(05):329–333
20 Sigward SM, Ota S, Powers CM. Predictors of frontal plane knee excursion during a drop land in young female soccer players. J Orthop Sports Phys Ther 2008;38(11):661–667
21 Powers CM. The influence of abnormal hip mechanics on knee injury: a biomechanical perspective. J Orthop Sports Phys Ther 2010;40(02):42–51
22 Burnet EN, Pidcoe PE. Isometric gluteus medius muscle torque and frontal plane pelvic motion during running. J Sports Sci Med 2009;8(02):284–288
23 Souza RB, Powers CM. Differences in hip kinematics, muscle strength, and muscle activation between subjects with and without patellofemoral pain. J Orthop Sports Phys Ther 2009;39(01):12–19
24 Herrington L. Knee valgus angle during landing tasks in female volleyball and basketball players. J Strength Cond Res 2011;25 (01):262–266
25 Cruz AC, Fonseca ST, Araújo VL, et al. Pelvic Drop Changes due to Proximal Muscle Strengthening Depend on Foot-Ankle Varus Alignment. Appl Bionics Biomech 2019;2019:2018059
26 Claiborne TL, Armstrong CW, Gandhi V, Pincivero DM. Relationship between hip and knee strength and knee valgus during a single leg squat. J Appl Biomech 2006;22(01):41–50
27 Resende RA, Kirkwood RN, Figueiredo EM. Cinemática da marcha de adultos jovens: dados normativos iniciais. Rev Ter Manual 2010;8(39):370–376
28 Baldon RM, Lobato DF, Carvalho LP, Wun PY, Serrão FV. Diferenças biomecânicas entre os gêneros e sua importância nas lesões do joelho. Fisioter Mov 2011;24(01):157–166
29 Barendrecht M, Lezeman HC, Duysens J, Smits-Engelsman BC. Neuromuscular training improves knee kinematics, in particular in valgus aligned adolescent team handball players of both sexes. J Strength Cond Res 2011;25(03):575–584
30 Willy RW, Davis IS. The effect of a hip-strengthening program on mechanics during running and during a single-leg squat. J Orthop Sports Phys Ther 2011;41(09):625–632
31 Zazulak BT, Ponce PL, Straub SJ, Medvecky MJ, Avedisian L, Hewett TE. Gender comparison of hip muscle activity during single-leg landing. J Orthop Sports Phys Ther 2005;35(05):292–299

Diagnosis and Treatment of Trigger Finger in Brazil – A Cross-Sectional Study*

Diagnóstico e tratamento do dedo de gatilho no Brasil - Estudo transversal

Paulo Henrique Jeronimo da Silva[1] Vinícius Ynoe de Moraes[1] Nicolau Granado Segre[1] Edson Sasahara Sato[1] Flávio Faloppa[1] João Carlos Belloti[1]

[1] Orthopedics and Traumatology Department, Escola Paulista de Medicina, Universidade Federal de São Paulo, São Paulo, Brazil

Rev Bras Ortop 2021;56(2):181–191.

Address for correspondence Paulo Henrique Jerônimo da Silva, Departamento de Ortopedia e Traumatologia, Escola Paulista de Medicina, Universidade Federal de São Paulo, Rua Botucatu, 740 - Térreo – Protocolo, São Paulo, SP, 04023-900, Brazil (e-mail: pauloepm76@yahoo.com.br).

Abstract

Objective The present paper aims to evaluate the therapeutic planning for trigger finger by Brazilian orthopedists.

Methods This is a cross-sectional study with a population composed of participants from the 2018 Brazilian Congress on Orthopedics and Traumatology (CBOT-2018, in the Portuguese acronym), who answered a questionnaire about the conduct adopted for trigger finger diagnosis and treatment.

Results A total of 243 participants were analyzed, with an average age of 37.46 years old; most participants were male (88%), with at least 1 year of experience (55.6%) and from Southeast Brazil (68.3%). Questionnaire analysis revealed a consensus on the following issues: diagnosis based on physical examination alone (73.3%), use of the Quinnell classification modified by Green (58.4%), initial nonsurgical treatment (91.4%), infiltration of steroids combined with an anesthetic agent (61.7%), nonsurgical treatment time ranging from 1 to 3 months (52.3%), surgical treatment using the open approach (84.4%), mainly the transverse open approach (51%), triggering recurrence as the main nonsurgical complication (58%), and open surgery success in $>$ 90% of the cases (63%), with healing intercurrences (54%) as the main complication. There was no consensus on the remaining variables. Orthopedists with different practicing times disagree on treatment duration ($p = 0.013$) and on the complication rate of open surgery ($p = 0.010$).

Conclusions Brazilian orthopedists prefer to diagnose trigger finger with physical examination alone, to classify it according to the Quinnell method modified by Green,

Keywords

- trigger finger
- questionnaire
- cross-sectional study
- stenosing tenosynovitis

* *Study developed at the Orthopedics and Traumatology Department, Escola Paulista de Medicina, Universidade Federal de São Paulo, São Paulo, Brazil.*

received
November 14, 2019
accepted
September 16, 2020
published online
October 29, 2020

DOI https://doi.org/10.1055/s-0040-1721363.
ISSN 0102-3616.

Thieme Revinter Publicações Ltda., Rua do Matoso 170, Rio de Janeiro, RJ, CEP 20270-135, Brazil

to institute an initial nonsurgical treatment, to perform infiltrations with steroids and local anesthetic agents, to sustain the nonsurgical treatment for 1 to 3 months, and to perform the surgical treatment using a transverse open approach; in addition, they state that the main nonsurgical complication was triggering recurrence, and report open surgery success in > 90% of the cases, with healing intercurrences as the main complication.

Resumo

Objetivo Avaliar o planejamento terapêutico para o dedo em gatilho por ortopedistas brasileiros.

Métodos Estudo transversal, cuja população foi composta por participantes do Congresso Brasileiro de Ortopedia e Traumatologia 2018 (CBOT-2018). Foi aplicado um questionário sobre a conduta adotada no diagnóstico e tratamento do dedo em gatilho.

Resultados Foram analisados 243 participantes com média de idade de 37.46 anos, na maioria homens (88%), tempo de experiência de pelo menos 1 ano (55,6%), e da região Sudeste (68.3%). A análise dos questionários evidenciou que há consenso nos seguintes quesitos: diagnóstico somente com exame físico (73,3%), classificação de Quinnell modificada por Green (58,4%), tratamento inicial não cirúrgico (91,4%), infiltração de corticoide com anestésico (61,7%) tempo de tratamento não cirúrgico de 1 a 3 meses (52,3%), tratamento cirúrgico pela via aberta (84,4%), principalmente via aberta transversa (51%), recidiva do engatilhamento como principal complicação não cirúrgica (58%), e o sucesso da cirurgia aberta em > 90% (63%), sendo a sua principal complicação as complicações cicatriciais (54%). Sem consenso nas demais variáveis. De acordo com a experiência, foram observadas diferenças referentes ao tempo de tratamento ($p = 0.013$) e a taxa de complicação da cirurgia aberta ($p = 0.010$).

Conclusões O ortopedista brasileiro tem preferência pelo diagnóstico do dedo em gatilho apenas com exame físico, classifica segundo Quinnell modificado por Green, tratamento inicial não cirúrgico, infiltrações com corticoide e anestésico local, tempo de tratamento não cirúrgico de 1 a 3 meses, tratamento cirúrgico por via aberta transversa, principal complicação não cirúrgica a recidiva do engatilhamento, e considera o sucesso da cirurgia aberta em > 90% dos casos, tendo como principal complicação as complicações cicatriciais.

Palavras-chave
- dedo em gatilho
- questionário
- estudos transversais
- tenossinovite estenosante

Introduction

Trigger finger (stenosing flexor tenosynovitis) was a term first proposed by Notta in 1850.[1] This condition is a common cause of hand pain, which can result in limited finger, edema, discomfort, and disability, with a "triggering" sensation.[2]

Trigger finger is characterized by blocked sliding movements of the flexor tendon during finger flexion and extension. These pathological changes lead to a discrepancy between the relative size of the flexor tendon and its tendon sheath, resulting in an inability to flex or extend the finger comfortably.[3] The annual incidence of trigger finger in the general population is of 28 per 100,000 people.[4] Among adults, women at the 5th and 6th decades of life are the most affected by trigger finger.[3,5,6] In addition, trigger finger epidemiology is associated with other conditions, including rheumatoid arthritis, gout, carpal tunnel syndrome, De Quervain disease, and diabetes mellitus.[3,7,8]

The classic "click" and locking presentation of a trigger finger is typically sufficient for its diagnosis. However, certain cases require a differential diagnosis from other conditions, such as tendon sheath infection, calcific peritendinitis or periarthritis.[9] Ultrasonography or magnetic resonance imaging (MRI) can aid in the differential diagnosis of these cases.[10]

Currently, there are several treatment options available for trigger finger, including noninvasive and surgical procedures.[11–13] Infiltrations are often recommended as the first line of treatment, using several drugs, including steroids and hyaluronic acid, with similar outcomes.[11,14] Despite the good outcomes from the steroid treatment, many patients with trigger finger still require surgical therapy.[8,12,15,16] Sato et al.[3] compared steroid injections with percutaneous and open surgical techniques for pulley release to treat trigger finger. Patients treated with steroids presented a cure rate of 86% after 2 injections, whereas all surgical patients were cured.

Even though trigger finger is epidemiologically relevant in orthopedics and traumatology, there is no standardized, uniform clinical conduct to classify, diagnose and treat this condition. Thus, the present study aimed to evaluate diagnosis and treatment methods for trigger finger adopted by Brazilian orthopedists.

Materials and Methods

Study Type

Cross-sectional, analytical, observational study carried out in the Department of Orthopedics and Traumatology, Hospital São Paulo, Universidade Federal de São Paulo (UNIFESP, in the Portuguese acronym), São Paulo, Brazil, from August 2018 to August 2019. The present study was approved by the Research Ethics Committee under the number CAAE 11957619000005505. It was carried out during the 2018 Brazilian Congress of Orthopedics and Traumatology (CBOT-2018, in the Portuguese acronym). Brazilian orthopedists and residents from orthopedics and traumatology programs, both males and females, present at CBOT-2018, who agreed to answer the questionnaire and signed the informed consent form (ICF) were included in the study. Participants from other nationalities, nonparticipating physicians, and subjects with incomplete information were not included.

Questionnaire Application

Participants were given a questionnaire with 15 questions regarding their demographics and the conduct adopted for trigger finger diagnosis and treatment (►**Appendix 1).**

Statistical Analysis

Sample size was calculated at 230 participants considering a 5% sampling error and a 95% confidence level. Proportional homogeneity was analyzed using the chi-squared test or the Fisher exact test. The three groups of respondents were compared using analysis of variance (ANOVA). The results were analyzed with SPSS Statistics for Windows Version 16.0 (SPSS Inc., Chicago, IL USA) and GraphPad Prism 5.0 (GraphPad Software, San Diego, CA, USA) with significance set at $p < 0.05$.

Table 1 Demographics of the respondents

Variables	N	%
Gender		
Female	29	12.0
Male	212	88.0
Unknown	2	
Brazilian region		
Southeast	155	63.8
Northeast	28	11.5
South	28	11.5
Central-West	18	7.4
North	14	5.8
Practicing time		
Resident	98	40.3
Up to 1 year	10	4.1
1-5 years	35	14.4
5-10 years	26	10.7
> 10 years	74	30.5
Specialty		
Orthopedics Residence	91	37.4
Trauma	48	19.8
Knee	24	9.9
Hand	17	7
Hand Surgery Residence	12	4.9
Shoulder/Elbow	11	4.5
Spine	10	4.1
Pediatrics	8	3.3
Foot/Ankle	7	2.9
External Fixation	5	2.1
Hip	5	2.1
Bone Tumor	4	1.6
Sports Trauma	1	0.4
Mean age (years old) 37.46 ± 11.01	**Minimum** 24.00	**Maximum** 79.00

Results

The study population was composed of 243 participants. Most participants were male (88%; $n = 212$), with at least 1 year of experience in their specialties (55.6%; $n = 145$). The majority of the participants were orthopedics residents (37.4%; $n = 91$) with subspecialization in trauma (19.8%; $n = 48$). The mean age of the participants was 37.46 years old. Most of them were from Southeast Brazil (68.3%; $n = 155$) (►**Table 1**).

Trigger finger was diagnosed by 73.3% ($n = 178$) of the respondents by locking observation during physical examination, and by 25.5% ($n = 62$) of the respondents based on physical examination and ultrasonography findings. For trigger finger classification, 58.0% ($n = 142$) of the respondents used the Green system, whereas 19.0% ($n = 46$) of them adopted the Quinell method. Regarding initial treatment options, most orthopedists selected nonsurgical methods, mainly physical therapy (46.5%; $n = 113$), followed by infiltration at the A1 pulley (31.7%; $n = 77$). Steroids and anesthetic agent combinations were the preferred treatment (61.70%; $n = 150$), and these infiltrations were mostly administered once (34.1%; $n = 83$) or twice (34.9%; $n = 97$). Treatment duration ranged from 1 to 3 months for most respondents (52.30%; $n = 127$). Among surgical treatment options, the open transverse approach (51.0%; $n = 124$) was the preferred procedure. The anesthesia protocol most reported by the respondents was sedation with local anesthetic administration (38.7%; $n = 94$) (►**Figure 1**).

Regarding success and complications from different treatment options, 46.6% ($n = 112$) of the respondents reported a

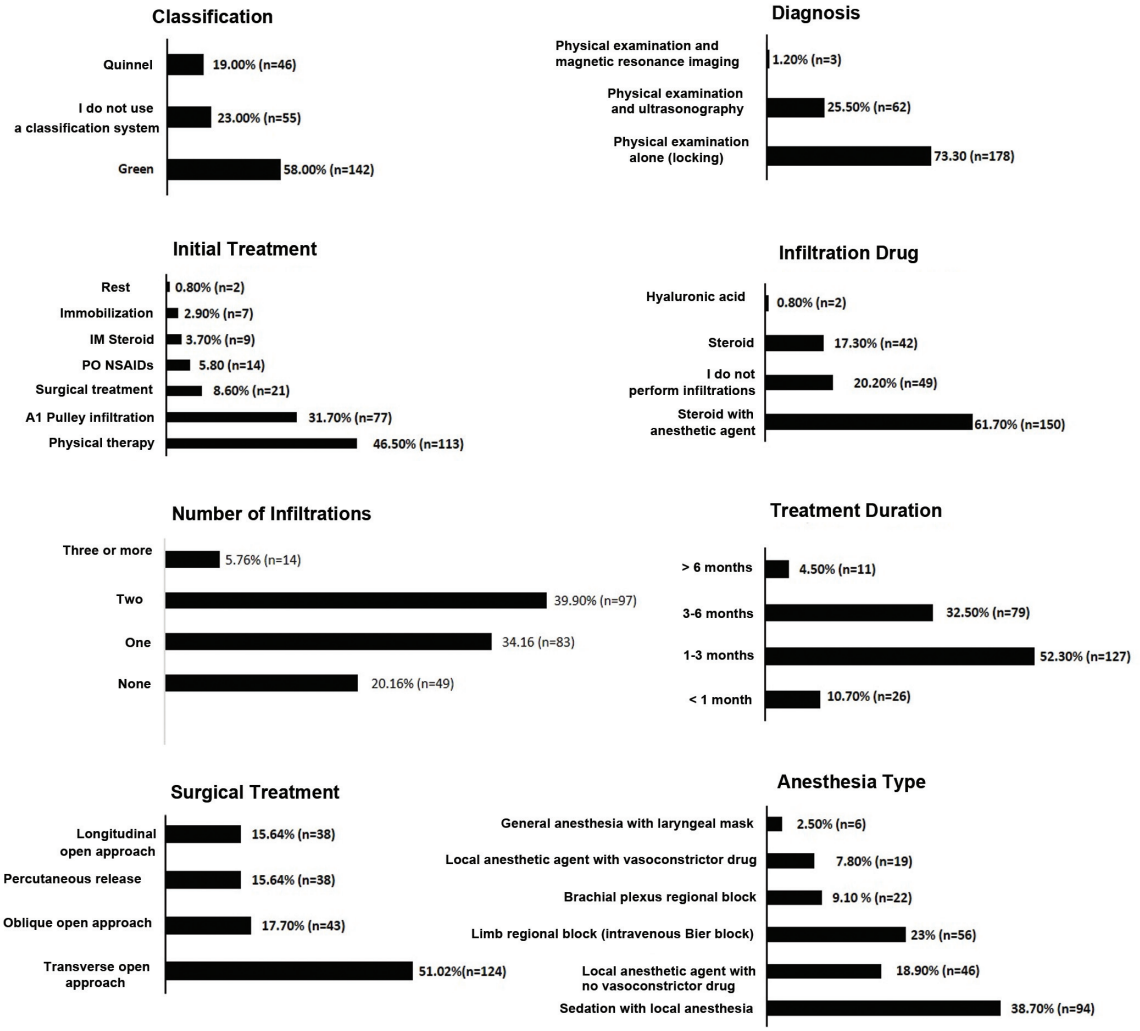

Fig. 1 Diagnosis and treatment of trigger finger. Abbreviations: IM, Intramuscular route; NSAIDs, non-steroidal anti-inflammatory drugs; PO, oral route.

success rate ranging from 30 to 60% for nonsurgical treatment; triggering recurrence was the most frequently reported complication (58.0%; $n = 140$). Percutaneous surgery had a success rate ranging from 60 to 90% for 43.0% ($n = 104$) of the respondents, and its most common complication was triggering recurrence (48.0%; $n = 117$). In contrast, open surgery had a success rate > 90.0% for 63.0% ($n = 154$) of the respondents, with healing intercurrences (54.0%; $n = 130$) as the most frequently reported complication (►**Figure 2**).

To determine whether the clinical practicing time influenced the answers pf the participants, the sample was divided into 3 groups: orthopedics residents ($n = 98$), clinical practice time ≤ 5 years ($n = 45$) and clinical practice time > 5 years ($n = 100$). All groups presented a higher frequency of male professionals, and the resident group (21.4%; $n = 21$) had the highest proportion of female participants compared with the remaining groups, with $p < 0.001$. As expected, residents had a lower mean age compared with the other groups, with $p < 0.001$. There was no statistically significant difference for the regional distribution of the participants (►**Table 2**).

There were no differences ($p > 0.05$) regarding trigger finger diagnosis and classification options according to the practicing time of the participants (►**Table 3**). Regarding nonsurgical treatment options and the practicing time of the orthopedist, differences in treatment duration were observed ($p = 0.013$). A treatment duration ranging from 1 to 3 months was the most commonly reported. However, a greater proportion of respondents with ≤ 5 years of experience (17.8%; $n = 8$) reported that the treatment lasted < 1 month compared with residents (7.1%; $n = 7$) and participants with > 5 years of experience (11.0%; $n = 11$). In addition, more residents stated that the treatment lasted for > 6 months (8.2%; $n = 8$) compared with participants with ≤ 5 years (0.0%; $n = 0$) or > 5 years (3.0%; $n = 3$) of experience.

Regarding surgical treatments according to the practicing time of the participants, there was a difference in open surgery in complications ($p = 0.010$) (►**Table 4**). Surgical wound complications were the most frequently mentioned

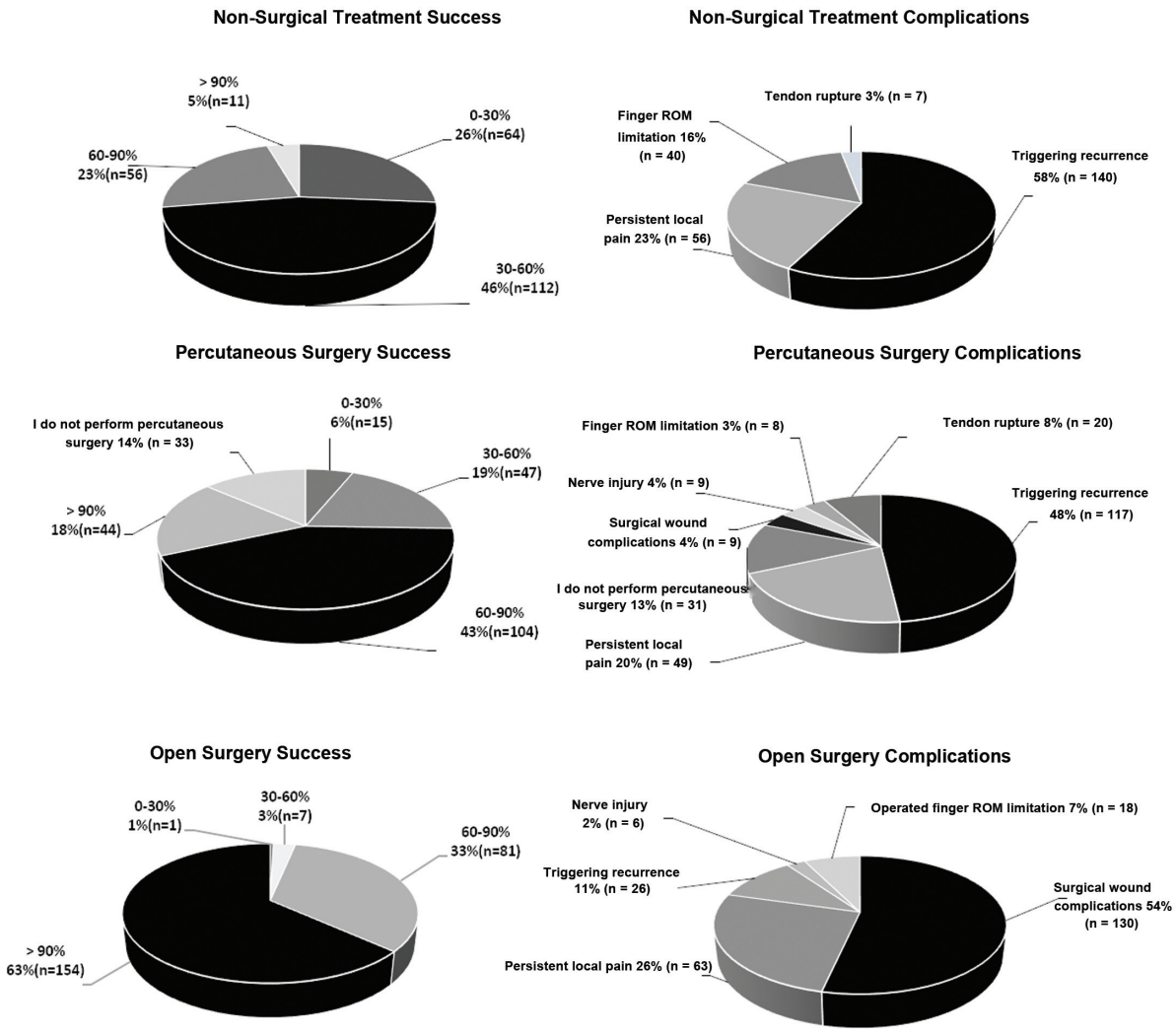

Fig. 2 Success and complications of trigger finger treatments. Surgical wound complications include adhesions, hematoma, and infection. Abbreviations: ROM, range of motion.

in all three groups. Persistent pain was reported by a higher number of residents (32.6%; $n = 32$) compared with professionals with $\leq$ 5 years (22.2%; $n = 10$) or $>$ 5 years (21.0%; $n = 21$) of experience. In addition, triggering recurrence was more observed by orthopedists with $>$ 5 years (16.0%; $n = 16$) of experience compared with residents (8.2%; $n = 8$) and professionals with $\leq$ 5 years (4.4%; $n = 2$) of clinical practice.

Discussion

The total sample consisted of 243 participants, with an average age of 37.46 years old. Most participants completed residence and had $>$ 10 years of clinical practice. This number of respondents was higher compared to other Brazilian studies evaluating orthopedists.[17–19] Okamura et al.[18] evaluated trends in carpal tunnel syndrome planning, diagnosis and treatment by Brazilian surgeons and reported that 40% of orthopedists had been practicing for $>$ 10 years.

Trigger finger was diagnosed due to locking observation during physical examination by 73.3% ($n = 178$) of the respondents; for 25.5% ($n = 62$) of the respondents, the diagnosis was based on physical examination and ultrasonography findings. These figures are consistent with the literature. Trigger finger is known for its classic presentation of snap and locking at the physical examination, which is typically sufficient for its diagnosis.[10] As such, radiographs are not required for trigger finger diagnosis.[20]

Several classification systems have been proposed for trigger finger.[1] In our study, the most used classifications are those by Green et al.[21] and Quinnell et al.,[15] with no differences according to the practicing time of the orthopedist. These results agree with a systematic review from Fiorini et al.[22]

Table 2 Respondents profile according to practicing time

	Practicing Time						
	Resident ($n = 98$)		$\leq$ 5 years ($n = 45$)		$>$ 5 years ($n = 100$)		
Variable							*p-value*
Age							
Mean	29.65 ± 3.58		32.60 ± 3.17		47.30 ± 10.50		$<$ **0.0001****
Gender	*n*	%	*n*	%	*n*	%	
Male	77	78.6	39	88.6	96	97.0	$<$ **0.001***
Female	21	21.4	5	11.4	3	3.0	
Unknown	2						
Region							
Southeast	68	69.39	25	55.56	62	62.0	0.227**
Central-West	9	8.82	1	2.22	8	8.0	
Northeast	9	8.82	9	20.00	10	10.0	
North	4	3.92	2	4.44	8	8.0	
South	8	7.84	8	17.78	12	12.0	

ANOVA*, Fischer test,** and chi-squared tests*** were used, considering $p < 0.05$ for statistically significant difference.

showing that most studies on trigger finger use the Quinnell classification for disease characterization.[3,22]

The initial treatment for trigger finger is conservative, including nonsteroidal anti-inflammatory drugs, immobilization, physical therapy and infiltrations.[11,22,23] Physical therapy is a conservative treatment for trigger finger, but some authors question its success.[24,25] Still, Salim et al.[24] compared the efficacy of physical therapy and steroid injection in the treatment of mild trigger finger. At 3 months, the success rate of steroid injections and physical therapy was of 97.4% and 68.6%, respectively. However, after 6 months of treatment, only patients treated with steroids experience pain and recurrence.

The opinion of the respondents on infiltration is consistent with studies recommending steroid injections as the first line of treatment.[11,23] The preference for steroid and anesthetic agent combinations for treatment was reported by 61.70% of respondents, especially in 1 or 2 applications. This conduct is consistent with the studies carried out by Clark et al.[26] and Rhoades et al.,[27] showing that a single-dose treatment can result in a success rate ranging from 72 to 82%. In addition, Marks et al.[23] reported an increased success rate of 91% after a second injection compared with the 84% success rate achieved with the first injection

The divergence of the conduct of the respondents regarding nonsurgical treatment duration with their practicing time reflects the several approaches reported in the literature. The preferred treatment duration ranged from 1 to 3 months, and differed according to the practicing time of the orthopedist, with $p = 0.013$. A treatment duration of < 1 month was mostly reported by respondents with a practicing time $\geq$ 5 years, whereas residents stated that treatment should last for at least 6 months. Some clinical studies in trigger finger adopt a 2- to 3-month follow-up,[28,29] which is similar to our findings. In contrast, other studies reported treatment for $>$ 6 months.[3,30]

Nonsurgical treatment had a success rate ranging from 30 to 60% for 46% of the respondents, and triggering recurrence was the most commonly reported complication. This success rate is inconsistent with a study from Sato et al.,[3] who reported a cure rate of 57% of patients undergoing steroid injection, which increased to 86% with the second infiltration. Despite the good outcomes from steroids, this technique has important limitations, such as the recurrence rate of up to 48%; in addition, this data agrees with the conduct of the respondents.[3,22]

Surgical treatment of trigger finger can use either an open or percutaneous approach. Among surgical treatment options, the preference of the respondents for open transverse (51.02%) and open oblique (17.70%) procedures was highlighted. This finding is consistent with other studies that indicate open surgical release as the standard technique for trigger finger surgical treatment, with no consensus on the best access route.[11,23]

Outpatient-based hand surgery has stimulated the use of local anesthesia and sedation to reduce hospitalization costs and time.[6,13,31,32] Our results are consistent with this approach. Respondents prefer sedation with local anesthetic agents (38.70%), which are considered a safe, quick, and effective option. However, its administration is painful and $\sim$10% of the patients prefer another form of anesthesia.[31] Thus, additional sedation can render the procedure more comfortable. The use of a local anesthetic agent with a vasoconstrictor drug was rarely stated by respondents (7.8%; $n = 19$), although it is known to be safe in hand surgeries.[33] A Brazilian study evaluated the use of local anesthesia with lidocaine and epinephrine in wrist, hand and finger surgery, with no tourniquet, sedation or anesthetist and did not report any epinephrine-related complications.[34]

Surgical treatment for trigger finger has a reported success rate of up to 97%.[3,22] Percutaneous surgery had 60 to 90%

Table 3 Nonsurgical diagnosis and treatment of trigger finger according to the practicing time of the orthopedist

	Practicing Time			
Variable	**Resident ($n = 98$)**	**$\leq$ 5 years ($n = 45$)**	**$>$ 5 years ($n = 100$)**	***p-value***
Diagnosis				
Physical examination alone (locking)	68 (69.4%)	34 (75.6%)	76 (76.0%)	0.146**
Physical examination and ultrasonography	30 (30.6%)	9 (20.0%)	23 (23.0%)	
Physical examination and magnetic resonance imaging	0 (0%)	2 (4.4%)	1 (1.0%)	
Classification				
Green	50 (51.0%)	28 (62.2%)	64 (64.0%)	0.375*
I do not use a classification system to treat	27 (27.6%)	10 (22.2%)	18 (18.0%)	
Quinell	21 (21.4%)	7 (15.6%)	18 (18.0%)	
Initial treatment				
Physical therapy	43 (43.9%)	17 (37.8%)	53 (53.0%)	0.672**
A1 Pulley infiltration	34 (34.7%)	17 (37.8%)	26 (26.0%)	
Surgical treatment	9 (9.2%)	5 (11.1%)	7 (7.0%)	
NSAIDs, PO	7 (7.1%)	2 (4.4%)	5 (5.0%)	
Steroid, IM	2 (2.0%)	2 (4.4%)	5 (5.0%)	
Immobilization	2 (2.0%)	1 (2.2%)	4 (4.0%)	
Rest	1 (1.0%)	1 (2.2%)	0 (0%)	
Drug used for infiltration				
Steroid with anesthetic agent	62 (63.3%)	29 (64.4%)	59 (59.0%)	0.626**
I do not perform infiltrations	21 (21.4%)	8 (17.8%)	20 (20.0%)	
Steroids	15 (15.3%)	8 (17.8%)	19 (19.0%)	
Hyaluronic acid	0 (0%)	0 (0%)	2 (2.0%)	
Number of Infiltrations				
None	19 (19.4%)	10 (22.2%)	20 (20.0%)	0.274**
1	41 (41.8%)	10 (22.2%)	32 (32.0%)	
2	34 (34.7%)	20 (44.5%)	43 (43.0%)	
$\geq$ 3	4 (4.1%)00	5 (11.1%)	5 (5.0%)	
Treatment Duration				
$<$ 1 month	7 (7.1%)	8 (17.8%)	11 (11.0%)	**0.013****
1-3 months	46 (46.9%)	29 (64.4%)	52 (52.0%)	
3-6 months	37 (37.8%)	8 (17.8%)	34 (34.0%)	
$>$ 6 months	8 (8.2%)	0 (0%)	3 (3.0%)	
Nonsurgical Treatment Complications				
Triggering recurrence	55 (56.1%)	27 (60.0%)	58 (58.0%)	
Persistent local pain	27 (27.6%)	8 (17.8%)	21 (21.0%)	0.805**
Limited finger ROM	14 (14.3%)	9 (20.0%)	17 (17.0%)	
Tendon rupture	2 (2.0%)	1 (2.2%)	4 (4.0%)	
Nonsurgical Treatment Success Rate				
0-30%	25 (25.5%)	9 (20.0%)	30 (30.0%)	0.616**
30-60%	47 (48.0%)	22 (48.9%)	43 (43.0%)	
60-90%	24 (24.5%)	11 (24.4%)	21 (21.0%)	
$>$ 90%	2 (2.0%)	3 (6.7%)	6 (6.0%)	

Abbreviations: IM, Intramuscular route; NSAIDs: non-steroidal anti-inflammatory drugs; PO: oral route; ROM, range of motion.
Healing complications include adhesions, hematoma, and infection. Fischer test** and chi-squared test*** were used, considering $p < 0.05$ for statistically significant difference.

Table 4 Surgical treatment for trigger finger according the practicing time of the orthopedist

	Practicing Time			
Variable	Resident ($n = 98$)	$\leq$ 5 years ($n = 45$)	$>$ 5 years ($n = 100$)	*p-value*
Anesthesia type				
Sedation with local anesthesia	35 (35.7%)	17 (37.8%)	42 (42.0%)	0.953**
Limb regional block#	23 (23.5%)	12 (26.7%)	21 (21.0%)	
Local anesthetic agent with no vasoconstrictor drug	21 (21.4%)	9 (20.0%)	16 (16.0%)	
Brachial plexus regional block	10 (10.2%)	4 (8.9%)	8 (8.0%)	
Local anesthetic agent with vasoconstrictor drug	7 (7.2%)	3 (6.6%)	9 (9.0%)	
General anesthesia with laryngeal mask	2 (2.0%)	0 (0%)	4 (4.0%)	
Surgical Treatment				
Transversal open approach	48 (49.0%)	24 (53.3%)	52 (52.0%)	
Oblique open approach	22 (22.4%)	6 (13.3%)	15 (15.0%)	
Percutaneous release	18 (18.4%)	7 (15.6%)	13 (13.0%)	0.366*
Longitudinal open approach	10 (10.2%)	8 (17.8%)	20 (20.0%)	
Percutaneous Surgery Complications				
Triggering recurrence	44 (44.9%)	23 (51.1%)	50 (50.0%)	
Persistent local pain	20 (20.4%)	12 (26.8%)	17 (17.0%)	0.806**
I do not perform percutaneous surgery	13 (13.2%)	5 (11.1%)	13 (13.0%)	
Tendon rupture	8 (8.2%)	1 (2.2%)	11 (11.0%)	
Operated finger ROM limitation	5 (5.1%)	1 (2.2%)	2 (2.0%)	
Nerve injury	4 (4.1%)	1 (2.2%)	4 (4.0%)	
Surgical wound complications	4 (4.1%)	2 (4.4%)	3 (3.0%)	
Open Surgery Complications				
Surgical wound complications	49 (50.0%)	26 (57.8%)	55 (55.0%)	**0.010****
Persistent local pain	32 (32.6%)	10 (22.2%)	21 (21.0%)	
Operated finger ROM limitation	8 (8.2%)	7 (15.6%)	3 (3.0%)	
Triggering recurrence	8 (8.2%)	2 (4.4%)	16 (16.0%)	
Nerve injury	1 (1.0%)	0 (0%)	5 (5.0%)	
Percutaneous Surgery Success				
0-30%	8 (8.2%)	3 (6.7%)	4 (4.0%)	0.858*
30-60%	18 (18.4%)	9 (20.0%)	20 (20.0%)	
60-90%	46 (46.9%)	17 (37.8%)	41 (41.0%)	
$>$ 90%	14 (14.3%)	10 (22.2%)	20 (20.0%)	
I do not perform percutaneous surgery	12 (12.2%)	6 (13.3%)	15 (15.0%)	
Open Surgery Success				
0-30%	0 (0%)	0 (0%)	1 (1%)	0.513*
30-60%	4 (4.1%)	2 (4.4%)	1 (1.0%)	
60-90%	34 (34.7%)	12 (26.7%)	35 (35.0%)	
$>$ 90%	60 (61.2%)	31 (68.9%)	63 (63.0%)	

Abbreviation: ROM, Range of motion.
Surgical wound complications include adhesions, hematoma, and infection; regional limb block refers to an intravenous Bier block. Fischer test** and chi-squared test*** were used, considering $p < 0.05$ for statistically significant difference..

of success for 43.0% of respondents, and its most common complication was triggering recurrence. In contrast, open surgery had a success rate > 90% for 63% of respondents. Regarding percutaneous surgery, the findings are not consistent with the literature, which shows that open and percutaneous procedures had similar efficacy, > 90%.[3]

Surgical wound intercurrences were the most reported complications of open surgery; however, there was a difference according to clinical practicing time, with $p = 0.010$. Persistent pain was more observed by residents, while trigger recurrence was more reported by professionals with > 5 years of clinical practice. Outcomes from open release of the A1 pulley are usually excellent,[11] with high success rates and minimal recurrence. Despite this, there are reports of complications, such as painful scars, infection, nerve damage and recurrence.[3,35]

Conclusion

When performing the therapeutic plan for trigger finger, Brazilian orthopedists establish the diagnosis with physical examination alone, use the Quinnell classification modified by Green, and initially institute a nonsurgical treatment for 1 to 3 months, consisting of infiltrations with steroids and local anesthetic agents; in case of failure, they opt for surgical treatment using an open transverse approach, which is successful in > 90% of patients. The main nonsurgical complications were triggering recurrences, and the main surgical complications were healing intercurrences.

Conflict of Interests

The authors have no conflict of interests to declare.

References

1 Yang TH, Chen HC, Liu YC, et al. Clinical and pathological correlates of severity classifications in trigger fingers based on computer-aided image analysis. Biomed Eng Online 2014;13(01):100
2 Clapham PJ, Chung KC. A historical perspective of the Notta's node in trigger fingers. J Hand Surg Am 2009;34(08):1518–1522
3 Sato ES, Gomes Dos Santos JB, Belloti JC, Albertoni WM, Faloppa F. Treatment of trigger finger: randomized clinical trial comparing the methods of corticosteroid injection, percutaneous release and open surgery. Rheumatology (Oxford) 2012;51(01):93–99
4 Saldana MJ. Trigger digits: diagnosis and treatment. J Am Acad Orthop Surg 2001;9(04):246–252
5 Marij Z, Aurangzeb Q, Rizwan HR, Haroon R, Pervaiz MH. Outpatient Percutaneous Release of Trigger Finger: A Cost Effective and Safe Procedure. Malays Orthop J 2017;11(01):52–56
6 de Freitas Novais Junior RA, Bacelar Costa JR, de Morais Carmo JM. Use of adrenalin with lidocaine in hand surgery. Rev Bras Ortop 2014;49(05):452–460
7 Freiberg A, Mulholland RS, Levine R. Nonoperative treatment of trigger fingers and thumbs. J Hand Surg Am 1989;14(03):553–558
8 Giordano M, Giordano V, Giordano J. Tratamento do dedo em gatilho pela injecao local de corticosteroide. Rev Bras Ortop 1997; 32(12):971–974
9 Kameyama M, Meguro S, Funae O, Atsumi Y, Ikegami H. The presence of limited joint mobility is significantly associated with multiple digit involvement by stenosing flexor tenosynovitis in diabetics. J Rheumatol 2009;36(08):1686–1690
10 Makkouk AH, Oetgen ME, Swigart CR, Dodds SD. Trigger finger: etiology, evaluation, and treatment. Curr Rev Musculoskelet Med 2008;1(02):92–96
11 Wang J, Zhao JG, Liang CC. Percutaneous release, open surgery, or corticosteroid injection, which is the best treatment method for trigger digits? Clin Orthop Relat Res 2013;471(06):1879–1886
12 Sato ES, dos Santos JB, Belloti JC, Albertoni WMFF, Faloppa F. Percutaneous release of trigger fingers. Hand Clin 2014;30(01):39–45
13 Mehlmann FM, Ferraro LH, Sousa PC, Cunha GP, Bergamaschi EC, Takeda A. Bloqueios seletivos guiados por ultrassom para cirurgias de dedo em gatilho para manutenção da flexão/extensão dos dedos – Série de casos. Braz J Anesthesiol 2019;69(01):104–108
14 Liu DH, Tsai MW, Lin SH, et al. Ultrasound-Guided Hyaluronic Acid Injections for Trigger Finger: A Double-Blinded, Randomized Controlled Trial. Arch Phys Med Rehabil 2015;96(12):2120–2127
15 Quinnell RC. Conservative management of trigger finger. Practitioner 1980;224(1340):187–190
16 Eastwood DM, Gupta KJ, Johnson DP. Percutaneous release of the trigger finger: an office procedure. J Hand Surg Am 1992;17(01): 114–117
17 Alves PL, Ueta FTS, Ueta RHS, et al. Perfil do cirurgião de coluna brasileiro. Coluna/Columna 2013;12(03):218–223
18 Okamura A, Guidetti BC, Caselli R, Borracini JA, Moraes VY, Belloti JC. How Do Board-Certified Hand Surgeons Manage Carpal Tunnel Syndrome? a National Survey. Acta Ortop Bras 2018;26(01):48–53
19 Matsumoto MK, Fernandes M, de Moraes VY, Raduan J, Okamura A, Belloti JC. Treatment of Fingertip Injuries By Specialists in Hand Surgery in Brazil. Acta Ortop Bras 2018;26(05):294–299
20 Katzman BM, Steinberg DR, Bozentka DJ, Cain E, Caligiuri DAGJ, Geller J. Utility of obtaining radiographs in patients with trigger finger. Am J Orthop 1999;28(12):703–705
21 Wolfe SW. Tenosynovitis. In: Green DP, Hotchkiss RN, Pederson WC, Wolfe SW, eds. Green's Operative Hand Surgery. Philadelphia: Elsevier; 2005:2137–2158
22 Fiorini HJ, Tamaoki MJ, Lenza M, Gomes dos Santos JB, Faloppa F, Belloti JC. Surgery for trigger finger (Review) Summary of Findings for the main Comparison. Cochrane Database Syst Rev 2018;(02):1–9
23 Marks MR, Gunther SF. Efficacy of cortisone injection in treatment of trigger fingers and thumbs. J Hand Surg Am 1989;14(04):722–727
24 Salim N, Abdullah S, Sapuan J, Haflah NHM. Outcome of corticosteroid injection versus physiotherapy in the treatment of mild trigger fingers. J Hand Surg Eur Vol 2012;37(01):27–34
25 Yildirim P, Gultekin A, Yildirim A, Karahan AY, Tok F. Extracorporeal shock wave therapy versus corticosteroid injection in the treatment of trigger finger: a randomized controlled study. J Hand Surg Eur Vol 2016;41(09):977–983
26 Clark DD, Ricker JH, MacCollum MS. The efficacy of local steroid injection in the treatment of stenosing tenovaginitis. Plast Reconstr Surg 1973;51(02):179–180
27 Rhoades CE, Gelberman RH, Manjarris JF. Stenosing tenosynovitis of the fingers and thumb. Results of a prospective trial of steroid injection and splinting. Clin Orthop Relat Res 1984;(190):236–238
28 Dierks U, Hoffmann R, Meek MF. Open versus percutaneous release of the A1-pulley for stenosing tendovaginitis: a prospective randomized trial. Tech Hand Up Extrem Surg 2008;12(03):183–187
29 Nikolaou VS, Malahias MA, Kaseta MK, Sourlas I, Babis GC. Comparative clinical study of ultrasound-guided A1 pulley release *vs* open surgical intervention in the treatment of trigger finger. World J Orthop 2017;8(02):163–169
30 Zyluk A, Jagielski G. Percutaneous A1 pulley release vs steroid injection for trigger digit: the results of a prospective, randomized trial. J Hand Surg Eur Vol 2011;36(01):53–56
31 Koegst WHH, Wölfle O, Thoele K, Sauerbier M. [The "Wide Awake Approach" in hand surgery: a comfortable anaesthesia method without a tourniquet]. Handchir Mikrochir Plast Chir 2011;43 (03):175–180
32 Cohen TJ. Tratamento percutaneo do dedo am gatilho. Rev Bras Ortop 1996;31(08):690–692

33 Pires Neto PJ, Moreira LA, Pires de Las Casas P. É seguro o uso de anestésico local com adrenalina na cirurgia da mão? Técnica WALANT. Rev Bras Ortop 2017;52(04):383–389
34 Sardenberg T, Ribak S, Colenci R, Campos RB, Varanda D, Cortopassi AC. 488 hand surgeries with local anesthesia with epinephrine, without a tourniquet, without sedation, and without an anesthesiologist. Rev Bras Ortop 2018;53(03):281–286
35 Turowski GA, Zdankiewicz PD, Thomson JG. The results of surgical treatment of trigger finger. J Hand Surg Am 1997;22(01):145–149

Annex 1 QUESTIONNAIRE OFF DIAGNOSIS AND TREATMENT OF TRIGGER FINGER

N A M E :
_____-
_____
AGE: _____ years

What is your speciality?
( ) Resident Orthopedics ( ) Resident hand surgery
( ) ORTHOPEDICIST / SPECIALTY:_____

How long have you been in your specialty?
a) I am a resident
b) up to 1 year
c) 1-5 years
d) 5-10 years
e) more than 10 years

1) What is the region in which you work?
a) south
b) southeast
c) north
d) northeast
e) Midwest

2) How do you diagnose a trigger finger?
a) Physical examination only (crash)
b) Physical examination and ultrasound
c) Physical examination and MRI
d) Other (specify) _____

3) What classification do you use to plan the treatment of the trigger finger?
a) Quinel
b) Green
c) other (specify) _____
d) do not use classification to treat

4) What is your preference for initial trigger finger treatment (only 1 option)?
a) physiotherapy
b) immobilization
c) VO NSAIDs
d) rest
e) IM corticoid
f) infiltration of the A1 pulley
g) surgical treatment

5) When infiltration is indicated, which substance do you prefer (only 1 option)?
a) Corticoid
b) Corticoid + anesthetic
c) Anesthetic
d) Hyaluronic acid
e) other (specify): _____

6) How many infiltrations do you perform on the trigger finger before considering treatment failure?
a) none (do not infiltrate)
b) 1
c) 2
d) 3 or more

7) How long do you treat the trigger finger until you indicate surgical treatment?
a) <1 month
b) 1-3 months
c) 3-6 months
d) >6 months

8) In the indication of surgical treatment, which type of anesthesia is your preference?
a) General anesthesia with laryngeal mask
b) Sedation + local anesthetic
d) Local anesthetic without vasoconstrictor
e) Local anesthetic with vasocontritor
f) Regional limb block () venous bier () brachial plexus block

9) In the indication of surgical treatment, what is your preference?
a) percutaneous release
b) transverse open path
c) oblique open road
d) longitudinal open path

10) What is your main complication in non-surgical treatment?
a) relapse of the triggering
b) persistent local pain
c) tendon rupture
d) ADM finger limitation

11) What is your main complication in percutaneous surgery?
a) relapse of the triggering
b) persistent local pain
c) complications of the surgical incision (adhesion, hematoma, infection)
d) ADM limitation of the operated finger
e) nerve damage
f) tendon rupture
g) I don't do percutaneous surgery

12) What is your main complication in open surgery?
a) relapse of the triggering
b) persistent local pain
c) complications of the surgical incision (adhesion, hematoma, infection)
d) ADM limitation of the operated finger

e) nerve damage

13) In your experience, what is the percentage of success with non-surgical treatment?
a) 0-30%
b) 30-60%
c) 60-90%
d) >90%

14) In your experience, what is the percentage of success with percutaneous surgical treatment?
a) 0-30%
b) 30-60%
c) 60-90%
d) >90%
e) I don't do percutaneous surgery

15) In your experience, what is the percentage of success with open surgical treatment?
a) 0-30%
b) 30-60%
c) 60-90%
d) >90%

Use of Propeller Flap in the Coverage of Soft-Tissue Injury in the Lower Limb*

Utilização de retalho em hélice para cobertura de lesões de partes moles em membro inferior

Adison de Souza Valente[1] Denis Ferreira de Borba[1] Daniel Ribeiro de Resende[1] Meyrelles Rodrigues Resende[1] Ricardo Gouvea Goulart[1] Sérgio José de Lima[1]

[1] Department of Orthopedics and Traumatology, Hospital de Urgências de Goiânia Dr. Valdemiro Cruz, Goiânia, GO, Brazil

Rev Bras Ortop 2021;56(2):192–197.

Address for correspondence Ricardo Gouvea Goulart, Departmento de Ortopedia e Traumatologia, Hospital de Urgências de Goiânia Dr. Valdemiro Cruz, Av. Pedro Ludovico, Goiânia, GO, 74820-300, Brazil (e-mail: ricardoggoulart@gmail.com).

Abstract

Objective To evaluate the use of a propeller flap to cover soft-tissue injuries in the lower limb.

Materials and Methods A retrospective study, with review of medical records, and a convenience sample of 14 patients operated between July 2018 and June 2019. The following clinical aspects were evaluated: sex; age group; type of injury; cause of the injury; initial diagnosis; affected location; techniques for incision and identification; surgical planning; flap design; postoperative period; result of the propeller flap; and complications.

Results The sample was composed of male patients (100%), with a mean age of 36.4 years, and 92.7% of the injuries resulted from motorcycle accidents, mostly on the right side (71.4%). The surgical planning of the propeller flap followed the same procedure in all cases. Immediate postsurgical complications were present in 35.7% of the cases, and they included excessive bleeding (14.3%), partial necrosis (14.3%), and flap dehiscence (7.1%). In total, 13 patients had excellent coverage, and only 1 had flap loss.

Conclusion The propeller-flap technique to cover lesions in the lower limb proved to be a good alternative in most cases evaluated, with a good surgical result, although complications were observed in some cases.

Keywords
- soft tissue injuries
- perforator flap
- lower extremity

Resumo

Objetivo Avaliar o uso de retalho em hélice para cobertura de lesões de partes moles em membro inferior.

* *Work developed at the Department of Orthopedics and Traumatology, Hospital de Urgências de Goiânia Dr. Valdemiro Cruz, Goiânia, GO, Brazil.*

received
December 11, 2019
accepted
April 15, 2020
published online
September 25, 2020

DOI https://doi.org/10.1055/s-0040-1714223.
ISSN 0102-3616.

Thieme Revinter Publicações Ltda., Rua do Matoso 170, Rio de Janeiro, RJ, CEP 20270-135, Brazil

Materiais e Métodos Estudo retrospectivo, de revisão de prontuários e amostra de conveniência, com 14 pacientes operados entre julho de 2018 e junho de 2019. Foram avaliados os seguintes aspectos clínicos: sexo; faixa etária; tipo de lesão; causa da lesão; diagnóstico inicial; local acometido; técnica de incisão e identificação; planejamento cirúrgico; desenho do retalho; pós-operatório; resultado do retalho em hélice; e complicações.

Resultados A amostra era composta por pacientes do sexo masculino (100%), com idade média de 36,4 anos, e 92,7% das lesões eram decorrentes de acidente motociclístico, a maioria do lado direito (71,4%). O planejamento cirúrgico do retalho em hélice seguiu o mesmo procedimento em todos os casos. As complicações pós-cirúrgicas imediatas estavam presentes em 35,7%, e incluíram sangramento excessivo (14,3%), necroses parciais (14,3%), e deiscência do retalho (7,1%). No total, 13 pacientes apresentaram ótima cobertura, e em apenas 1 houve perda do retalho.

Conclusão A técnica do retalho em hélice para a cobertura de lesões em membro inferior mostrou-se uma boa alternativa na maioria dos casos avaliados, com um bom resultado cirúrgico, embora tenham sido observadas complicações em alguns casos.

Palavras-chave
- lesões dos tecidos moles
- retalho perfurante
- extremidade inferior

Introduction

The World Health Organization (WHO) estimates that about 50 million victims of traffic accidents live with disabilities or sequelae.[1] In Brazil, data from the Unified Health System (Sistema Único de Saúde, SUS, in Portuguese) indicate an estimated cost of R$ 2.9 billion (Brazilian currency) due to traffic accidents.[2]

Pedestrians, cyclists, and motorcyclists are the groups most vulnerable to traffic accidents. Most patients are victims of motorcycle accidents, and they are young (25 to 35 years old) and male.[3] Polytrauma resulting from a motorcycle accident causes more serious injuries to the head and extremities, with the main causes of death being fractures of the limbs and pelvis, followed by trauma, laceration or rupture of abdominal organs, and traumatic brain injuries.[4]

Traffic accidents lead to orthopedic trauma. Advances in medicine stimulate the improvement of surgical techniques.[5] The injuries include complex injuries to the lower limbs, which are a challenge regarding which type of treatment is most appropriate.[6] Reconstructive surgeries are complex due to the anatomical characteristics that lead to difficulty in treating soft-tissue injuries.[7]

The flaps consist of mobilized tissue that is kept attached to its vascular pedicle, ensuring adequate irrigation.[8] The use of propeller flaps to cover soft-tissue injuries started in 1991 as a surgical approach to the substantial loss caused by trauma. Its use in the clinical practice has improved as knowledge about the cutaneous vascular system increased. The factors involved in choosing the most appropriate surgical technique include the location, the extent of the lesion, the exposure of noble structures, and the surgeon's experience with reconstruction techniques.[9]

The use of the propeller flap to cover lesions is an option when the area to be treated is small to medium in size, located in a well-vascularized region, and surrounded by healthy tissues. In this technique, we should consider the quality and volume of the transferred soft tissue, the orientation of the scar and the adequate planning of the flap, to enable the direct closure of the donor site without tension in the area. When these indications are respected, the propeller flap has a high success rate, low morbidity, fast recovery, good esthetic results, and reduced cost.[10]

The aim of the present article was to evaluate the use of a propeller flap to cover soft-tissue injuries in the lower limb, as well as to identify the main causes of trauma and the complications resulting from the surgical technique.

Material and Methods

The present is a retrospective cross-sectional study, which was carried out by reviewing medical records and using a convenience sample. Data were obtained from the electronic records of the patients cared for and registered in the Conecte/w (Wareline do Brasil, Goiânia, GO, Brazil) software at the orthopedics emergency room of Hospital de Urgências, from July 2018 to June 2019, for surgical treatment of soft-tissue injuries in the lower limbs. Data collection was carried out with the Medical Archive and Statistics Sector (Setor de Arquivo Médico e Estatística, SAME, in Portuguese).

After selecting the medical records, the following clinical aspects were evaluated: 1) sex; 2) age group; 3) type of injury; 4) cause of the injury; 5) initial diagnosis; 6) affected site; 7) incision and identification technique; 8) surgical planning; 9) flap design; 10) postoperative period; 11) result of the propeller flap; and 12) complications. The data were collected in a specific form, and for the purpose of comparison, photographic records of the surgical and postsurgical procedures were used, and the frequencies were estimated in relation to the variables.

Results

Within 1 year, 14 individuals with soft-tissue injuries in the lower limbs undergoing the propeller-flap surgical technique were identified. Regarding gender, all patients were male ($n = 14$; 100%). The mean age of the patients was 36.4 ± 8.48 years, ranging from 26 to 48 years, with the highest frequency being that of young adults (25 to 29 years; $n = 4$; 28.6%) and adults between 45 and 49 years of age ($n = 4$; 28.6%). Regarding the type of injury, most patients presented soft-tissue injuries, with exposure of noble structures such as tendons, and without associated open fractures ($n = 08$; 57%); the right side was the most affected ($n = 10$; 71.4%).

Motorcycle accidents were the main cause of injury among patients undergoing the propeller-flap surgical procedure ($n = 13$; 92.7%). Only 1 (7.1%) patient suffered an injury resulting from a car accident. Among the affected areas (►**Table 1**), the posterior aspect of the distal third of the right leg was the most frequently affected ($n = 5$; 35.7%), followed by the medial distal third on the same side ($n = 3$; 21.5%).

The design of the cover flap of the wound varied from 4×3 cm to 11×4 cm. The flap dimensions ranged from 12 cm^2 to 70 cm^2, with a mean size of 29 cm^2 and an interquartile range of 21 cm^2 to 38 cm^2. Immediate postsurgical complications were present in 35.7% ($n = 5$) of the cases, and they included excessive bleeding ($n = 2$; 14.3%), partial necrosis ($n = 2$; 14.3%), and flap dehiscence (n = 1; 7.1%). In 42.9% ($n = 6$) of the cases, skin grafting was necessary to cover the donor area (►**Table 1**). Regarding the result of the surgical technique used, thirteen patients had excellent coverage, and in only one there was loss of the flap.

As for the surgical planning, in all cases, the procedure summarized below was followed. Perforator flaps were indicated to cover wounds in the distal third of the leg and perimalleolar region in the ankle. The arterial axes were the posterior tibial artery and the anterior tibial artery. For anteromedial and posterior wounds, the option was for the posterior tibial artery and lateral anterior tibial artery. The choice of the perforator flap followed the aforementioned criteria. The patient was anesthetized in the operating room, and exsanguination of the lower limb was performed. Afterwards, the flap design was made, and the probable point of location of the pedicle (perforating artery) was marked, but it was impossible to use the Doppler to identify the pedicle due to the unavailability of this equipment in the hospital.

For the surgical technique, the procedure used in the cases is summarized below. After drawing the flap and marking the probable location of the perforating artery, a skin and subcutaneous incision was made up to the fascia. The fascia was raised subfacially to locate the perforating artery for the nutrition of the flap. The perforating artery was identified, with confirmation of its origin in the main axis in the posterior or anterior tibial artery and entry into the flap through the fascia. Afterwards, a template was made with a compress cut to the size of the wound to be reconstructed up to the pedicle. The flap was then dissected and raised close to the fascia. In all procedures, we ensured that the fascia was part of the flap, since it would be responsible for the perfusion of the flap. Afterwards, the flap was rotated 180°, with a larger flap covering the wound. Subsequently, the tourniquet was released, and the flap perfusion was verified, and the suture was performed. The failure in the donor area was covered with skin graft when necessary.

The postoperative period described in the medical record consisted of daily changing the non-compressive dressings and maintaining the limb elevated. After hospital discharge, the outpatient follow-up was carried out. Between two and four

Table 1 Summary of cases of soft-tissue injury submitted to the propeller-flap surgical technique

Case	Age (years)	Flap (cm)	Affected location	Complications	Additional procedures
1	42	10×2	Medial face of the distal third of the right leg	No Complications	Skin graft
2	37	7×7	Medial face of the distal third of the left leg	Bleeding	Flap slimming
3	48	10×7	Distal posterior face of the right leg	No Complications	Skin graft
4	46	8×3	Posterior face of the distal third of the left leg	Bleeding	None
5	48	11×4	Distal posterior face of the right leg	No Complications	Skin graft
6	48	7×5	Medial face of the distal third of the right leg	No Complications	None
7	35	9×4	Medial face of the distal third of the right leg	No Complications	None
8	35	5×3	Medial face of the middle third of the right leg	No Complications	None
9	26	6×4	Distal posterior face of the right leg	Partial flap necrosis	Skin graft
10	28	5×3	Distal posterior face of the right leg	Flap dehiscence	None
11	27	4×3	Medial face of the middle third of the right leg	No Complications	None
12	32	6×4	Lateral face of the distal third of the left leg	Partial flap necrosis	None
13	27	6×4	Lateral face of the distal third of the right leg	No Complications	Skin graft
14	31	8×3	Medial distal third of the left leg	No Complications	Skin graft

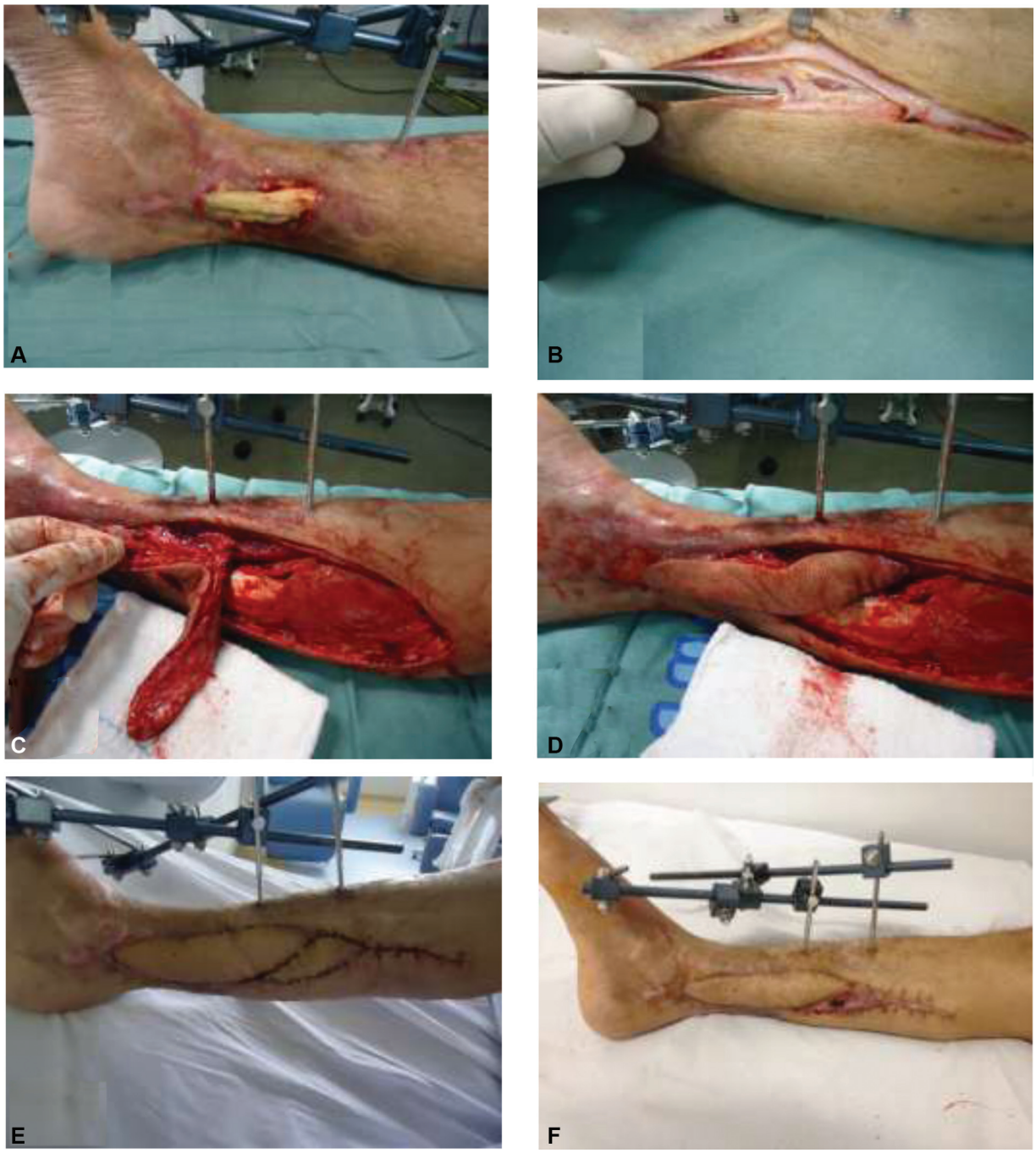

Fig. 1 (A) Soft-tissue injury with tendon exposure; (B) location of the perforating artery; (C) dissection of the flap; (D) flap rotation; (E) cover and graft; (F) postsurgical outcome.

weeks, good flap maintenance and lesion coverage were already reported in the medical record. ►**Figures 1** and **2** present the photographic records available in the medical file referring to the surgical procedure with propeller flap performed on patients in cases 1 and 5 respectively (►**Table 1**).

Discussion

In the state of Goiás, Brazil, there was an average of 91 traffic accidents per day in the first half of 2019. About 60% of the victims of traffic accidents in the capital city of Goiânia, during this period, were on motorcycles. Male individuals aged between 20 and 29 years represent 42% of the total of people involved in motorcycle accidents in our country,[11] data similar to those observed in the present study. Sado et al.[12] evaluated the characteristics of victims of motorcycle accidents admitted to the Emergency Hospital from December 1st to 31, 2007, and observed that the majority were male (91%), and the most frequent injuries and surgical interventions were located in the lower limbs (53.3%).

Shen et al.,[13] when evaluating patients with soft-tissue injuries examined at a hospital in China, observed that most were male (80.6%; $n = 29$), and the average age was 39.7 years. Mendieta et al.[14] evaluated the use of the propeller

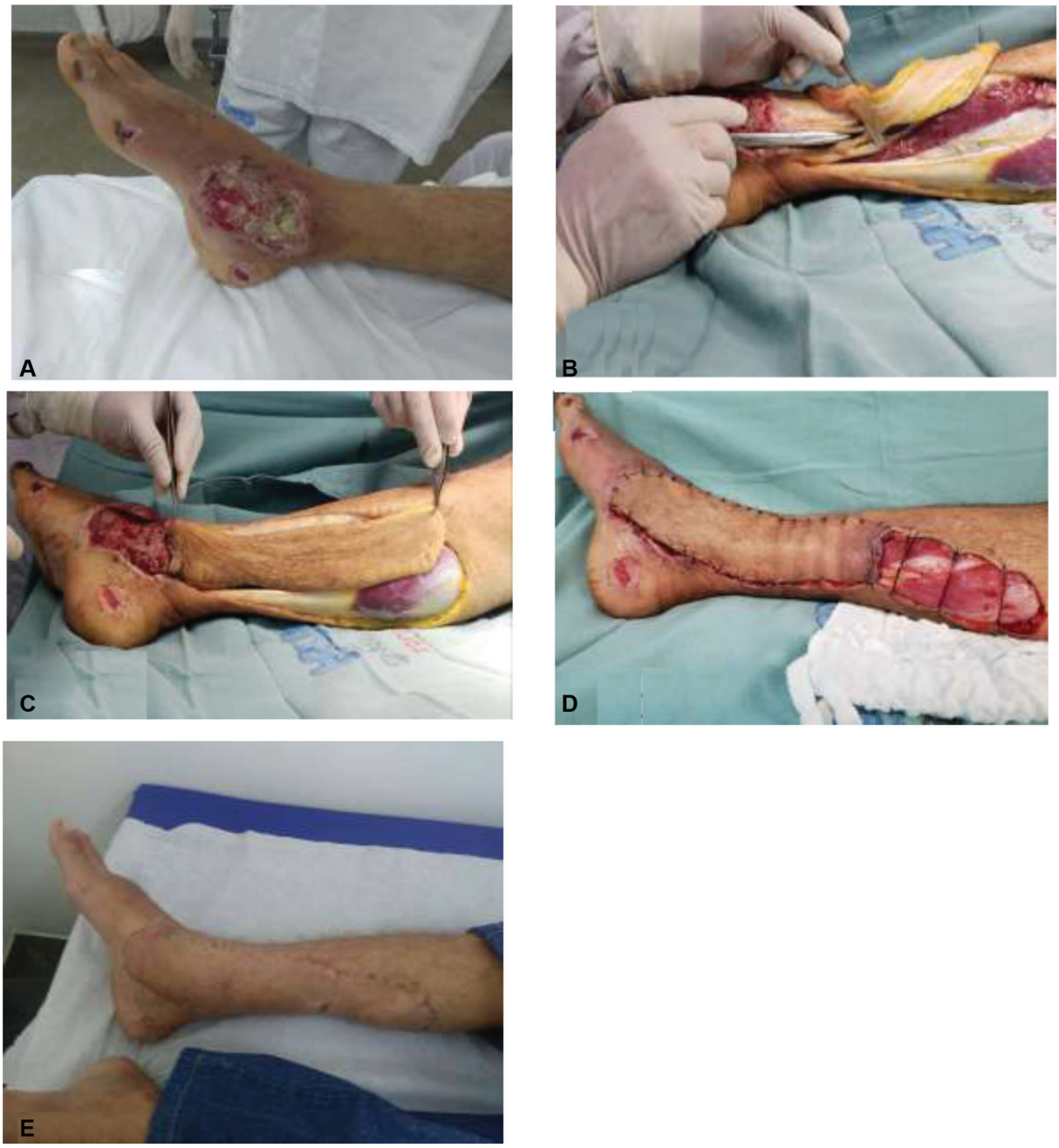

Fig. 2 (A) Soft-tissue injury with tendon exposure; (B) location of the perforating artery; (C) dissection of the flap; (D) flap rotation; (E) postsurgical outcome.

flap to cover soft-tissue injuries to the lower limbs in individuals examined at a hospital in Nicaragua, in which the mean age of the patients was 32 years, and the male gender accounted for 75% of the cases, numbers that are lower than those observed in the present study.

Lesions in the lower limbs have a low ratio of fatal cases; however, they require reparative, corrective surgery, and, in some cases, amputations, which can compromise the patients' quality of life.[5] When assessing the profile of individuals involved in motorcycle accidents in the city of São Paulo, Brazil, Debieux et al.[15] observed that most injuries occurred in the lower limbs (53.9%), and more frequently in the age group between 21 and 24 years (45%). Rezende et al.,[9] when evaluating the epidemiological profile, surgical treatment and postoperative results of patients with complex traumatic injuries to the lower limbs, observed that the motorcycle accident was responsible for the majority of the injuries (37.8%), and that the lower third of the leg was the region most affected by trauma (50.4%), followed by the medial third (32%).

Exposure of noble areas is common when lesions occur in the distal third of the leg, requiring that they be covered with good quality tissues and vascularity.[6] The use of flaps to cover injuries resulting from trauma in soft tissues offers similarities in texture to the injured area, good appearance, and partial or complete repair of the donor site. The size of the flaps depends on the extent of the area to be covered.[13] Shen et al.[13] reported in their study flaps ranging from 10×5 cm to 34×18 cm,

values higher than those reported in the present study. Sasidaran et al.[16] performed reconstruction of soft-tissue defects in the lower limb in 6 patients from a Malaysian hospital in which the flap dimensions ranged from 3 × 3 cm to 10 × 5 cm, values closer to those observed in the present study.

Bajantri et al.[17] suggested the use of propeller flaps for defects of up to 50 cm^2; however, D'Arpa et al.[18] stated that there are other factors that should be considered when establishing a maximum flap size, since it depends on the patient's body and leg size, skin flaccidity, flap volume, adequate closure of the donor site, and countless other factors. The authors conclude that propeller flaps are still an attractive option for small and medium defects, especially at the level of the leg and foot.

When evaluating the postsurgical results, Nelson et al.[19] found a partial loss rate of 11.6%, lower than that observed in the present study (14.3%). Sisti et al.[10] conducted a literature review between 2005 and 2015 and estimated the rate of postsurgical complications resulting from the propeller-flap technique at 22.6%, and the highest frequency was observed in the lower limb (31.8%), with partial flap necrosis and venous congestion being the most frequent complications. In the present study, the complication rate was higher than the mean observed by Sisti et al.,[10] but with similarity in relation to the most frequent complications.

Conclusion

Despite the limited number of medical records of patients undergoing the propeller-flap technique to cover lesions in the lower limb, the use of this type of flap proved to be a good alternative in most of the evaluated cases, with good surgical results, although complications were observed in some cases.

Conflict of Interests

The authors have no conflict of interests to declare.

References

1 Rodrigues BL, Portela AR, Pastore Neto M, Drumond AF. Lesão grave de partes moles decorrente de acidente motociclístico. Rev Med Minas Gerais 2013;23(04):536–539

2 Aquino Y. Acidentes no trânsito deixaram mais de 1,6 milhão feridos em 10 anos: seis de cada dez casos graves são de pessoas entre 15 e 39 anos. Empresa Brasil de Comunicação, Brasília, 23 mai 2019, Saúde. Disponível em: http://agenciabrasil.ebc.com.br/saude/noticia/2019-05/acidentes-no-transito-deixaram-mais-de-16-milhao-feridos-em-10-anos. [Accessed: July 23 2019]

3 Andrade SM, Jorge MH. Características das vítimas por acidentes de transporte terrestre em município da Região Sul do Brasil. Rev Saude Publica 2000;34(02):149–156

4 Koizumi MS. Padrão das lesões nas vítimas de acidentes de motocicleta. Rev Saude Publica 1992;26(05):306–315

5 Saad FT, Almeida KG, Almeida PY, et al. Reconstrução de dorso do pé com retalho supramaleolar lateral de fluxo reverso em menor de 4 anos de idade. Rev Bras Cir Plást 2015;30(02):324–332

6 Chang AJ, Milcheski DA, Nakamoto H, Tuma P Junior, Lobato R, Ferreira MC. Condutas em traumas complexos de partes moles de membros inferiores no HCFMUSP. Rev Bras Cir Plást 2013;28(3, Suppl)1–103

7 Macedo JL, Rosa SC, Silva AA, Filho Neto AVR, Ruguê PH, Scartazzini C. Versatilidade do uso do retalho do músculo gastrocnêmio medial na reconstrução de lesões de partes moles de membros inferiores. Rev Bras Cir Plást 2016;31(04):527–533

8 Teixeira Neto N, Chi A, Paggiaro AO, Ferreira MC. Tratamento cirúrgico das feridas complexas. Rev Med (São Paulo) 2010;89 (3/4):147–151

9 Rezende MR, Rabelo NT, Benabou JE, et al. Cobertura do terço distal da perna com retalhos de perfurantes pediculados. Acta Ortop Bras 2008;16(04):223–229

10 Sisti A, D'Aniello C, Fortezza L, et al. Propeller Flaps: A Literature Review. In Vivo 2016;30(04):351–373

11 DETRAN. Departamento estadual de trânsito. Estatísticas. Disponível em: http://inside.detran.go.gov.br/acidente/index.htm. [Accessed: July 14 2019]

12 Sado JM, Morais FD, Viana FP. Caracterização das vítimas por acidentes motociclísticos internados no hospital de urgências de Goiânia. Rev Movimenta 2009;2(02):49–53

13 Shen L, Liu Y, Zhang C, et al. Peroneal perforator pedicle propeller flap for lower leg soft tissue defect reconstruction: Clinical applications and treatment of venous congestion. J Int Med Res 2017;45(03):1074–1089

14 Mendieta M, Cabrera R, Siu A, Altamirano R, Gutierrez S. Perforator Propeller Flaps for the Coverage of Middle and Distal Leg Soft-tissue Defects. Plast Reconstr Surg Glob Open 2018;6(05):e1759

15 Debieux P, Chertman C, Mansur NS, Dobashi E, Fernandes HJ. Lesões do aparelho locomotor nos acidentes com motocicleta. Acta Ortop Bras 2010;18(06):353–356

16 Sasidaran R, Zain MA, Basiron NH, Ajik S. Propeller flaps in lower limb reconstruction: case series. Anaplastology 2013;3(01):1–4

17 Bajantri B, Bharathi RR, Sabapathy SR. Wound coverage considerations for defects of the lower third of the leg. Indian J Plast Surg 2012;45(02):283–290

18 D'Arpa S, Toia F, Pirrello R, Moschella F, Cordova A. Propeller flaps: a review of indications, technique, and results. BioMed Res Int 2014;2014:986829

19 Nelson JA, Fischer JP, Brazio PS, Kovach SJ, Rosson GD, Rad AN. A review of propeller flaps for distal lower extremity soft tissue reconstruction: Is flap loss too high? Microsurgery 2013;33(07):578–586

Osteosynthesis of Fractures of the Metacarpal Neck with Self-Compressing Screw - Preliminary Analysis of 21 Cases*

Osteossíntese de fraturas do colo do metacarpo com parafuso autocompressivo - Análise preliminar de 21 casos

Celso Ricardo Folberg[1] Jairo André de Oliveira Alves[1] Otávio Pereira Cadore[2] Fernando Maurente Sirena[1]

[1] Hand Surgery Group, Orthopedics and Traumatology Service, Hospital de Clínicas de Porto Alegre, Porto Alegre, RS, Brazil
[2] Orthopedics and Traumatology Service, Hospital de Clínicas de Porto Alegre, Porto Alegre, RS, Brazil

Address for correspondence Celso Ricardo Folberg, MSc, Rua Sinke, 236, casa 45, Porto Alegre, RS, 90840-150, Brazil (e-mail: cfolberg@hcpa.edu.br).

Rev Bras Ortop 2021;56(2):198–204.

Abstract

Objective The present study aims to analyze the clinical results of the surgical treatment of metacarpal neck fractures with retrograde intramedullary fixation using cannulated headless screws (Herbert type).

Methods Retrospective study of 21 closed fractures deviated from the metacarpal neck in 21 patients operated between April 2015 and November 2018.

Results The sample included 19 men and 2 women. The mechanisms that caused the trauma were punching, falling to the ground and motor vehicle accident (n = 14, 5 and 2). The affected metacarpals were the 5th, 3rd, and 2nd (n = 19, 1 and 1). Surgical indications were neck-shaft diaphysis of the metacarpal $> 30°$ for the 2nd and 3rd metacarpals and $> 40°$ for the 5th metacarpal, shortening $\geq$ 5mm, rotational deviation, and the desire of the patient not to use plaster cast. In the immediate postoperative period, patients remained without immobilization and were instructed to mobilize their fingers according to tolerance. All patients had total active mobility $> 240°$ and returned to their former occupations. All fractures consolidated and there were no reinterventions.

Discussion The great advantages of the headless screw technique are its low morbidity, sufficient stability to avoid external immobilization, and reproducibility at low cost.

Conclusion This is an easy, fast technique that has excellent results for the surgical treatment of displaced fractures of the neck of the metacarpals.

Keywords
- fractures, bone
- hand
- metacarpus

* *Work developed at the Hand Surgery Group, Orthopedics and Traumatology Service, Hospital de Clínicas de Porto Alegre (HCPA), Porto Alegre, RS, Brazil.*

received
January 17, 2020
accepted
May 5, 2020

DOI https://doi.org/10.1055/s-0040-1714229.
ISSN 0102-3616.

Thieme Revinter Publicações Ltda., Rua do Matoso 170, Rio de Janeiro, RJ, CEP 20270-135, Brazil

Resumo

Objetivo O presente estudo visa analisar os resultados clínicos do tratamento cirúrgico das fraturas de colo do metacarpo com fixação intramedular retrógrada utilizando parafusos canulados sem cabeça (tipo Herbert).

Métodos Estudo retrospectivo de 21 fraturas fechadas desviadas do colo do metacarpo em 21 pacientes operados entre abril de 2015 e novembro de 2018.

Resultados A casuística incluiu 19 homens e 2 mulheres. Os mecanismos causadores do trauma foram soco, queda ao solo e acidente com veículo motorizado (n = 14, 5 e 2). Os metacarpos acometidos foram o V, III e II (n = 19, 1 e 1). As indicações cirúrgicas foram angulação colo-diáfise do metacarpo $> 30°$ para os II e III metacarpos e $> 40°$ para o V metacarpo, encurtamento $\geq$ 5mm, desvio rotacional e o desejo do paciente de não utilizar imobilização gessada. No pós-operatório imediato, os pacientes permaneceram sem imobilização e orientados a mobilizar os dedos conforme tolerância. Todos os pacientes ficaram com mobilidade ativa total $> 240°$ e retornaram às suas antigas ocupações. Todas fraturas consolidaram e não houve reintervenções.

Discussão As grandes vantagens da técnica com parafuso sem cabeça são sua baixa morbidade, estabilidade suficiente para não precisar de imobilização externa e reprodutibilidade com baixo custo.

Conclusão Esta é uma técnica fácil, rápida, e que apresenta ótimos resultados para o tratamento cirúrgico das fraturas deslocadas do colo dos metacarpos.

Palavras-chave

- fraturas ósseas
- mãos
- metacarpo

Introduction

Metacarpal and phalangeal fractures account for 18% of all fractures below the elbow[1] and can be treated in several ways. Fractures of the neck of the metacarpals may have surgical indication when presenting rotational deviation, angulation or shortening, and the exact parameters of acceptable alignment are still controversial.[2]

Among the methods of internal fixation, we can highlight Kirschner wires, plates, and screws. The former usually require postoperative immobilization, promoting joint stiffness as it does not allow early mobility.[3] Plates and screws usually require extensive soft tissue dissection, which can cause tendon stiffness and adhesions. Although there is still no consensus on the best method, surgical treatment covers an overall complication rate of up to 36%. Of these, the most common are tendon injury, pseudoarthrosis, vicious consolidation, avascular necrosis, stiffness, and adhesions.[4–6]

In 2010, Boulton et al described a fixation technique for subcapital metacarpal fractures in order to minimize these complications and also promote early mobility, using a cannulated headless screw with retrograde fixation.[7] Later, Del Piñal et al[8] improved the technique, adding different reduction and fixation methods for comminuted fractures and for those fractures more likely to lose reduction or shortening, increasing the range of indications for complex fractures. In this study, the authors described 69 fractures in 59 patients, including 17 open fractures, being treated in just one time. He concluded that this is his method of choice for transverse and short oblique diaphyseal fractures, in addition to metaphyseal metacarpal and phalangeal fractures, being contraindicated only in cases of open physis and current infection.

Our work describes the surgical technique and clinical results of retrograde intramedullary percutaneous fixation of the metacarpal neck fractures. In all cases, a cannulated headless screw was used in a series of cases operated between 2015 and 2018.

Methods

After approval by the Research Ethics Committee, a retrospective evaluation of clinical and radiographic data of 24 patients with closed metacarpal neck fractures surgically treated with retrograde headless screws (Herbert) was performed between April 2015 and November 2018. Three patients were lost follow-up and were excluded from the assessment. All patients were operated on and followed by the senior author (Folberg C. R.).

Standard radiographs in anteroposterior and oblique views of the hand were obtained to assess fracture deviation and angulation. The measure of angulation in degrees was measured in oblique views. The surgical indications were neck-diaphysis metacarpal angle $> 30°$ for the 2^{nd} and 3^{rd} metacarpals, and $> 40°$ for the 5^{th} metacarpal, shortening $\geq$ 5 mm, rotational deviation, and patient's wish not to use cast immobilization. All patients were evaluated by the senior author both before and after surgery, discussing the risks and benefits of surgery. Before signing the informed consent form, in addition to the guidelines on the surgical procedure, the postoperative instructions were widely discussed, explaining the importance of early mobilization without load so that they could achieve complete joint mobility as soon as possible.

Surgical Technique

All patients were operated under sedation and axillary anesthetic block of the brachial plexus, except for the last two patients. In these, wide awake local anesthesia no tourniquet (WALANT) was the technique used, when local anesthesia with adrenaline is used and the patient remains awake during the procedure.

Fractures were reduced in a closed manner with manual traction, manipulation of the proximal and distal fragments and flexion of the metacarpophalangeal joint. In three cases it was necessary to use a Kirschner wire to reduce the fracture, which was introduced into the focus of the fracture leveraging and maintaining the reduction temporarily until the Herbert screw was introduced.

A 16-gauge needle was positioned, with the aid of an image intensifier, in the center of the metacarpal head in both anteroposterior and lateral views and directed to the intramedullary canal. This needle was inserted manually into the intramedullary canal of the metacarpal until it crossed the focus of the fracture in the proximal fragment. The guidewire of the Herbert screw was introduced through the needle to the base of the metacarpal, where it was then fixed (►**Figure 1**). The needle was removed and an incision (stab-type incision with a scalpel in the longitudinal direction of the tendon) of ~ 3 mm adjacent to the guidewire was made through the skin, the extensor tendon and the joint capsule. Afterwards, the 1.6 mm long and 2.0 mm short drills were used to prepare for the insertion of the 3.0 mm Herbert screw. In all cases, the longest available screw (30 mm) was used, always remaining below the joint surface under radioscopic control.

In 2 patients with unstable comminuted fractures, in whom the compression of the fragments would not be beneficial for the fixation – the objective would only be to stabilize the fracture – a 1.5 mm Kirschner wire was passed, transfixing and stabilizing the distal fragment to the adjacent metacarpal. After stabilizing the fracture with the screw, maintaining the height of the metacarpal, the Kirchner wire was removed. In other cases, the rotational deviation was controlled by viewing the fluoroscopy, and when the procedure was completed, with active or passive mobility of the fingers. There was no need for temporary fixation of the distal fragment for rotational control, since during fixation there did not appear to be significant rotational deviation. Rotational deviations and osteosynthesis stability were tested right after fixation. In patients in whom local anesthesia was used (WALANT) the test was performed with active mobility, and the others with passive mobility of the fingers and wrist.

After skin suture and dressing, an elastic band was applied and the patient was instructed to mobilize the fingers according to tolerance for 5 to 7 days until the first postoperative review, when control radiographs were obtained. With the decrease in pain and edema, patients were encouraged to mobilize their fingers for a full range of motion. At the next consultation, about 3 weeks after the operation, new radiographs were taken. If the range of motion was improving very slowly, the patient was referred to a physiotherapy clinic. Otherwise, he was encouraged to keep the exercises at home. Patients were reevaluated at 6 and 12 weeks postoperatively, when most patients had their final evaluation if they had ample mobility and no complaints.

Results

The sample included 19 men and 2 women, with a mean age of 33.4 years old (18–75 years old). The fracture occurred in the right hand in 15 patients and in the left hand in 6 patients. The mechanisms causing the trauma were punching against a wall/table/other people ($n = 14$), falling to the ground ($n = 5$) and traffic accident ($n = 2$). Fractures occurred in the neck of the 5^{th} metacarpal ($n = 19$), the 3^{rd} metacarpal ($n = 1$) and the 2^{nd} metacarpal ($n = 1$).

The mean time from fracture to surgery was 9 ± 6 days.

Patient data are summarized in ►**Table 1**.

The operative time in all cases was < 45 minutes (interval between 10–42 minutes). There were no transoperative complications.

All fractures showed clinical and radiological consolidation. There was no case of vicious consolidation (no significant angular or rotational deviation). The last radiographs obtained with a longer follow-up did not show degenerative changes in any patient.

No patient had postoperative infection, tendon or capsular adhesions or complications related to the screw that required reoperation. All 21 patients had an excellent functional result, with an active total finger range of motion $> 240°$. Only one patient (second metacarpal fracture) had a 10° extensor lag and 10° less flexion of the metacarpophalangeal joint than the contralateral side (►**Figure 2**), without functional repercussions. Two patients had to remain undergoing physiotherapy and occupational therapy after 12 weeks postoperatively until complete range of motion was achieved, 1 at 16 and the other at 20 weeks. All patients returned to their previous activities, both laboral and sportive, as well as recreational ones, with no complaints regarding hand function.

Discussion

The use of Kirschner wires in the surgical treatment of isolated fractures deviated from the metacarpals was, for a long time, the method of choice. Based on the flexible fastening concepts proposed by Ender et al[9] and subsequently by Foucher,[10] with anterograde intramedullary osteosynthesis, or stabilizing the fracture with crossed wires, presents good results.[11] However, complications such as infection, early loss of fixation, stiffness and nonconsolidation can reach 16% of cases.[12,13]

The choice for headless cannulated self-compressing screws introduced by Herbert et al to treat wrist and carpal fractures,[14] and more recently in the treatment of metacarpal and phalangeal fractures,[8,15–18] is an alternative to conventional treatments and brings some advantages: it

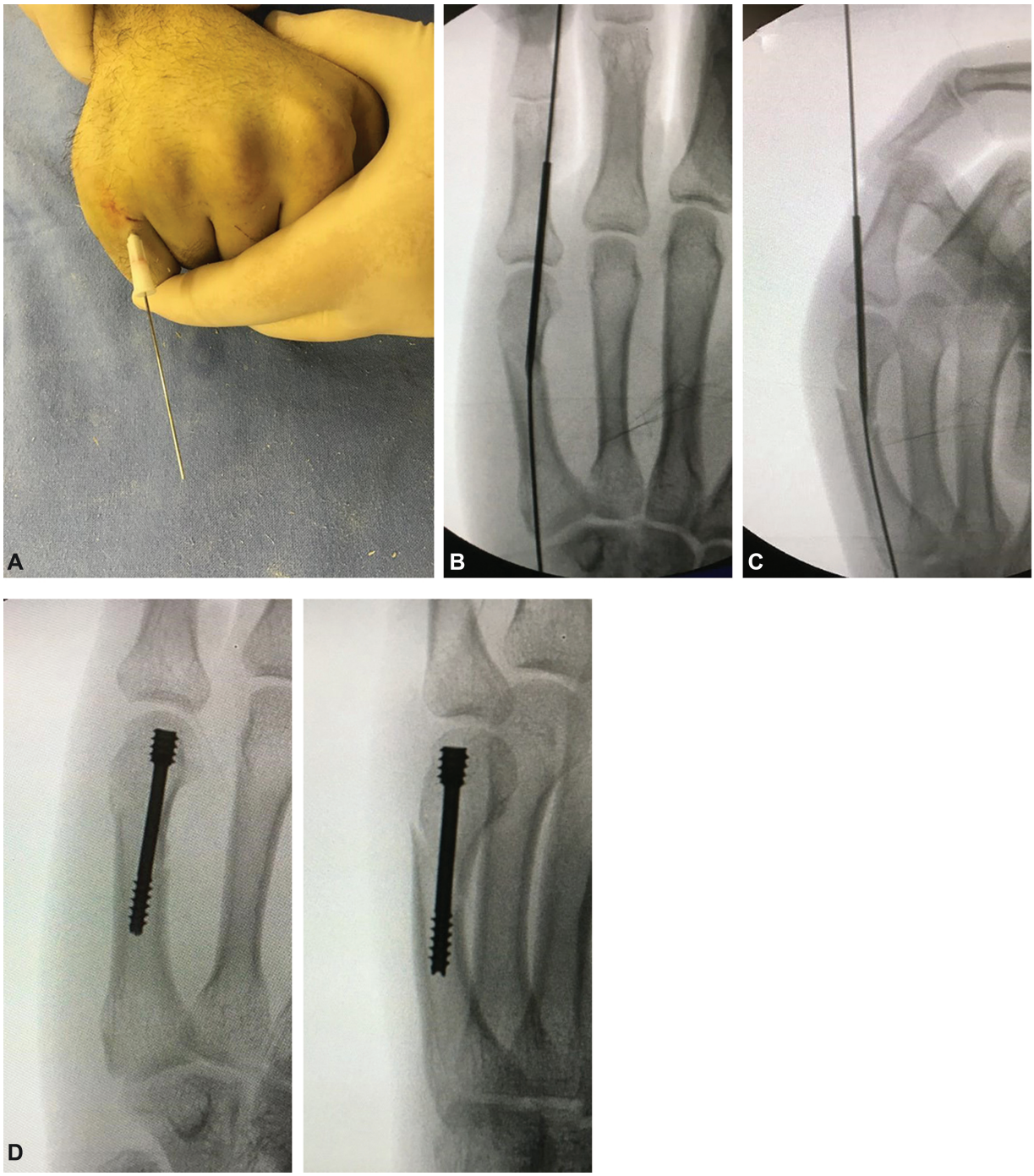

Fig. 1 Details of the surgical technique: A) Introduction of the needle and guidewire after fracture reduction; B and C) Radioscopic control; D and E) Immediate postoperative result of fixation.

does not violate the focus of the fracture, it does not need plaster cast, and it allows early mobility. In addition, several studies have shown biomechanical superiority of intramedullary screws over intramedullary Kirschner wires.[19,20] The stability in the fracture focus can be given by fixing the screw thread in the endosteal canal, or as an intramedullary tutor, and it can even be a mixture of both, as suggested by Del Piñal et al.[8]

Our technique proposes the placement of the guidewire without a previous incision, and only a minimal incision (stab-type incision with the scalpel blade in the longitudinal direction of the tendon), with no direct view of the tendon, of the joint capsule and of the articular surface of the metacarpal. Ruchelsman et al[16] described a small approach with longitudinal opening of the extensor tendon and dorsal arthrotomy, but, as well as in the work of Jann et al,[17] we believe that fluoroscopy provides a good view of the screw entry point. Lesion of the extensor tendon, as well as chondral lesion of the metacarpal head, caused by the entrance of the screw head, were not considered

Table 1 Sample Characterization

Variables	$n = 21$
Age (years old) - mean ± SD	33.5 ± 14.3
Affected side – n (%)	
Right	15 (71.4)
Left	6 (28.6)
Bone – n (%)	
2nd Metacarpal	1 (4.8)
3rd Metacarpal	1 (4.8)
5th Metacarpal	19 (90.5)
Angulation (degrees) – mean ± SD	
2nd Metacarpal	32.0 ± 0.0
3rd Metacarpal	35.0 ± 0.0
5th Metacarpal	49.8 ± 11.4
Mechanism – n (%)	
Punch	14 (66.7)
Falling to the ground (football, cycling, falling from one's own height)	5 (23.8)
Motorcycle/car accident	2 (9.5)
Injury time to surgery (days) – mean ± SD	9.14 ± 6.17

Abbreviation: SD, standard deviation.

significant.[18,21] The request for active hand mobilization, with complete finger extension just after the screw was inserted, demonstrated functionality of the extensor mechanism during the operation. This was maintained in this way in all cases. The fixation of these fractures with local anesthesia with adrenaline and without the use of a tourniquet (WALANT), as described by Lalonde et al,[22] allows the awake patient to have active mobility during the operation. This makes it possible to test the extensor mechanism and visualize the stability of osteosynthesis under fluoroscopy, reinforcing for the patient the idea of being able to mobilize the finger safely and early. The protection of the affected finger, syndactylyzing it with the adjacent finger for 30 days postoperatively as performed in the work by Jann et al[17] was not necessary in our cases.

Some authors claim that there is no compression at the fracture site, as the screw would only function as an internal stabilizer.[23] However, in the most comminuted fractures, compression of the screw may cause the fracture to become unstable and cause fracture deviation and shortening. In these cases, the use of a second screw (usually of smaller diameter) for stabilization is indicated, as it is well described by Del Piñal et al,[8] but it requires greater skill from the surgeon as the space is often small for placing two screws. The placement of a 1.5 mm Kirchner wire between the heads of the fractured metacarpal and the adjacent one, volarly to the screw already partially penetrated, seemed to be easy and practical. This maneuver prevents the screw from compressing the fracture focus but allows for excellent stability when fixing the screw to the head. In the two cases in which we used this technique, we removed the wire immediately after passing the screw, confirming the stability of the fracture focus, and obtaining good results.

The results of our series of patients are consistent with those in the literature, especially with the work of Del Piñal et al,[8] Ruchelsman et al,[16] Tobert et al,[23] Doarn et al,[24] and Romo-Rodriguez et al,[25] all presenting excellent functional results and no case of pseudoarthrosis or vicious consolidation. More recently, Beck et al reinforced these findings in their review of the literature on the topic.[26] In a patient in our series, a small extensor lag (10°) remained, but this change was not significant in relation to the total range of motion (240°), not preventing an optimal functional result.

This is a technique that violates the articular cartilage of the metacarpal head and is open to criticism. However, a three-dimensional quantitative analysis by computed tomography (CT) performed by ten Berg et al[21] demonstrated that the dorsal entry point of the screw in the metacarpal head is only reached by the base of the proximal phalanx after 87% of the 120° extension arch performed in the sagittal plane. This analysis also shows that the occupied surface area of the metacarpal head and of the subchondral head volume are minimal. A study shows that in the medium term, no changes were found in the metacarpal head with the use of intramedullary devices up to 5 mm in diameter.[27] In addition, it is always worth remembering the already established use of this screw in scaphoid, radial head, capitellum and other articular surfaces. There is no report in the literature of complications due to chondral alteration in the metacarpal head after osteosynthesis with headless intramedullary screw in the short and medium term. Although the current evidence points to a future without chondral changes with the use of this technique, long-term studies are needed to prove it.

Our work has some limitations: it is a retrospective study with a limited number of patients. In addition, the follow-up time for some patients was relatively short, so that definitive conclusions cannot be reached about degenerative joint changes or some other complication that may arise with a longer follow-up. Even so, due to the good results presented here, which reproduce the findings in the literature, this technique confirms to be very effective, safe, and reproducible for metacarpal neck osteosynthesis.

Conclusion

Retrograde intramedullary osteosynthesis with a headless screw (Herbert type) in fractures of the metacarpal neck has shown excellent radiological and functional results in all patients in this series of 21 cases presented and has proven to be an excellent minimally invasive option for the treatment of these hand fractures.

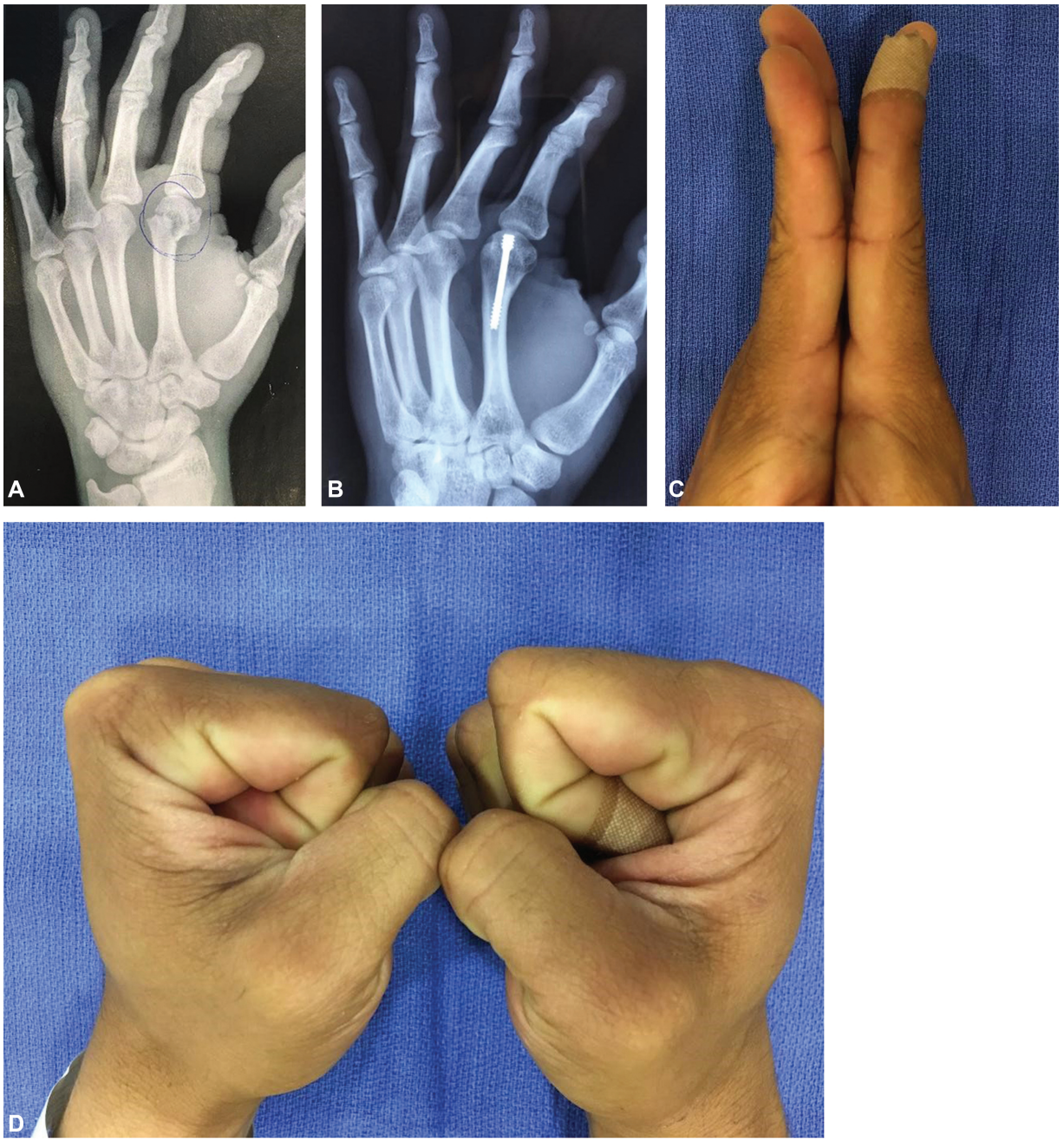

Fig. 2 A) Fracture of the neck of the second metacarpal; B) Late postoperative radiography; C) Minimum extensor lag; D) Slight deficit of flexion of the metacarpophalangeal joint.

Conflict of Interests

The authors have no conflict of interests to declare.

References

1 Chung KC, Spilson SV. The frequency and epidemiology of hand and forearm fractures in the United States. J Hand Surg Am 2001; 26(05):908–915
2 Strub B, Schindele S, Sonderegger J, Sproedt J, von Campe A, Gruenert JG. Intramedullary splinting or conservative treatment for displaced fractures of the little finger metacarpal neck? A prospective study. J Hand Surg Eur Vol 2010;35(09):725–729
3 Johnson KA. Posterior tibial tendon. In: Weiss AP, Goldfarb CA, Hentz VR, Raven RB, Slutsky DJ, Steinmann SP, Budoff JE, Calfee RP, eds. Textbook of hand and upper extremity surgery. Chicago: American Society for the Surgery of the Hand; 2013:76–90
4 Creighton JJ Jr, Steichen JB. Complications in phalangeal and metacarpal fracture management. Results of extensor tenolysis. Hand Clin 1994;10(01):111–116
5 Kollitz KM, Hammert WC, Vedder NB, Huang JI. Metacarpal fractures: treatment and complications. Hand (N Y) 2014;9 (01):16–23
6 Page SM, Stern PJ. Complications and range of motion following plate fixation of metacarpal and phalangeal fractures. J Hand Surg Am 1998;23(05):827–832
7 Boulton CL, Salzler M, Mudgal CS. Intramedullary cannulated headless screw fixation of a comminuted subcapital metacarpal fracture: case report. J Hand Surg Am 2010;35(08):1260–1263

8 del Piñal F, Moraleda E, Rúas JS, de Piero GH, Cerezal L. Minimally invasive fixation of fractures of the phalanges and metacarpals with intramedullary cannulated headless compression screws. J Hand Surg Am 2015;40(04):692–700
9 Ender J, Simon-Weidner R. Die Fixierung der trochanteren Bruche mit runden elastischen Condylennageln. Acta Chir Austriaca 1970;2(01):40–42
10 Foucher G. "Bouquet" osteosynthesis in metacarpal neck fractures: a series of 66 patients. J Hand Surg Am 1995;20(3 Pt 2): S86–S90
11 Schädel-Höpfner M, Wild M, Windolf J, Linhart W. Antegrade intramedullary splinting or percutaneous retrograde crossed pinning for displaced neck fractures of the fifth metacarpal? Arch Orthop Trauma Surg 2007;127(06):435–440
12 Hsu LP, Schwartz EG, Kalainov DM, Chen F, Makowiec RL. Complications of K-wire fixation in procedures involving the hand and wrist. J Hand Surg Am 2011;36(04):610–616
13 Stahl S, Schwartz O. Complications of K-wire fixation of fractures and dislocations in the hand and wrist. Arch Orthop Trauma Surg 2001;121(09):527–530
14 Herbert TJ, Fisher WE. Management of the fractured scaphoid using a new bone screw. J Bone Joint Surg Br 1984;66(01):114–123
15 Geissler WB. Cannulated percutaneous fixation of intra-articular hand fractures. Hand Clin 2006;22(03):297–305, vi
16 Ruchelsman DE, Puri S, Feinberg-Zadek N, Leibman MI, Belsky MR. Clinical outcomes of limited-open retrograde intramedullary headless screw fixation of metacarpal fractures. J Hand Surg Am 2014;39(12):2390–2395
17 Jann D, Calcagni M, Giovanoli P, Giesen T. Retrograde fixation of metacarpal fractures with intramedullary cannulated headless compression screws. Hand Surg Rehabil 2018;37(02):99–103
18 Borbas P, Dreu M, Poggetti A, Calcagni M, Giesen T. Treatment of proximal phalangeal fractures with an antegrade intramedullary screw: a cadaver study. J Hand Surg Eur Vol 2016;41(07):683–687
19 Avery DM 3rd, Klinge S, Dyrna F, et al. Headless compression screw versus Kirschner wire fixation for metacarpal neck fractures: a biomechanical study. J Hand Surg Am 2017;42(05):392.e1–392.e6
20 Jones CM, Padegimas EM, Weikert N, Greulich S, Ilyas AM, Siegler S. Headless screw fixation of metacarpal neck fractures: a mechanical comparative analysis. Hand (N Y) 2019;14(02):187–192
21 ten Berg PW, Mudgal CS, Leibman MI, Belsky MR, Ruchelsman DE. Quantitative 3-dimensional CT analyses of intramedullary headless screw fixation for metacarpal neck fractures. J Hand Surg Am 2013;38(02):322–330.e2
22 Lalonde D, Eaton C, Amadio P, Jupiter J. Wide-awake hand and wrist surgery: a new horizon in outpatient surgery. Instr Course Lect 2015;64:249–259
23 Tobert DG, Klausmeyer M, Mudgal CS. Intramedullary Fixation of Metacarpal Fractures Using Headless Compression Screws. J Hand Microsurg 2016;8(03):134–139
24 Doarn MC, Nydick JA, Williams BD, Garcia MJ. Retrograde headless intramedullary screw fixation for displaced fifth metacarpal neck and shaft fractures: short term results. Hand (N Y) 2015;10(02): 314–318
25 Romo-Rodríguez R, Arroyo-Berezowsky C. Osteosíntesis mínimamente invasiva con tornillos centromedulares canulados para fracturas de metacarpianos. Acta Ortop Mex 2017;31(02):75–81
26 Beck CM, Horesh E, Taub PJ. Intramedullary screw fixation of metacarpal fractures results in excellent functional outcomes: a literature review. Plast Reconstr Surg 2019;143(04):1111–1118
27 Evrard H, Nokerman B. [Centromedullary nailing in metacarpal fractures]. Acta Orthop Belg 1973;39(06):1035–1044

Arthroscopic Bristow: Assessments of Safety and Effectiveness, 12 Years of Experience*

Bristow artroscópico: Avaliação da segurança e da eficácia, 12 anos de experiência

Jose Carlos Garcia Júnior[1]

[1] Shoulder Group, Núcleo Avançado de Estudos em Ortopedia e Neurocirurgia (NAEON), São Paulo, São Paulo, Brazil

Rev Bras Ortop 2021;56(2):205–212.

Address for correspondence Jose Carlos Garcia Júnior, PhD, Núcleo Avançado de Estudos em Ortopedia e Neurocirurgia, Avenida Ibiraquera 2.144, Moema, São Paulo, SP, 04028-001, Brazil (e-mail: josecarlos@naeon.org.br).

Abstract

Objective The open Bristow procedure is a long established and effective method for treating anterior shoulder instability. Following the trends of minimally-invasive surgeries, these procedures were performed arthroscopically, and their outcomes were evaluated.

Methods A total of 43 shoulders of patients submitted to Bristow procedures by arthroscopy, using a graft positioned horizontally and a screw, with at least two years of postoperative follow-up, were evaluated regarding quality of life, de novo dislocation index, and loss of lateral rotation.

Results The mean follow-up time was of 76 months (range: 129 to 24 months). The University of California at Los Angeles (UCLA) score varied from 25.56 ± 0.50 (standard deviation [SD] = 3.25) to 33.23 ± 0.44 (SD = 2.91) ($p < 0.0001$). Two or more years after surgery, the mean Rowe score was of 94.25 ± 1.52 (SD = 1.34), whereas the good results standard is 75 ($p < 0.0001$). The mean value for the simple shoulder test was of 11.35 ± 0.21 (SD = 1.34), while the mean value of the lateral rotation loss was of $10.37° \pm 1.36°$ (SD = 8.58°). There were no de novo dislocations.

In total, there were 12 complications, 8 of which had no clinical repercussions. The clinically-significant complications included an infection six months after surgery with a potential hematogenous origin, a coracoid fracture that required an intraoperatively procedure change, and two patients with previous impingement who required synthesis material removal more than six months after surgery.

Conclusion Although the arthroscopic Bristow procedure was effective in treating anterior shoulder instability, it is not a complication-free surgery.

Keywords

- orthopedic procedures
- shoulder instability
- shoulder dislocation
- arthroscopy

* *Work developed at the Shoulder Group, Núcleo Avançado de Estudos em Ortopedia e Neurocirurgia (NAEON), São Paulo, São Paulo, Brazil.*

received
January 21, 2019
accepted
July 18, 2019
published online
December 13, 2019

DOI https://doi.org/10.1055/s-0039-1697972.
ISSN 0102-3616.

Thieme Revinter Publicações Ltda., Rua do Matoso 170, Rio de Janeiro, RJ, CEP 20270-135, Brazil

Resumo

Objetivo O procedimento de Bristow aberto é um método há muito estabelecido e eficaz no tratamento da instabilidade anterior do ombro. Seguindo as tendências das cirurgias minimamente invasivas, essa cirurgia foi realizada por artroscopia, e seus resultados foram avaliados.

Métodos Foram avaliados 43 ombros de pacientes submetidos ao procedimento de Bristow por artroscopia, com o enxerto em posição horizontal e uso de um parafuso, com pelo menos dois anos de seguimento pós-cirúrgico, por meio de escores qualidade de vida, índice de reluxação e perda de rotação lateral.

Resultados A média de seguimento foi de 76 meses (variando de 129 a 24 meses), o escore da University of California at Los Angeles (UCLA) variou de $25,56 \pm 0,50$ (desvio padrão [DP] $= 3,25$) para $33,23 \pm 0,44$ (DP $= 2,91$) ($p < 0,0001$). A média com 2 anos ou mais de cirurgia para o escore de Rowe foi de $94,25 \pm 1,52$(DP $= 1,34$), sendo que o padrão de bons resultados é de 75 pontos ($p < 0,0001$). A média do teste simples de ombro foi de $11,35 \pm 0,21$ (DP $= 1,34$), e, para perda de rotação lateral, foi de $10,37° \pm 1,36°$ (DP $= 8,58°$). Não houve reluxações.

Entre os 43 pacientes operados, ocorreram um total de 12 complicações, das quais 8 não apresentaram qualquer repercussão clínica. As complicações com repercussão clínica foram uma infecção de possível origem hematogênica seis meses após a cirurgia, uma fratura do coracoide que fez com que o paciente precisasse mudar o procedimento no intraoperatório, e dois pacientes com impacto anterior, que necessitaram de retirada de material de síntese mais de seis meses após a cirurgia.

Conclusão O procedimento de Bristow artroscópico mostrou eficácia no tratamento da instabilidade anterior do ombro, embora não seja livre de complicações.

Palavras-chave

- procedimentos ortopédicos
- instabilidade do ombro
- luxação do ombro
- artroscopia

Introduction

Anterior instability is one of the most common orthopedic conditions in shoulder surgery, with up to 23.9 cases per 100,000 people per year at the United States.[1]

Among the surgical techniques to treat this condition, one of the most effective and well-established is the coracoid process and conjoined tendon transfer to the anterior glenoid border.[2]

It is speculated that this procedure was performed by Bristow before 1929;[3] however, greater technical details were only reported in 1958 by Helfet,[4] who described in length the technique he had learned in 1939 from Bristow himself. In 1954, Michel Latarjet[5] established the modern concepts of this surgery using a screw to fix the coracoid process and the possible subscapularis opening. Patte et al[6] disseminated this technique in continental Europe in the 1980s using two 4.5-mm screws for graft fixation in a vertical position.

The technique of coracoid process and conjoined tendon transfer to the anteroinferior border of the glenoid cavity was modified many times, but all alterations respected the basic principles of triple blockade: bone block by the coracoid process, increased tension at the inferior portion of the subscapularis muscle, and direct block by the conjoined tendon.[7] Several of these modifications were successful, but also had known complications, including loss of lateral rotation, osteoarthritis, pain, musculocutaneous nerve damage and pseudarthrosis.[8]

These complications resulted in many surgeons abandoning this procedure in favor of labral reconstruction, especially with the technological evolution of arthroscopy.

Recently, the continuous evolution of minimally-invasive methods allowed this procedure to be performed consistently by arthroscopy with arthroscopic Latarjet.[7] The intra-articular view allows the surgeon to better position the graft, minimizing complications such as osteoarthritis and instability. Insertion under intra-articular view also ensures the presence of the medullary cavity in contact areas, improving osteointegration.[7,9,10]

However, this approach required new instruments with increased surgical costs.

In 2009, a new arthroscopic surgical technique that enabled the coracoid process and conjoined tendon graft transfer through a minimally-invasive approach, with no costs resulting from the use of new special materials, was published. In this technique, the graft is inserted horizontally into the anterior border of the glenoid cavity using common arthroscopy materials, a small malleolar screw and a washer, a technique known as the Bristow procedure.[11]

The present study describes the outcomes of at least two years of follow-up of 43 patients submitted to the Bristow procedure to treat anterior shoulder instability.

Methods

From September 2007 to December 2016, 48 patients underwent surgical procedures for anterior shoulder instability

treatment using the arthroscopic Bristow technique with horizontal graft. All procedures were performed by the same surgeon. This is a retrospective study, and the preoperative evaluation is considered as the baseline.

The first three patients were not submitted to preoperative or postoperative score determination with a follow-up period longer than two years; data from two other patients were lost.

The remaining 43 patients met the following inclusion criteria, and were evaluated in the present study.

Inclusion Criteria

The inclusion criteria were: patients over 18 years old; with fFollow-up period of at least two years; with Bankart bone lesion with glenoid loss greater than 20% (assessed by magnetic resonance imaging [MRI] or computed tomography [CT] according to the percentage loss of circumference diameter of the lower glenoid cavity toward its largest axis of bone loss); humeral avulsion of the glenohumeral ligament (HAGHL): failure of previous arthroscopic Bankart surgery; instability severity index greater than 6; and competitive, contact sport athletes with any bone loss.[12]

Exclusion Criteria

The exclusion criteria were: patients without baseline assessment data; patients whose preoperative data were lost or who were followed up for less than two years after surgery; those who did not agree with the evaluation; patients under 18 years old or from vulnerable populations; and patients submitted to other previous surgeries, except for arthroscopic Bankart procedures.

Scores and Measurements

The following scores and measurements were assessed:

Modified University of California at Los Angeles (UCLA) score: although initially designed to assess shoulder arthroplasty outcomes, it was modified for use in other orthopedic shoulder conditions.[13]

Simple shoulder test (SST): one of the most recognized tests in the functional evaluation of the shoulder.

Rowe score: created only for postoperative evaluation, its results must be compared with cutoff values of 75 and 90, indicating good and optimal results respectively.

Loss of lateral rotation with adducted arm: the baseline was determined at the preoperative evaluation. Goniometry was performed manually; data were recorded at 5° intervals, and differences were reported.

Elevation: losses greater than 10° were reported.

Evaluations

The patients were assessed at baseline by lateral rotation measurement and the UCLA score. Two years or more after surgery, the patients were evaluated regarding lateral rotation, elevation, UCLA, SST and Rowe values.

The postoperative evaluations included radiographic examinations in every patient. Postoperative CT scans were restricted to those patients with suspected complications.

Statistical Analysis

The statistical analysis was performed using the Stata 15 (StataCorp., College Station, TX, US) software for Mac.

Data were tested for normality and evaluated according to their statistical nature using two-tailed curves and values of $p < 0.05$. Data were evaluated regarding intention-to-treat (ITT) whenever possible.[14] The interim sample size analysis was performed by verifying its statistical power.

The causes for patient withdrawal from the study were reported.

Surgical Technique

The patients are placed in the beach chair position under general anesthesia, and a standardized four-portal surgical technique is used. These portals are a posterior portal, an anterolateral portal, a portal just above the coracoid process, and an anteromedial trans-subscapular portal; the placement of the last two portals is aided by an intravenous catheter measuring 2.1 × 45 mm to ensure the best position (►**Fig. 1**).[11]

With the optics at the posterior portal, the subscapularis muscle tendon is open broadly following fiber direction with a strong Kelly forceps, electrocautery, and shaver through the anteromedial trans-scapular portal (►**Fig. 2**). The rotator interval and the origin of the coracoacromial ligament at the superolateral border of the coracoid process are removed with electrocautery and shaver. The glenoid cavity is enlarged by inserting the shaver through the anterolateral portal. Then, using the anteromedial trans-scapular portal, the drill passes through the open space in the subscapularis tendon and touches the border of the anteroinferior glenoid cavity. The optics is moved to the anterolateral portal for better viewing, and a hole is made 5 to 6 mm medial to the anterior edge of the glenoid cavity.[15] The size of this hole is measured. The optics is removed from the intra-articular space and placed at the anterior subdeltoid; then, the pectoralis minor tendon is released by electrocauterization through the portal located above the coracoid process, and the osteotomy of the coracoid process is performed with a microsaw and osteotomes. The use of the Kocher forceps previously inserted into the conjoined

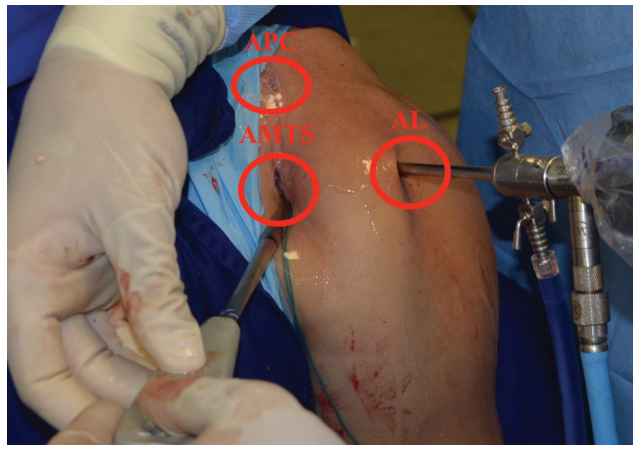

Fig. 1 Portals: APC, portal above the coracoid process; AMTS, anteromedial trans-subscapular portal; AL, anterolateral portal.

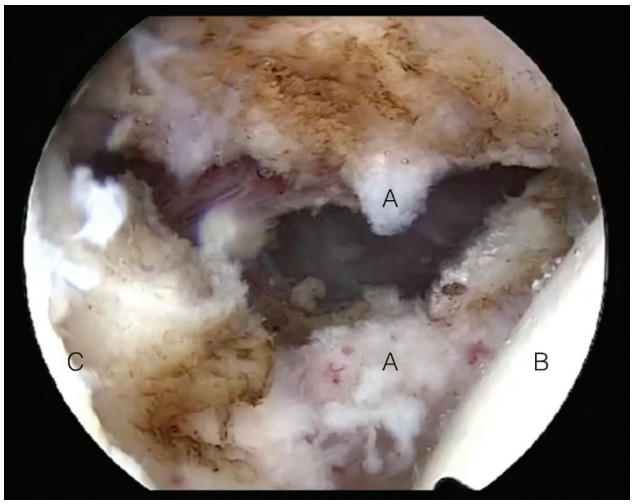

Fig. 2 Arthroscopic image of the shoulder showing the opening of the subscapularis tendon. A) subscapular B) humerus C) glenoid cavity.

tendon through the anteromedial portal can facilitate its exteriorization (►**Figs. 3** and **4**). The size of the 3.5 mm malleolar screw must be the sum of the glenoid cavity depth and the measured graft size after exteriorization through the anteromedial portal. A washer must always be used in this procedure.

Then, a #5 multifilament nylon suture or a #2 high-strength suture is placed between the washer and the screw head to pull it against the key, preventing the screw from coming off the key, and securing the graft in the glenoid cavity through the opening made in the subscapularis tendon (►**Figs. 5** and **6**). A Kocher forceps is inserted through the portal located above the coracoid process, with a slight compression, to control graft rotation during fixation.

If the graft has an articular step, the bone shaver can be used to even it.

Increasing screw torque does not necessarily mean that the graft is properly secured; to test screw tightness, a probe must be used to verify whether the washer is loose or secure.

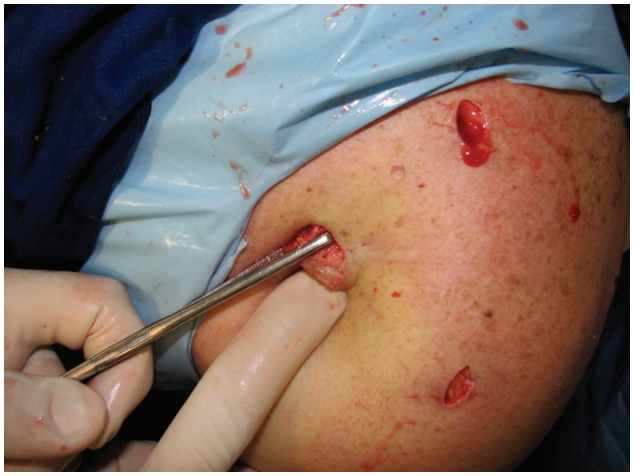

Fig. 3 Image of the left shoulder with the coracoid process externalized with the aid of a Kocher forceps.

Fig. 4 Screw passing through the externalized coracoid process graft.

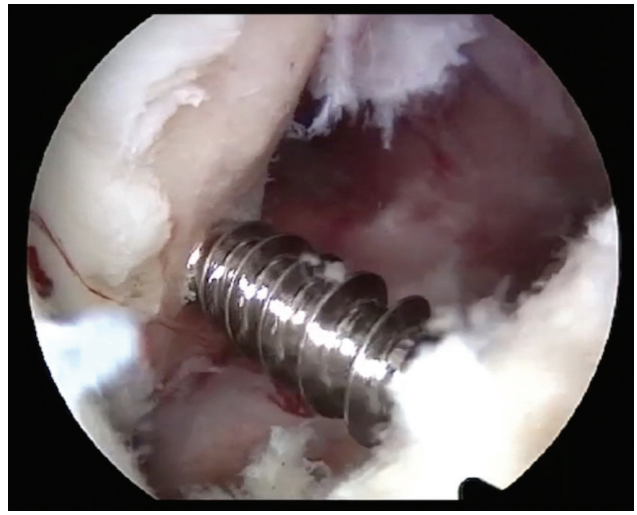

Fig. 5 Arthroscopic image of the shoulder showing the fixation in the anterior glenoid cavity; the arthroscope is in the anterolateral portal.

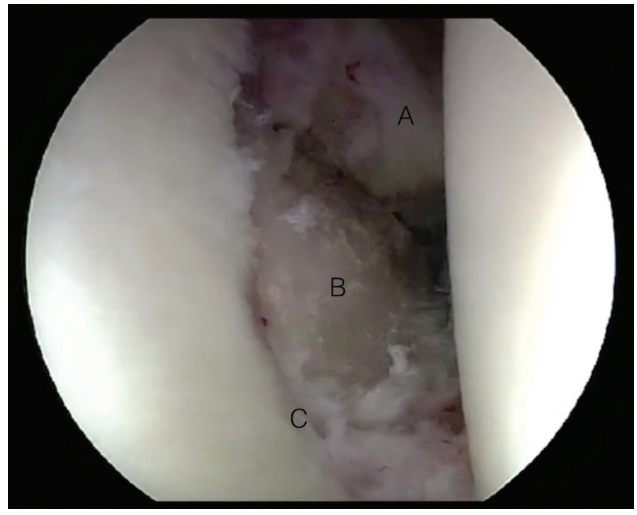

Fig. 6 Arthroscopic image of the shoulder showing the final fixation of the coracoid process graft in the anterior glenoid cavity; the arthroscope is in the posterior portal. A) subscapular B) inserted coracoid process C) glenoid cavity.

Results

Out of 43 patients evaluated at baseline, 3 could not be assessed postoperatively. With the baseline data, these patients were maintained in the sample, and their scores were copied from the baseline to the two-year assessment (ITT) to avoid any bias that might favor the procedure.

The evaluated group consisted of 42 men and 1 woman with a mean age of 32.88 years (18–60 years); the left side was affected in 15 patients, whereas the right side was affected in 28 patients. The median follow-up time was 76 months (range: 129-24 months).

The causes for these procedures were the following: 28 patients had Bankart bone lesions with at least 20% of bone loss; 1 individual had HAGHL; 9 patients had a history of previous failed Bankart procedures; and 5 patients presented an instability severity index greater than 6.

The mean UCLA, Rowe, lateral rotation loss and TSO values for these 43 patients (ITT) are summarized in ►**Table 1**.

The data presented statistically consistent results.[16]

There were no elevation differences greater than 10° regarding the contralateral side, except for 2 cases.

The medial rotation was not evaluated; however, 10 out of 40 patients had discomfort and disability during the extremes of this movement (SST, question 11).

Intraoperative Complications (43 Patients)

There were two coracoid process fractures, including an incomplete lesion submitted to coracoid process cerclage with #5 multifilament nylon and an arthroscopic Bristow procedure. The other fracture was complete and multifragmented, so we opted for an arthroscopic conjoined tendon tenodesis in the anterior portion of the trans-scapular glenoid cavity, with excellent long-term functional outcome. This last patient was one of the three who could not be evaluated postoperatively, since he was not submitted to the procedure under study.

No paresis, paresthesia or nerve damage occurred in either case.

Postsurgical Complications (40 Patients)

There were three pseudarthroses without clinical repercussions.

An 8.84° screw twist occurred in the medial direction of the axial plane without clinical repercussions, since the graft consolidated even after twisting.

There were four osteolyses, three without clinical repercussions and one requiring screw removal. Osteoarthritis was present in three patients; in two of them, the condition was moderate, and in one, it was deemed initial according to the classification by Samilson and Prieto.[17] Two of these patients already had moderate osteoarthritis before the surgical procedure.

One patient had an infection with a potential hematogenous origin six months after the procedure. Anterior impingement was observed in two patients, including one with associated graft osteolysis, and both required synthesis material removal. There were no subdislocations or de novo dislocations after the procedure.

Concomitant lesions were treated in four patients, including three superior labral anterior and posterior (SLAP) lesions and one cuff injury.

In total, there were 12 complications, 8 of which had no clinical repercussions. Complications with repercussions included infection six months after surgery with potential hematogenous origin, a coracoid fracture requiring an intraoperatively procedural change, and two patients with previous impingement who required synthesis material removal more than six months after surgery. These four patients with complications presented good responses to the instituted treatments, with clinical improvement, except for the patient with infection, who presented the worst functional outcomes in this series.

The interim analysis of the sample size showed an adequate size considering a significance level of 0.001, with 99% of statistical power.[18,19]

Discussion

Recent changes in coracoid process transfer procedures have been reported, enabling its performance by arthroscopy.[7,9,10]

The advantages of the arthroscopic method include the following: better visualization of the graft insertion site; possibility of correction of articular steps under visualization; intra-articular visualization of the graft to ascertain its correct location; the ability to test lateral rotation under articular visualization; possible concomitant treatment of other injuries; reduced adhesions; and improved cosmesis.[1,7] The disadvantages are the increased costs related to arthroscopy, the lengthy learning curve, and the need for specific training.[7]

Table 1 Comparison of the values of the UCLA score, the Rowe score, the simple shoulder test and loss of lateral rotation

	Baseline (±standard deviation or cutoff values for good/excellent results)	> 2 years postsurgery (±standard deviation)	*p*-value	*n*
UCLA	25.56 ± 0.50	33.23 ± 0.44	< 0.0001	43
Rowe	75 (good results)	94.25 ± 1.52	< 0.0001	40
Rowe	90 (excellent results)	94.25 ± 1.52	0.0082	40
SST	————————	11.35 ± 0.21	—	40
Loss of lateral rotation	————————	10.37 ± 1.36	—	40

Abbreviations: SST, simple shoulder test; UCLA, University of California at Los Angeles.

Coracoid process fractures were the worst complication from this procedure (three cases). Edwards and Walch[20] suggest a two-finger technique, in which the screw torque is performed with only the thumb and the index finger, avoiding excessive screw torque over the graft. Washer visualization and test, in which the probe is run over the washer to make sure it is fixed, can also increase the safety of the procedure, as in some cases the increased torque felt on the key may not be due to graft compression, but to the fixation in the contralateral cortex. As for size, a 3.5-mm non-cannulated screw and washer appear to be the most suitable option. The aforementioned precautions ended coracoid process fractures in the present series. In cases of fracture in which cerclage is not possible or feasible, the author suggests a conjoined tendon tenodesis in the anterior portion of the glenoid cavity with anchors.

Cadaveric studies have not found significant biomechanical differences between conjoined tendon tenodesis and coracoid process and conjoined tendon osteosynthesis, suggesting that there is no need for bone block to achieve shoulder stability in surgical procedures.[21,22] It is reported that shoulder stability may be more closely linked to soft tissue passive and active mechanisms that are difficult to measure.[23]

In fact, neither the Bristow nor the Latarjet procedures, as originally described, have enough bone to produce the bone-blocking effect. In the Bristow procedure described by Helfet, the coracoid process is sutured to the anterior portion of the glenoid, whereas in the Latarjet procedure, the coracoid process is osteotomized before the insertion of the pectoralis minor, completely preserving this muscle attachment, and the graft is very small.[4,5]

Although the bone-blocking effect certainly added stability to the procedure in the modern Bristow and Latarjet variations, this benefit may only be perceived in patients with Hill-Sachs lesions in a region located at a distance from the cuff attachment that is greater to or equal than the original diameter of the glenoid cavity minus the bone loss times 0.83.[24]

The literature discusses the ideal screw diameter for coracoid transfers. Walsh and Boileau use 4.5-mm screws[25]; Burkhart et al[26] and Di Giacomo et al[27] use 3.75-mm cannulated screws; and Lafosse et al[7] use 3.5-mm screws. All of these authors use vertically-oriented grafts. In the technique presented in the present study, the screw diameter will depend on the physical characteristics of the patient, but there is a clear preference for non-cannulated 3.5-mm screws with washers.

Walsh and Boileau[25] do not recommend using washers because of the large size of the screws and the proximity to the washer when the graft is left upright. In this procedure, which is performed with a smaller screw, the use of a washer resulted in mechanical benefits, and it is recommended for two reasons: for load distribution and because it is a test option in case of doubt whether the screw tightness comes from the torque against the contralateral cortex or actual graft compression.

In the arthroscopic Bristow procedure, graft osteolysis was only observed in three cases, and none in the last 15 patients. Since osteolysis can be associated with compression forces imposed on the graft, perhaps the two-finger fixation methods and the washer testing have been instrumental in these outcomes.[27] However, there is a potential bias because postoperative evaluations were performed by radiographs alone, leaving CT scans for cases in which possible complications were suspected.

A case of impinged osteolysis required screw excision.[28]

Even with only 1 case of synthesis material removal, 11 out of 40 patients answered "no" or "discomfort" to question 11 of the SST. As such, some impingement may be underestimated by this series. The author accepts that there may be an impingement, with no or low clinical repercussions, on 27.5% patients. Screw removal was required in 2 of the 11 patients with impingement. The impingement may be associated with the graft angle, which must be perpendicular to the fracture line and preferably not greater than the continuity angle of the glenoid cavity circumference. Direct and dynamic visualization through the intra-articular space gives the surgeon a greater control for graft positioning, avoiding articular steps. The author suggests that graft size and obliquity are determining factors in both impingement and effective glenoid depth.[29]

In the present study, the reoperation rate was of 5%, which is similar to the one previously reported for open procedures.[8]

Two patients already had osteoarthritis before the procedure, and only one case presented new radiographic signs. This low rate of osteoarthritis may be associated with the direct visualization that enables intraoperative corrections to prevent articular steps.

The absence of an articular step reduces the load on the graft because there is no mechanical stress point, resulting in no significant changes in the pressure over the superior-posterior glenoid quadrant.[10] It has been shown that not only graft lateralization, but also its medialization, are associated with postoperative complications. Medialization greater than 5 mm is associated with higher recurrence rates of shoulder instability.[30] The better intra-articular evaluation of the arthroscopic fixation region may be a positive factor to avoid this complication.

So far, since there are no recurrences of instability and the follow-up of quality of life shows statistically significant results, it is possible to affirm the effectiveness of the technique.

In the present study, three pseudarthroses were observed, but none had clinical repercussions, which is consistent with the literature. The amount of pseudarthroses may be underestimated because the follow-up was mostly performed with conventional radiographs, which can make this diagnosis difficult.

The author suggests that the use of a single screw is sufficient to fix the coracoid process. Hovelius et al[30] reported 11 de novo dislocations in 319 shoulders, that is, a 3% rate, after the open Bristow procedure. Of these patients, 13% had pseudarthrosis; however, the fibrous union was enough to prevent recurrences. De novo dislocations were more associated with graft medialization than with pseudarthroses.[30]

The absence of de novo dislocations in the present study may be associated with a better graft positioning, improving

the contact of the scarified area of the anterior glenoid cavity with the graft cancellous bone in horizontal position; however, the sample is too small to suggest such conclusions. Low recurrence rates, close to 1%, in more than 2,346 open surgical procedures, are cited in the literature; the results of the present study suggest this same trend of good results for the arthroscopic procedure.[31]

Lower de novo dislocation rates are not associated with the use of two screws in similar techniques.[26,32]

The postsurgical alteration of the musculocutaneous nerve has not been observed, despite its 0.7% incidence in the literature.[10] Even with no neurological impairment, the author suggests larger series in order to draw any conclusions regarding the superiority of the neurological safety of the procedure.

The procedure resulted in the same length of hospital stay as other similar arthroscopic surgeries, with a significant economic advantage due to the exclusive use of basic arthroscopy materials, a small fragment screw and a washer.

Conclusion

The arthroscopic Bristow procedure showed extremely significant effectiveness in the treatment of anterior shoulder instability; however, it is not a complication-free procedure, with a 9% complication rate in the present series.

Conflicts of Interest

The author is a consultant for Zimmer-Biomet.

References

1 Zacchilli MA, Owens BD. Epidemiology of shoulder dislocations presenting to emergency departments in the United States. J Bone Joint Surg Am 2010;92(03):542–549
2 Boileau P, Villalba M, Héry JY, et al. Risk factors for recurrence of shoulder instability after arthroscopic Bankart repair. J Bone Joint Surg Am 2006;88(08):1755–1763
3 Page CM, Bristow WR. The treatment of fractures and dislocations in general practice. 3rd ed. Oxford: Oxford Medical Publications; 1929
4 Helfet AJ. Coracoid transplantation for recurring dislocation of the shoulder. J Bone Joint Surg Br 1958;40-B(02):198–202
5 Latarjet M. A propos du traitement des luxations récidivantes de l'épaule. Lyon Chir 1954;49(08):994–997
6 Patte D, Bernageau J, Rodineau J, et al. [Unstable painful shoulders (author's transl)]. Rev Chir Orthop Repar Appar Mot 1980;66(03): 157–165
7 Lafosse L, Lejeune E, Bouchard A, et al. The arthroscopic Latarjet procedure for the treatment of anterior shoulder instability. Arthroscopy 2007;23(11):1242.e1–1242.e5
8 Griesser MJ, Harris JD, McCoy BW, et al. Complications and reoperations after Bristow-Latarjet shoulder stabilization: a systematic review. J Shoulder Elbow Surg 2013;22(02):286–292
9 Boileau P, Bicknell RT, El Fegoun AB, et al. Arthroscopic Bristow procedure for anterior instability in shoulders with a stretched or deficient capsule: the "belt-and-suspenders" operative technique and preliminary results. Arthroscopy 2007;23(06): 593–601
10 Nourissat G, Nedellec G, O'Sullivan NA, et al. Mini-open arthroscopically assisted Bristow-Latarjet procedure for the treatment of patients with anterior shoulder instability: a cadaver study. Arthroscopy 2006;22(10):1113–1118
11 Garcia JC, Garcia JPM, Mattos CA, et al. Arthroscopic Bristow-Latarjet-Like procedure: Surgical technique. Tech Shoulder Elbow Surg 2009;10:94–98
12 Balg F, Boileau P. The instability severity index score. A simple pre-operative score to select patients for arthroscopic or open shoulder stabilisation. J Bone Joint Surg Br 2007;89(11): 1470–1477
13 Romeo AA, Bach BR Jr, O'Halloran KL. Scoring systems for shoulder conditions. Am J Sports Med 1996;24(04):472–476
14 Streiner D, Geddes J. Intention to treat analysis in clinical trials when there are missing data. Evid Based Ment Health 2001;4(03): 70–71
15 Young AA, Baba M, Neyton L, et al. Coracoid graft dimensions after harvesting for the open Latarjet procedure. J Shoulder Elbow Surg 2013;22(04):485–488
16 Pocock SJ. When to stop a clinical trial. BMJ 1992;305 (6847):235–240
17 Samilson RL, Prieto V. Dislocation arthropathy of the shoulder. J Bone Joint Surg Am 1983;65(04):456–460
18 Harmonised Tripartite Guideline ICH. Statistical principles for clinical trials (E9). 1998. Available at: http://www.ich.org/fileadmin/Public_Web_Site/ICH_Products/Guidelines/Efficacy/E9/Step4/E9_Guideline.pdf
19 Peacock JL, Peacock PJ. Sample size for comparative studies: means. In: Peacock JL, Peacock PJ, editors. Oxford handbook of medical statistics. 3rd ed. Oxford: Oxford University Press; 2011
20 Edwards TB, Walch G. The Latarjet procedure for recurrent anterior shoulder instability: rationale and technique. Oper Tech Sports Med 2002;10(01):25–32
21 Thomas PR, Parks BG, Douoguih WA. Anterior shoulder instability with Bristow procedure versus conjoined tendon transfer alone in a simple soft-tissue model. Arthroscopy 2010;26(09): 1189–1194
22 Yamamoto N, Muraki T, An KN, et al. The stabilizing mechanism of the Latarjet procedure: a cadaveric study. J Bone Joint Surg Am 2013;95(15):1390–1397
23 Panchal AP, Osbahr DC, Douoguih W, et al. Conjoined tendon transfer vs modified Bristow in a glenoid bone loss model: A biomechanical study. Orthop J Sports Med 2013;1(4 Suppl):2325967113S00012
24 Yamamoto N, Itoi E, Abe H, et al. Contact between the glenoid and the humeral head in abduction, external rotation, and horizontal extension: a new concept of glenoid track. J Shoulder Elbow Surg 2007;16(05):649–656
25 Walsh G, Boileau P. Latarjet-Bristow procedure for recurrent anterior instability. Tech Shoulder Elbow Surg 2000;1:256–261
26 Burkhart SS, De Beer JF, Barth JR, et al. Results of modified Latarjet reconstruction in patients with anteroinferior instability and significant bone loss. Arthroscopy 2007;23(10):1033–1041
27 Giacomo GD, Costantini A, de Gasperis N, et al. Coracoid bone graft osteolysis after Latarjet procedure: A comparison study between two screws standard technique vs mini-plate fixation. Int J Shoulder Surg 2013;7(01):1–6
28 Ghodadra N, Gupta A, Romeo AA, et al. Normalization of glenohumeral articular contact pressures after Latarjet or iliac crest bone-grafting. J Bone Joint Surg Am 2010;92(06): 1478–1489
29 Lippitt SB, Vanderhooft JE, Harris SL, et al. Glenohumeral stability from concavity-compression: A quantitative analysis. J Shoulder Elbow Surg 1993;2(01):27–35
30 Hovelius L, Sandström B, Olofsson A, et al. The effect of capsular repair, bone block healing, and position on the results of the Bristow-Latarjet procedure (study III): long-term follow-up in 319 shoulders. J Shoulder Elbow Surg 2012;21(05):647–660

31 Garcia JC Jr, do Amaral FM, Belchior RJ, et al. Comparative Systematic Review of Fixation Methods of the Coracoid and Conjoined Tendon in the Anterior Glenoid to Treat Anterior Shoulder Instability. Orthop J Sports Med 2019;7(01):2325967118820539

32 Collin P, Rochcongar P, Thomazeau H. [Treatment of chronic anterior shoulder instability using a coracoid bone block (Latarjet procedure): 74 cases]. Rev Chir Orthop Repar Appar Mot 2007;93 (02):126–132

Usage Evaluation of a Mobile App to Help Understand the Rehabilitation Process of Shoulder Surgery*

Avaliação do uso de aplicativo de celular para auxílio no processo de reabilitação da cirurgia do ombro

André Luis Giusti[1] Sandro da Silva Reginaldo[1] Thiago Barbosa Caixeta[1]
Eduardo Damaceno Chaibe[1,2] Leonardo Vieira Santos Moraes[1,3] Rodolpho Lemes de Oliveira[1]

[1] Department of Orthopedics and Traumatology, Hospital das Clínicas da Universidade Federal de Goiás, Goiânia, GO, Brazil
[2] Centro de Reabilitação e Readaptação Dr Henrique Santillo, Goiânia, GO, Brazil
[3] Hospital Ortopédico de Goiânia, Goiânia, GO, Brazil

Address for correspondence André Luis Giusti, MD, Departamento de Ortopedia e Traumatologia do Hospital das Clínicas da Universidade Federal de Goiás, Goiânia, GO 74605-020, Brazil (e-mail: andreluisgiusti@yahoo.com.br).

Rev Bras Ortop 2021;56(2):213–217.

Abstract

Objective The present paper aims to evaluate the quality of a mobile phone application (app) designed to guide patients after shoulder surgical procedures.

Methods A free and easily accessible app was developed to help patients at home. Patients were monitored for app use and adaptation before physical therapy started. At the end of 6 weeks, a qualitative questionnaire was employed to determine the usability of the app.

Results In total, 97% of the respondents reported that the app was easy to download, the exercises were readily understood, and they would recommend the app. Ninety-three percent of the participants agreed that the app made them feel a greater degree of participation in the treatment of their illness, while 90% considered the app self-explanatory.

Conclusion The virtual platform helps the patients to understand the treatment, aiding the medical prescription of postoperative exercises to be performed at home.

Keywords
- rehabilitation
- shoulder/surgery
- physical therapy specialty
- orthopedics
- cell phone

Resumo

Objetivo Avaliar a qualidade de um aplicativo de celular desenvolvido para orientar pacientes em período pós-operatório de procedimentos cirúrgicos do ombro.

Métodos Desenvolveu-se um aplicativo gratuito e de fácil acesso para auxiliar os pacientes em domicílio. Os indivíduos foram monitorados quanto ao uso do aplicativo

* The present study was developed at the Department of Orthopedics and Traumatology of Hospital das Clínicas da Universidade Federal de Goiás, Goiânia, GO, Brazil.

received
June 10, 2019
accepted
December 20, 2019
published online
June 8, 2020

DOI https://doi.org/10.1055/s-0040-1708517.
ISSN 0102-3616.

Thieme Revinter Publicações Ltda., Rua do Matoso 170, Rio de Janeiro, RJ, CEP 20270-135, Brazil

e adaptação à sua prática antes do início da fisioterapia. Ao final de 6 semanas, aplicou-se um questionário qualitativo para avaliar a usabilidade do aplicativo.

Resultados Um total de 97% dos respondentes afirmaram que foi fácil executar o *download* do aplicativo, que os exercícios sugeridos foram prontamente entendidos, e relataram que indicariam o aplicativo. Noventa e três por cento da amostra concorda que o aplicativo fez com que se sentissem mais participativos com relação ao tratamento de sua doença, enquanto 90% consideraram o aplicativo autoexplicativo.

Conclusão O uso de uma plataforma virtual é uma ferramenta de compreensão sobre o tratamento e auxilia na prescrição médica de exercícios pós-operatórios domiciliares.

Palavras-chave
- reabilitação
- ombro/cirurgia
- fisioterapia
- ortopedia
- telefone celular

Introduction

The guidance given by the doctor about the rehabilitation process after a surgical procedure is critical to achieve a successful outcome, and it must be well understood by the patient. Rehabilitation protocols have been discussed and applied for a long time, ranging according to lesion type, service orientation, and surgeon's preference.

Since the shoulder joint is subject to rapid postoperative stiffness and atrophy, rehabilitation is usually as important as the surgical procedure.[1] Therefore, it is important that the patient performs some movements before being referred to a rehabilitation service[2]

Both the general population and medical providers try to keep up with the newest developments in internet access and smartphone technologies. Now, doctors and patients can communicate in a virtual environment through mobile applications[3–9] to discuss postoperative guidelines, solve simple doubts, and strengthen the doctor-patient relationship.[7]

It is undeniable that mobile phone applications (apps) facilitate communication[8] Patients undoubtedly become more active in their treatment[4] and feel included, thus increasing their participation in the process.

To clarify procedure-related doubts, an app with self-explanatory videos was developed so that patients can review their doctor's guidance. The app does not intend to treat patients; it is simply a means of communication for patients to follow professional prescription. Thus, the present study aimed to qualitatively evaluate an app developed to guide patients in the postoperative period of shoulder surgical procedures, helping them to understand the initial rehabilitation process.

Materials and Methods

In this study, a questionnaire assessed the perception of the patients regarding the creation of an app to guide them after shoulder surgeries. The questionnaire included questions about the ease of downloading and understanding the exercises, possible app indication to other people, patients' participation in their condition and whether the app was considered self-explanatory.

The app was created using the iGenApps software (iGenApps, San Francisco, CA, USA), available on Android@ and Playstore. This app was developed to be free, with simple, didactic language, using a sequence of texts, videos, and illustrations (►**Figure 1**). The iGenApps software, which uses Java language, was used as a platform, and it allows the creation of apps for both Android and iOS systems. The creation and development of the app was carried out by one of the authors (►**Figure 2**).

The iGenApps software allows the insertion of texts and video links. As such, a series of videos was recorded on YouTube, and links, along with texts, were made available in the app.

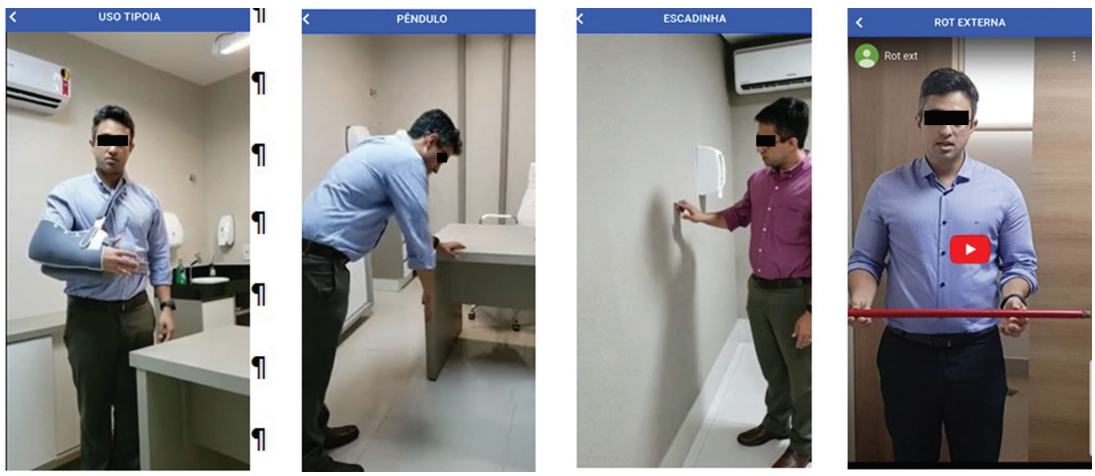

Fig. 1 Guidelines for exercises performance. Source: Author's personal file.

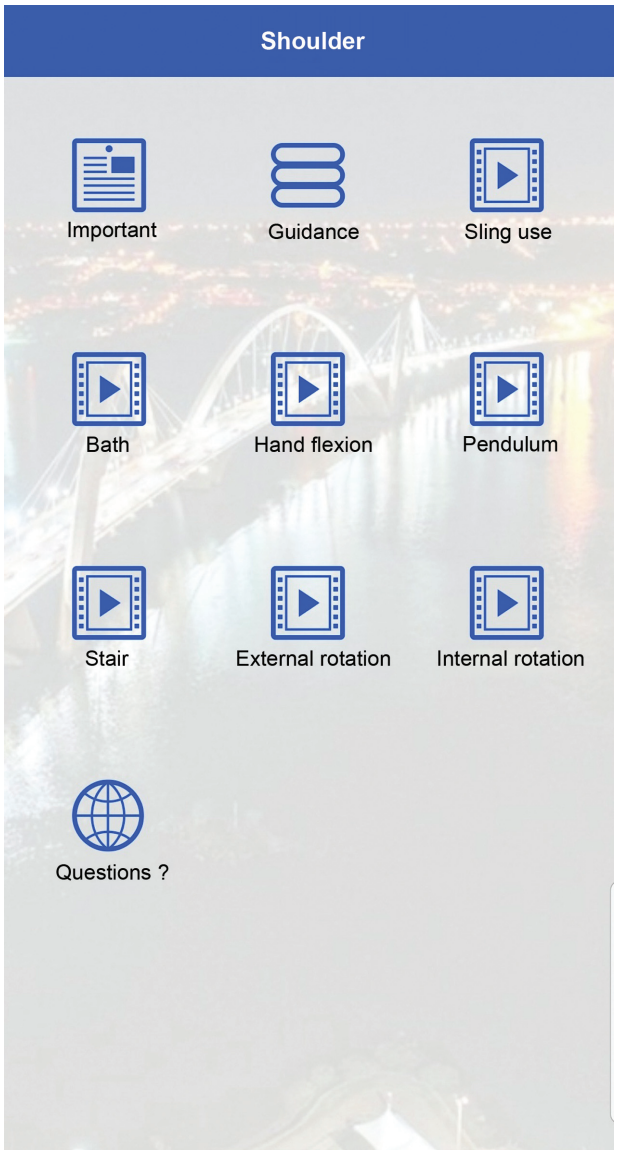

Fig. 2 Mobile application home screen. Source: Author's personal file.

After the surgery, the attending physician explained the postoperative guidelines, as usual, but asked patients to watch the videos to remember the exercises shown during the first postoperative visit.

The patients were monitored on app use through a tool that reported the number of accesses. At the end of a 6-week follow-up period, when the patient was referred for rehabilitation, a questionnaire (**Appendix 1**) assessed app use in a qualitative way.

Thirty-two patients were evaluated; two of them were excluded due to lack of internet access (both lived in rural areas). The questionnaire was applied during the postoperative period in accredited hospitals with advanced training in shoulder and elbow surgery at our institution.

Results

Of the 30 patients comprising the sample, 13 were male and 17 were female, with a mean age of 48 years; most of them

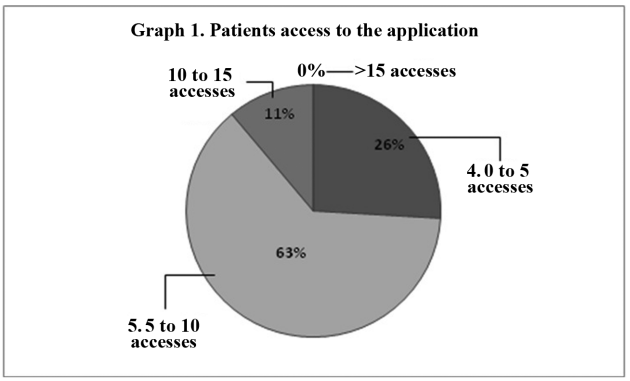

Fig. 3 Patient access to the application.

attended elementary school (10 patients) and high school (14 patients). Two patients were college graduates, three were illiterate and none held a postgraduate degree.

Most patients accessed the app 5 to 10 times (►**Figure 3**).

Regarding the questionnaire, 97% of respondents reported that it was easy to download the app, that the exercises were readily understood, and that they would recommend the app to someone who had doubts on how to perform these exercises after shoulder surgery. When asked if the app made them feel more participatory in the treatment of their condition, 93% patients said yes, and 90% considered the app self-explanatory. Questionnaire data are shown in ►**Table 1**.

Discussion

Patients reported that the app helped them to understand the exercises. One of them said, "the videos gave me confidence to perform the exercises prescribed by the doctor." The videos allowed the patients to review the prescribed exercises, reducing doubts about their execution at home. These data are consistent with findings in the literature in which smartphones were considered practical.[10] In contrast, complaints about the low scientific evidence on app use for rehabilitation,[3] validation, and lack of direct medical participation in apps were not observed in our study. Physicians were directly involved in all phases of the app creation, and the exercises included in the videos had already been described and validated by another rehabilitation study.[1]

The question "Would you recommend the application to someone who has doubts about the surgical procedure?" assessed satisfaction with the app use, and it elicited mostly positive answers. Two situations warrant such acceptance. The first one is familiarity with technology and accessibility, as patients can access the app at any time from the comfort of their homes. This practical aspect is also observed in other studies.[4,8–12] The second one is the feeling of greater doctor-patient proximity.[2]

Despite the doctor-patient proximity proposed by the app, two patients said that videos were quite didactic, but that the doctor's explanation will always be more informative. One patient reported that the app did not influence his understanding, since the doctor had already answered all his

Table 1 Questionnaire on application use

Questions	Total amount of answers	YES Answers		NO Answers	
		Amount	Percentage (%)	Amount	Percentage (%)
Was the application easy to download?	30	29	97	1	3
Did the application facilitate the understanding of the exercises?	30	29	97	1	3
Would you recommend the application to someone who has doubts about the surgical procedure?	30	29	97	1	3
Did the application make you feel more participatory about the treatment of your illness?	30	28	93	2	7
Do you consider the application self-explanatory?	30	26	87	4	13

doubts. This demonstrates that, despite technological assistance, the presence of a physician is extremely relevant in any phase of treatment.

Similar findings were described by Harder et al,[4] with an app created by a health care professional, in this case a physical therapist, to assist post-mastectomy rehabilitation. The study had a positive impact, since the app helped patients in the post-treatment for breast cancer, but their sample (nine patients) was smaller compared to ours. Eaton et al[13] evaluated the use of an interface in medical learning and concluded that it helped residents and surgery fellowships.

Rassouli et al[5] evaluated several apps for chronic lung disease rehabilitation in a 20-day period and concluded that, in addition to being reasonable tools, they provide additional information to attending physicians.

Another research, carried out with the purpose of instructing home exercises, evaluated five patients with adhesive capsulitis and revealed that technology is useful for patient rehabilitation. This app had the advantage to evaluate and record the range of motion and exercise duration per patient.[14] Our app was not able to record the viewing time of each exercise, but it facilitated communication and understanding, consistent with several other studies.[4–6,8]

Gilbert et al[8] evaluated the rehabilitation of patients with shoulder conditions using the MUJO app (Paris, France) and concluded that it does not interfere with any rehabilitation protocol already in place. On the contrary, it can be implemented and adapted to the routine of the attending physician and specialist physical therapist.

It is always useful to point out that failure to follow prescriptions or carrying them out incorrectly is a possibility, since the patient is an active part of his/her treatment. We suggest that future studies evaluate patients who had access to and used an app, assessing the quality of their rehabilitation compared with a group not using this technology.

Conclusion

We conclude that a virtual platform is useful for treatment understanding and helps the medical prescription of exercises to be performed at home after shoulder surgery.

The proposed app is easy to understand, quick for the operating system and fulfills the objective of guiding patients as part of their treatment, including them as actors in the treatment of their own conditions.

Conflict of Interests

The authors declare that there are no conflict of interests.

References

1 Veado MAC, Flóra W. Reabilitação pós-cirúrgica do ombro. Rev Bras Ortop 1994;29(09):661–664
2 De Marco MA. Do modelo biomédico ao modelo biopsicossocial: Um projeto de educação permanente. Rev Bras Educ Med 2006;30 (01):60–72
3 Lau AY, Piper K, Bokor D, Martin P, Lau VSL, Coiera E. Challenges During Implementation of a Patient-Facing Mobile App for Surgical Rehabilitation: Feasibility Study. JMIR Human Factors 2017;4 (04):e31
4 Harder H, Holroyd P, Burkinshaw L, et al. A user-centred approach to developing bWell, a mobile app for arm and shoulder exercises after breast cancer treatment. J Cancer Surviv 2017;11(06): 732–742
5 Rassouli F, Boutellier D, Duss J, Huber S, Brutsche MH. Digitalizing multidisciplinary pulmonary rehabilitation in COPD with a smartphone application: an international observational pilot study. Int J Chron Obstruct Pulmon Dis 2018;13:3831–3836
6 Zhang M, Ying J, Amron SB, et al. A Smartphone Attention Bias Intervention for Individuals With Addictive Disorders: Protocol for a Feasibility Study. JMIR Res Protoc 2018;7(11):e11822
7 Liu HT, Chia RM, Setiawan IMA, Crytzer TM, Ding D. Development of "My Wheelchair Guide" app: a qualitative study. Disabil Rehabil Assist Technol 2019;14(08):839–848
8 Gilbert AW, Hauptmannova I, Jaggi A. The use of assistive technology in shoulder exercise rehabilitation - a qualitative study of acceptability within a pilot project. BMC Musculoskelet Disord 2018;19(01):133
9 De La Cruz Monroy MFI, Mosahebi A. The Use of Smartphone Applications (Apps) for Enhancing Communication With Surgical Patients: A Systematic Review of the Literature. Surg Innov 2019; 26(02):244–259
10 Wong SJ, Robertson GA, Connor KL, Brady RR, Wood AM. Smartphone apps for orthopaedic sports medicine – a smart move? BMC Sports Sci Med Rehabil 2015;7(23):1–7
11 Xie B, Su Z, Zhang W, Cai R. Chinese Cardiovascular Disease Mobile Apps' Information Types, Information Quality, and Interactive

Functions for Self-Management: Systematic Review. JMIR Mhealth Uhealth 2017;5(12):e195
12 Chen HC, Chuang TY, Lin PC, Lin YK, Chuang YH. Effects of Messages Delivered by Mobile Phone on Increasing Compliance With Shoulder Exercises Among Patients With a Frozen Shoulder. J Nurs Scholarsh 2017;49(04):429–437
13 Eaton M, Scully R, Schuller M, et al. Value and Barriers to Use of the SIMPL Tool for Resident Feedback. J Surg Educ 2019;76(03): 620–627
14 Stütz T, Emsenhuber G, Huber D, et al. Mobile Phone-Supported Physiotherapy for Frozen Shoulder: Feasibility Assessment Based on a Usability Study. JMIR Rehabil Assist Technol 2017;4(02):e6

Appendix 1–Questionnaire

1) AGE:
2) GENDER: MALE / FEMALE
3) EDUCATION:
ILLITERATE
ELEMENTARY SCHOOL
HIGH SCHOOL
COLLEGE
POSTGRADUATE DEGREE
4) DO YOU HAVE YOUR OWN INTERNET ACCESS OR DO YOU SHARE IT?
YES
NO
5) NUMBER OF APPLICATION ACCESSES:
0 TO 5
5 TO 10
10 TO 15
OVER 15.
6) WAS THE APPLICATION EASY TO DOWNLOAD?
YES
NO
7) DID THE APPLICATION FACILITATE THE UNDERSTANDING OF THE EXERCISES?
YES
NO
8) WOULD YOU RECOMMEND THE APPLICATION TO SOMEONE WHO HAS DOUBTS ABOUT THE SURGICAL PROCEDURE?
YES
NO
9) DID THE APPLICATION MAKE YOU FEEL MORE PARTICIPATORY ABOUT THE TREATMENT OF YOUR ILLNESS?
YES
NO
10) DO YOU CONSIDER THE APPLICATION SELF-EXPLANATORY (OR WOULD YOU REQUIRE A DOCTOR TO EXPLAIN IT FOR YOU)?
YES
NO

Impact of the "Mind the risk" Campaign of Sociedade Brasileira de Ortopedia e Traumatologia on Risk Perception and Use of the Surgical Checklist by Brazilian Orthopedists*

Impacto da campanha "Considere o Risco", da Sociedade Brasileira de Ortopedia e Traumatologia, na percepção do risco e na utilização do checklist cirúrgico por ortopedistas brasileiros

Germana Lyra Bähr[1] Geraldo da Rocha Motta Filho[1]

[1] Division of Traumatology and Orthopedics, Instituto Nacional de Traumatologia e Ortopedia (Into), Rio de Janeiro, RJ, Brazil

Rev Bras Ortop 2021;56(2):218–223.

Address for correspondence Geraldo da Rocha Motta Filho, MD, MSc, Instituto Nacional de Traumatologia e Ortopedia (into), Rua Raimundo de Magalhães, 92, Gávea, Rio de Janeiro, RJ, 22451-150, Brazil (e-mail: geraldomotta@terra.com.br).

Abstract

Objective To analyze the impact of the educational actions included in the "Mind the Risk" campaign of Sociedade Brasileira de Traumatologia e Ortopedia (Brazilian Society of Traumatology and Orthopedics, SBOT, in Portuguese), to increase the perception of the risk involved in the surgical activity and the use of the surgical checklist.

Methods A comparative research was performed during the 50th Brazilian Congress on Orthopedics and Traumatology (50° CBOT, in Portuguese) in November 2018, using a questionnaire similar to the one used in previous two versions.

Results The number of participants was 730, corresponding to 18,7% of the total of 3,903 enrolled in the 50° CBOT. Among the participants, 542 orthopedists (74,2%) reported having experienced errors within the surgical units and 218 (29,8%) surgeries in wrong sites. In total, 624 participants (85,5%) reported marking the surgical site and 402 (55%) using the surgical checklist systematically.

Conclusion In the sample studied, it was evidenced that SBOT's efforts to disseminate the World Health Organization (WHO) protocol were effective, reducing the number of orthopedists who were unaware of it from 65.3% (in 2012) to 20.7% (in 2018), and expanding its use. In 2018, 402 participants (55%) reported the systematic use of the protocol, compared with 301 (40,8%) in 2014. These data confirm the need

Keywords
- patient safety
- medical errors
- surgical procedures
- checklist

* *Work developed at Instituto Nacional de Traumatologia e Ortopedia (Into), Rio de Janeiro, RJ, Brazil.*

received
June 24, 2019
accepted
October 30, 2019
published online
April 2, 2020

DOI https://doi.org/10.1055/s-0040-1701285.
ISSN 0102-3616.

Thieme Revinter Publicações Ltda., Rua do Matoso 170, Rio de Janeiro, RJ, CEP 20270-135, Brazil

for educational campaigns and systematic training, not only to promote behavioral change, but especially a cultural change.

Resumo

Objetivo Analisar o impacto das ações educacionais inseridas na campanha "Considere o Risco", da Sociedade Brasileira de Traumatologia e Ortopedia (SBOT), para aumentar a percepção do risco envolvido na atividade cirúrgica e a utilização do *checklist* cirúrgico.

Métodos Realização de pesquisa comparativa, durante o 50° Congresso Brasileiro de Ortopedia e Traumatologia (50° CBOT), em novembro de 2018, utilizando questionário semelhante ao de duas versões anteriores.

Resultados O número de participantes foi de 730, correspondendo a 18,7% do total de 3.903 inscritos no 50° CBOT. No total, 542 ortopedistas (74,2%) relataram já ter vivenciado erros dentro do centro cirúrgico e 218 (29,8%) cirurgias em locais errados; 624 participantes (85,5%) afirmaram marcar o local da cirurgia e 402 (55%) utilizar regularmente o checklist cirúrgico.

Conclusão Na amostra pesquisada, ficou evidenciado que os esforços da SBOT para a disseminação do conhecimento do protocolo da Organização Mundial de Saúde (OMS) foram efetivos, reduzindo a quantidade de ortopedistas que o desconheciam de 65,3% (em 2012) para 20,7% (em 2018), e ampliando sua utilização. Em 2018, 402 ortopedistas (55% da amostra) referiram fazer uso frequente do protocolo no ambiente cirúrgico, em comparação com 301 (40,2%) em 2014. Estes dados confirmam a necessidade de campanhas educacionais e treinamentos sistemáticos, não apenas para promover uma mudança de comportamento, como também, principalmente, uma mudança cultural.

Palavras-chave
- segurança do paciente
- erros médicos
- procedimentos cirúrgicos
- lista de verificação

Introduction

Concern about the risks involved in the medical practice date to antiquity, as shown by the *primum non nocere* principle (first, do no harm) attributed to Hippocrates.

Medical societies around the world have recognized this concern and led a movement to curb medical errors and establish safe surgery concepts. The American Academy of Orthopedic Surgeons (AAOS) began its efforts with the "Wrong-Site Surgery" initiative as early as the 1980s, publishing its preliminary results in 1984.[1–3]

In 2000, the Institute of Medicine's (IOM) publication *To Err is Human: Building a Safer Health System*[4] raised awareness among the public, the media, politicians and medical professionals, and consolidated the interest regarding this topic.

In 2002, the member countries of the World Health Organization (WHO), recognizing the need to reduce harm and suffering to patients and families resulting from medical errors, agreed on a resolution to increase patient safety within a public policy. In 2004, the WHO created the World Alliance for Patient Safety, which, starting in 2005, set the priority issues to be addressed every two years, known as "Global Challenges."[5]

Between 2007 and 2008, the second global challenge (Safe Surgery) aimed to improve safety in the surgical environment, raising quality and safety standards for surgical care through 4 important actions: 1) prevention of surgical site infections; 2) safe anesthesia; 3) safe surgical teams; and 4) surgical care indicators.[5] These actions were the basis for the "Safe Surgery Saves Lives" campaign in WHO member countries.

In 2008, the Brazilian Ministry of Health joined the campaign, whose main objective was the adoption, by hospitals, of a standardized 19-item checklist designed to improve communication between surgical team members, reduce the risk of patient harm and errors, and minimize surgery-associated complications and deaths. The surgical checklist must be employed in all surgeries, in three phases: before anesthesia (Sign In), before skin incision (Time Out), and before the patient leaves the operating room (Sign Out) (►**Figure 1**).[6]

The use of the WHO surgical checklist has been mandatory in the United States, Canada, England and Jordan, but it is only suggested in many countries, including Brazil.

Two important retrospective studies[7,8] suggest that at least 50% of surgical adverse events are preventable. Most of these events are not caused by technical issues, but rather by lack of teamwork, leadership, communication, decision-making and situational awareness, as even the simplest procedures involve dozens of critical steps, with countless opportunities for failure and huge potential for errors resulting in patient injury.[9,10]

The most critical obstacle to increase safety in the surgical environment is the lack of risk perception by most professionals, especially surgeons. In addition, poor communication between team members can interfere with their performance and patient safety. A team working together to use their knowledge and skills to benefit the patient, combining technical accuracy and safety, is able to prevent a considerable proportion of life-threatening complications.[9,10]

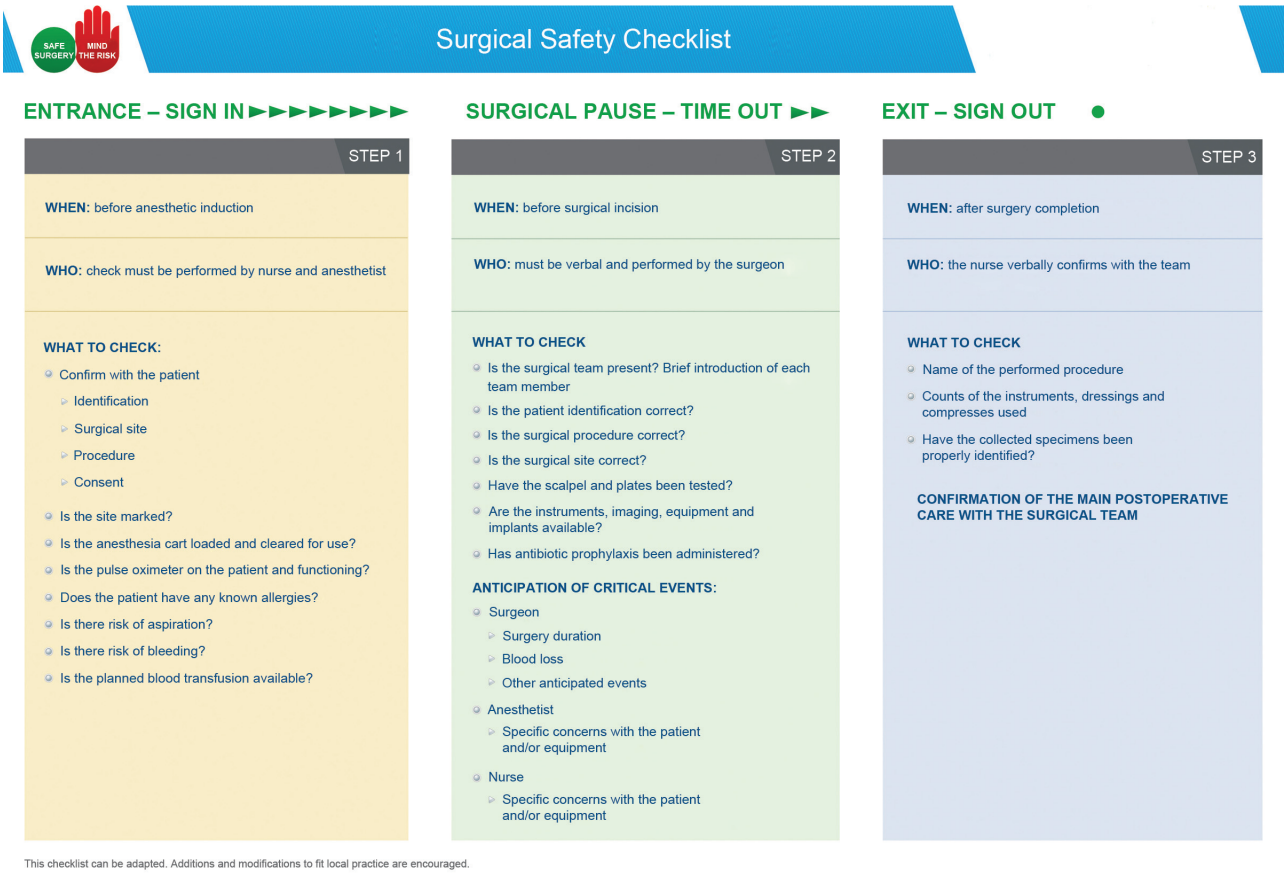

Fig. 1 Surgical checklist proposed by the World health Organization (WHO) and adapted for use at our institution.

Therefore, the correct use of tools such as the WHO Safe Surgery Protocol can help achieve this goal, including improving communication among surgical team members.[11]

According to a study[12] published at the *Journal of Bone and Joint Surgery Reviews* in 2016, the actual incidence of misplaced surgeries in orthopedics is unknown due to the lack of the exact number of procedures performed and the absence of an infrastructure to standardize error reporting. However, the study reveals that 21% of hand surgeons, 50% of spine surgeons, and 8.3% of knee surgeons reported having performed at least one surgery in the wrong site during their career. The study concludes that every orthopedic surgeon is at risk of performing surgery in the wrong site during their practice, and that prevention should be a priority in orthopedics. Moreover, it suggests that, in addition to factors such as surgeon leadership, commitment and ongoing vigilance, processes encouraging effective team communication, checklists, data collection and analysis should be used in orthopedic surgical settings to improve patient safety.

To diagnose the perception of safety in the surgical environment and the degree of use of the WHO Safe Surgery Protocol by orthopedic surgeons in Brazil, a survey was conducted in November 2012, during the 44th Brazilian Congress on Orthopedics and Traumatology (CBOT, in Portuguese). This survey showed that 328 respondents (65,3%) were partially or totally unaware of the protocol, and that 123 (70,5%) of those who knew it, had no training to use it.[13]

Based on these results, Sociedade Brasileira de Ortopedia e Traumatologia (Brazilian Society of Orthopedics and Traumatology, SBOT, in Portuguese) launched in 2012 the "Mind the Risk" educational campaign, aiming not only to increase the awareness of orthopedic surgeons regarding surgical risks, but also to disseminate the use of the WHO surgical checklist as an error-prevention barrier. The campaign encompassed various educational actions to disseminate information about safety in the surgical environment, including lectures at congresses, discussion forums and instructive materials, which were available at the SBOT website and were published in medical journals, banners and folders.

The present study aimed to analyze the impact of the educational actions included in SBOT's "Mind the Risk" campaign to increase awareness on surgical risks and to encourage the use of the surgical checklist as a protective barrier against errors six years after its introduction.

Materials and Methods

The present is an exploratory, quantitative research using a questionnaire about "Safe Surgery" applied to 3,903 orthopedists participating in the 50th CBOT, organized by SBOT, in the city of Rio de Janeiro, Brazil, in November 2018. The questionnaire, which was similar to the questionnaires applied to Brazilian orthopedic surgeons in 2012, at the

44th CBOT, and in 2014, at the 46th CBOT, was based on the questionnaire used by the AAOS, which, in turn, was based on the material used by the American Academy of Otolaryngology – Head and Neck Surgery (AAO-HNS) and modified to comply with the orthopedics and traumatology pratices.[14,15]

The research project was approved by the Ethics in Research Committee of Instituto Nacional de Traumatologia e Ortopedia (Into), Rio de Janeiro, Brazil, under CAAE (Sisnep) number 36204914.0.0000.5273.

The SurveyMonkey (SurveyMonkey, San Mateo, CA, US) data collection and analysis tool was used and enabled an efficient and rapid evaluation of the results. Questionnaires were distributed by e-mail to all congress participants in 3 moments at 10-day intervals, in case there was no response on the first submission. The deadline to send the filled-out questionnaire was one month after the first submission.

The professionals who filled out the questionnaire were not selected by any specific criteria other than their willingness to participate in the study. Thus, the sample size was random.

Results

The 50th CBOT was attended by 3,903 orthopedists, but only 730 questionnaires were filled out, representing 18.7% of the total.

Most respondents, 237 (32,5%) were experts on general orthopedics. The most common subspecialties were knee surgery with 133 (18,2%), followed by orthopedic trauma with 65 (8,9%) and hip surgery with 59 (8,1%).

As for geographic region, the respondents worked in almost every Brazilian state, except for the states of Sergipe, Rondônia, Amapá and Roraima. The state of São Paulo had the highest representation in the sample, with a total of 199 orthopedists (27,3% of the respondents), followed by Rio de Janeiro with 197 (27%) and Minas Gerais with 73 (10%).

Among these 730 orthopedists, 572 (78.4%) reported having completed residency in orthopedics and traumatology.

Regarding professional experience, 278 respondents (38,1%) had less than 5 years, 89 (12,2%) had 5 to 10 years, 151 (20,7%) had 10 to 20 years and 212 (29%) had over 20 years of practice.

Most respondents (551; 75.5%) were specialists accredited by SBOT.

In total 423 orthopedists (58%) who spontaneously filled out the questionnaire were not involved in the scientific activities of the congress.

Most orthopedists (624; 85.5%) reported marking the surgical site before referring the patient to the operating room, while almost the same number of professionals (599; 82%) reported checking the implant material and equipment conditions before anesthesia.

The most frequent error category was related to incomplete or damaged surgical material identified after the beginning of the procedure, corresponding to 418 cases (72,3% of the total), followed by problems with equipment or instruments in the operating room with 395 cases (68,3% of these incidents). 413 incidents (71,4%) were notified, so that improvements could be implemented.

Table 1 Professionals that do not mark the surgical site

	2012	2014	2018
Total number of respondents	**502**	**748**	**730**
Do not mark the surgical site	183 (36.5%)	269 (36%)	106 (14.5%)

Most respondents (542, 74.2%) reported having experienced an error within the operating room during their practice; 218 (29.8%) experienced surgery in the wrong site, and 36 (4.9%) witnessed surgery in the wrong patient.

Despite the recognition of the surgical risk and the WHO protocol as a safety barrier for patients, physicians and institutions by 505 (87.2%) out of 579 respondents who reported knowing the protocol in 2018, 151 (20.7%) orthopedists also reported full or partial unawareness of such document; in addition, 365 (50%) reported not having been trained in its use. However, 402 (55%) orthopedists reported using this tool regularly.

Six years after the launch of the SBOT campaign, the present study revealed that: **1.** 106 surgeons (14,4%) still do not mark the surgical site in 2018, compared to 183 (36,5%) in 2012 (►**Table 1**); **2.** 151 (20,7%) are still unaware of the WHO Safe Surgery Protocol in 2018, compared to 328 (65,3%) in 2012 (►**Table 2**); **3.** 505 (69,1%) recognize the surgical checklist as an important safety barrier in the surgical environment, compared to 174 (34,7%) in 2012 (►**Table 3**); and **4.** 402 of the respondents (55%) reported using the tool regularly in 2018, against 301 (40,2%) in 2014 (►**Table 4**).

Discussion

Researches involving specific populations have limitations. Here, although survey participation was restricted (18.7%; 730), it was higher than in those performed by the AAO-HNS (18.6%), the AAOS (16.6%)[15] and the SBOT in 2012 (15,5%, 502). (15.5%).[13] The use of standards employed by these three societies was intended to increase the consistency of the information collected and to enable the comparison of the findings, especially among the 3 SBOT surveys, which were carried out in 2012, 2014 and 2018.

The respondents were concentrated in the states of São Paulo, Rio de Janeiro and Minas Gerais (64.3%), which is consistent with the geographic distribution of orthopedists in Brazil. Similarly, specialists with medical residency accounted for 78.4% of the respondents, which corresponds to the number

Table 2 Professionals declaring not knowing the World Health Organization (WHO) Guidelines on Safe Surgery

	2012	2014	2018
Total number of respondents	**502**	**748**	**730**
Do not know the guidelines	328 (65.3%)	341 (45.6%)	151 (20.7%)

Table 3 Professionals who know the World Health Organization (WHO) Guidelines on Safe Surgery and recognize them as a safety barrier

	2012	2014	2018
Total number of respondents	**502**	**748**	**730**
Do know the guidelines and recognize them as a safety barrier	174 (34.7%)	407 (54.4%)	505 (69.1%)

Table 4 Professionals regularly using the World Health Organization (WHO) Guidelines on Safe Surgery

	2012	2014	2018
Total number of respondents	**502**	**748**	**730**
Regularly use the guidelines	No data	301 (40.2%)	402 (55.0%)

of SBOT members who usually attend the Brazilian congress. The number of professionals who reported having experienced a surgery in a wrong site or patient at some point in their careers represented 34,7% of the total (253 cases). Errors related to surgery on the wrong site accounted for 59,1% of incidents in the AAOS survey, 56% in the study by the Joint Commission on The Accreditation of Healthcare Organizations (JCAHO) and 40,8% (205 cases) in the 2012 SBOT study.[13]

Reports from American subspecialty societies also corroborate these findings. The American Society for Surgery of the Hand (ASSH) reported 21% of surgeries in wrong sites.[17] In spine surgery, according to a survey by the American Academy of Neurologic Surgeons, this number is even more alarming, with 50% of respondents reporting having had surgery at the wrong level at least once.[18,19] A survey from the American Academy of Foot and Ankle Surgeons also showed a 13% incidence of surgery in the wrong site.[20]

The present study concludes that members of subspecialties presenting higher frequency of surgeries in the wrong site, such as hand, spine and foot and ankle surgeons, represented a smaller percentage of the respondents. This piece of information corroborates the idea of pay more attention to these subspecialists because the literature shows that anatomical features from these regions favor errors.[17–20]

The number of respondents with less than 5 years of experience (28.9%) was a surprise, as younger professionals were expected to be more aware of safety culture, an undeniably current theme.

In total, 58% of the orthopedists who spontaneously filled out the questionnaire were not involved in the scientific activities of the congress. The premise that speakers, who are traditionally closer to academic circles, would be more interested in participating and transmitting knowledge on the subject of "Patient Safety" was not confirmed, as only 307 (42%) of the respondents acted as speakers.

Most orthopedists (624; 85.5%) reported marking the site to be operated before referring the patient to the operating room, while almost the same percentage, 599 (82%), reported checking the implant material and the functioning of the room equipment before anesthesia, which shows a certain maturity in risk perception.

The most frequent error category was related to incomplete or damaged surgical material identified after the beginning of the procedure, followed by problems in operating room equipment or instruments. According to the AAOS, in developed countries, equipment-related errors are the most common failure, accounting for 29% of the total, followed by communication errors (24.7%).[15] On the other hand, the most frequent error category in the Brazilian orthopedic environment, that is, incomplete or damaged surgical material, is not a significant concern in the United States.

In total, 151 (20.7%) orthopedic surgeons reported being totally or partially unaware of the WHO protocol, and 365 (50%) mentioned that they had not been trained in its use. These figures reveal that training regarding the use of the WHO protocol is still required.

Our results suggest that the educational campaign had a positive impact on improving safety in the surgical environment, but SBOT still has a long way to go, as the regular use of error barriers is a cultural change only possible through awareness actions and systematic training, involving both surgeons and all surgical staff.

A similar study[21] conducted in the United Kingdom in 2010 had already shown that educational programs can significantly increase the use of checklists and the positive perception related to them by staff members.

An initiative to update orthopedic surgeons on the safety principles and fundamentals of the surgical practice, recognizing significant opportunities for improvements in the quality, safety and value of child care, conducted by the Pediatric Orthopedic Society of North America (POSNA) in 2016, signals that SBOT is on the right track in advocating this cultural change.[22]

Moreover, results from a systematic review conducted by POSNA in 2018, in which 36 scientific papers were selected according to the degree of contribution for the improvement of safety and quality of care, clearly demonstrate the importance of such initiatives.[23]

Another striking initiative of this kind would be the inclusion in the syllabus of quality and safety as topics in the training and qualification of residents.[24] Although commitment and excellence at an individual level are essential, orthopedists should be concerned with systems and protocols that provide greater value to care.

As such, SBOT published a textbook on orthopedics and traumatology with an entire chapter dedicated to "Patient Safety,"[25] which, in addition to highlighting the importance of the subject, is of great value for the formation of new orthopedists.

Conclusions

Medical errors do occur and pose a risk to patient safety. Applied research has shown that the surgical environment

requires a cultural change to improve safety not only for patients, but also for professionals and institutions.

The first step in this cultural change is to recognize the errors and the possibility of learning from them. As such, researches indicate a degree of maturity on the part of the orthopedists, since more than 70% the of respondents on all surveys reported experiencing errors in the surgical environment.

The present study also shows that SBOT's efforts to increase surgical risk perception by advocating the use of the WHO surgical checklist as a safety barrier through the "Mind the Risk" campaign had a positive impact, significantly increasing the number of orthopedists who recognize the Safe Surgery Protocol as a safety barrier and frequently use it.

At the same time, the research also indicates that topic-related guidance, systematic training and education are required, especially for young, less experienced orthopedists, to promote a cultural change in the surgical environment.

This change, achievable only through systematic actions directed not only to surgeons, but also to all surgical staff, is especially indicated and desired in orthopedics and traumatology, which are responsible for most surgical adverse events, most of them preventable with the WHO Safe Surgery Protocol.

Conflict of interests

The authors have no conflict of interests to declare.

References

1 American Academy of Orthopaedic Surgeons. Information statement 1015. Wrong-site surgery. 2003 Out. Disponível em: http://www.aaos.org/about/papers/advistmt/1015.asp [acesso em 26 de março de 2013]
2 Wong D, Herndon J, Canale T. An AOA critical issue. Medical errors in orthopaedics: practical pointers for prevention. J Bone Joint Surg Am 2002;84(11):2097–2100
3 Herndon JH. One more turn of the wrench. J Bone Joint Surg Am 2003t85(10):2036–2048
4 Kohn LT, Corrigan JM, Donaldson MS, Eds. To err is human: building a safer health system. Washington, DC: National Academy Press; 2000
5 World Health Organization. World Alliance for Patient Safety: Forward Programme, 2008–2009. Disponível em: www.who.int/patientsafety/en/ [Acesso em 10 de dezembro de 2018]
6 ANVISA – Portal Segurança do Paciente. Disponível em: https://www20.anvisa.gov.br/segurancadopaciente/index.php/noticias/60-cirurgiasseguras-salvam-vidas [Acesso em 02 de junho de 2019]
7 Gawande AA, Thomas EJ, Zinner MJ, Brennan TA. The incidence and nature of surgical adverse events in Colorado and Utah in 1992. Surgery 1999;126(01):66–75
8 Kable AK, Gibberd RW, Spigelman AD. Adverse events in surgical patients in Australia. Int J Qual Health Care 2002;14(04):269–276
9 Catchpole K, Mishra A, Handa A, McCulloch P. Teamwork and error in the operating room: analysis of skills and roles. Ann Surg 2008;247(04):699–706
10 Lingard L, Espin S, Whyte S, et al. Communication failures in the operating room: an observational classification of recurrent types and effects. Qual Saf Health Care 2004;13(05):330–334
11 Panesar SS, Noble DJ, Mirza SB, et al. Can the surgical checklist reduce the risk of wrong site surgery in orthopaedics?–Can the checklist help? Supporting evidence from analysis of a national patient incident reporting system. J Orthop Surg Res 2011;6:18
12 Santiesteban L, Hutzler L, Bosco JA 3rd, Robb W 3rd. Wrong-Site Surgery in Orthopaedics: Prevalence, Risk Factors, and Strategies for Prevention. JBJS Rev 2016;4(01):pii: 01874474–201601000–00003
13 Motta Filho G, Silva LF, Ferracini AM, Bahr GL. Protocolo de Cirurgia Segura da OMS: o grau de conhecimento dos ortopedistas brasileiros. Rev Bras Ortop 2013;48(06):554–562
14 Shah RK, Kentala E, Healy GB, Roberson DW. Classification and consequences of errors in otolaryngology. Laryngoscope 2004;114(08):1322–1335
15 Wong DA, Herndon JH, Canale ST, et al. Medical errors in orthopaedics. Results of an AAOS member survey. J Bone Joint Surg Am 2009;91(03):547–557
16 The Joint Commission. Universal Protocol. Disponível em: http://www.jointcommission.org/standards_information/up.aspx [Acesso em 10 de dezembro de 2018]
17 Meinberg EG, Stern PJ. Incidence of wrong-site surgery among hand surgeons. J Bone Joint Surg Am 2003;85(02):193–197
18 Wong DA. Spinal surgery and patient safety: a systems approach. J Am Acad Orthop Surg 2006;14(04):226–232
19 Mody MG, Nourbakhsh A, Stahl DL, Gibbs M, Alfawareh M, Garges KJ. The prevalence of wrong level surgery among spine surgeons. Spine 2008;33(02):194–198
20 Schweitzer KM Jr, Brimmo O, May R, Parekh SG. Incidence of wrong-site surgery among foot and ankle surgeons. Foot Ankle Spec 2011;4(01):10–13
21 Sewell M, Adebibe M, Jayakumar P, et al. Use of the WHO surgical safety checklist in trauma and orthopaedic patients. Int Orthop 2011;35(06):897–901
22 Glotzbecker MP, Wang K, Waters PM, McCarthy J, Flynn JM, Vitale MG; POSNA committee on the Quality, Safety, Value Initiative (QSVI). Quality, Safety, and Value in Pediatric Orthopaedic Surgery. J Pediatr Orthop 2016;36(06):549–557
23 Miller DJ, Cahill PJ, Janicki JA, Stephenson LP, Choi PD. What's New in Pediatric Orthopaedic Quality, Safety, and Value? A Systematic Review With Results of the 2016 POSNA Quality, Safety, and Value Initiative (QSVI) Challenge. J Pediatr Orthop 2018;38(10):e646–e651
24 Black KP, Armstrong AD, Hutzler L, Egol KA. Quality and Safety in Orthopaedics: Learning and Teaching at the Same Time: AOA Critical Issues. J Bone Joint Surg Am 2015;97(21):1809–1815
25 Bahr GL. Segurança na Prática Cirúrgica Ortopédica. In: Motta G, Barros T. Ortopedia e Traumatologia. Rio de Janeiro: Elsevier; 2018

Reconstruction with a Custom made Prosthetic Wrist Arthrodesis after Bone Tumor Resections of the Distal Radius. Single Centre Experience*

Reconstrução com implante metálico personalizado de artrodese após ressecções de tumor ósseo do rádio distal. Experiência em um único centro

Bartlomiej Szostakowski[1] Eric Staals[1] Lyris Onwordi[1] Robin Pollock[1] John A. Skinner[1]

[1] Joint Reconstruction and Sarcoma Unit, Royal National Orthopaedic Hospital NHS Trust, Brockley Hill, Stanmore, Middlesex, HA7, United Kingdom

Address for correspondence Bartlomiej Szostakowski, Joint Reconstruction and Sarcoma Unit, Royal National Orthopaedic Hospital NHS Trust | Brockley Hill Stanmore | Middlesex | HA7 4LP, United Kingdom (e-mail: bartek.szostakowski@gmail.com).

Rev Bras Ortop 2021;56(2):224–229.

Abstract

Objective The present study aimed at analyzing the clinical, radiological and functional results of the reconstruction of the distal radius after tumor resection with a custom-made metal arthrodesis implant and compare them with other types of distal radius reconstruction, as presented in the literature.
To our best knowledge, this is the first article describing this particular type of implant and patient functionality.

Methods Functional outcomes of reconstruction of the distal radius were assessed in a series of 4 patients. Three of the patients having had resection of giant cell tumors (GCTs), one patient having had resection of osteosarcoma.

Results There were no major implant-related complications like infection, nonunion or loosening. Two patients had to undergo further surgery for protruding metalwork. Overall function was good according to the Musculoskeletal Tumor Society MSTS and Disabilities of the Arm, Shoulder, and Hand (DASH) scores.

Conclusion The present study shows that custom-made metal arthrodesis implant benefits from the fact that it can be used as a salvage option when other treatments have failed, or it can be used as a primary option in cases in which there is limited bone stock after distal radius tumor resection.

Keywords
- sarcoma
- giant cell tumors
- distal radius
- wrist
- arthrodesis
- prosthesis

* *Work developed at the Joint Reconstruction and Sarcoma Unit, Royal National Orthopaedic Hospital NHS Trust, Brockley Hill, Stanmore, Middlesex, HA7.*

received
April 27, 2020
accepted
September 17, 2020
published online
March 22, 2021

DOI https://doi.org/10.1055/s-0040-1721366.
ISSN 0102-3616.

Thieme Revinter Publicações Ltda., Rua do Matoso 170, Rio de Janeiro, RJ, CEP 20270-135, Brazil

Resumo

Objetivo O presente estudo teve como objetivo analisar os resultados clínicos, radiológicos e funcionais da reconstrução do rádio distal após a ressecção do tumor com implante metálico personalizado de artrodese e compará-los com outros tipos de reconstrução do rádio distal, conforme apresentado na literatura.

Pelo que conhecemos, este é o primeiro artigo descrevendo esse tipo particular de implante e funcionalidade no paciente.

Métodos Os desfechos funcionais de reconstrução do rádio distal foram avaliados em uma série de 4 pacientes. Três dos pacientes tiveram ressecção de tumores de células gigantes (TCGs), sendo um paciente com ressecção de osteossarcoma.

Resultados Não houve complicações relacionadas ao implante, como infecção, não sindicalidade ou afrouxamento. Dois pacientes tiveram que passar por uma nova cirurgia para a protusão da prótese metálica. A função geral foi boa de acordo com as pontuações da Musculoskeletal Tumor Society (MSTS) e Disabilities of the Arm, Shoulder, and Hand (DASH).

Conclusão O estudo mostra que o implante metálico personalizado de artrodese se beneficia do fato de que pode ser usado como opção de salvamento quando outros tratamentos falharam, ou pode ser usado como opção primária nos casos em que há estoque ósseo limitado após a ressecção do tumor do rádio distal.

Palavras-chave

- sarcoma
- tumores de células gigantes
- rádio distal
- punho
- artrodese
- prótese

Introduction

Reconstruction of the distal radius after a segmental resection for a bone tumor is often challenging. En-bloc resections are usually indicated for primary malignant bone tumors, and, occasionally, for advanced or recurrent benign bone tumors. The difficulty in reconstructing the distal radius is due to the complex anatomy of the wrist joint, the vicinity to important neurovascular structures, and the scarce local soft tissue coverage. As these patients are often young and active, a functional, stable, and durable reconstruction is required.

Many techniques have been applied to reconstruct the distal radius after tumor resection. Either wrist arthrodesis or joint reconstruction can be achieved using massive allografts, vascularized or nonvascularized autografts, ulnar transposition, and endoprosthetic implants. Most of the reports on distal radius reconstruction after tumor resection are single case studies or small series, due to the rarity of this indication.[1]

The authors of the present study describe a single institution experience in reconstruction of the distal radius after tumor resection with a custom-made metal arthrodesis implant. The aim of the present study was to analyze the clinical, radiological and functional results and compare them with other types of distal radius reconstruction, as presented in the literature.

Materials and Methods

A retrospective review was performed of 4 consecutive distal radius reconstructions with a custom-made metal arthrodesis implant. All operations were performed at the authors' institution in the period between 2009 and 2013. Clinical data were obtained from the notes, plain radiographs were evaluated, and the patients were contacted personally for the functional assessment. Data was collected regarding patients (age, gender, hand dominance), tumor characteristics (diagnosis, stage, margins), surgery (antibiotic prophylaxis, surgical approach, length of resection, soft tissue reconstruction), oncologic outcome and function. Functional results were analyzed according to the Musculoskeletal Tumor Society (MSTS) and the Disabilities of the Arm, Shoulder, and Hand (DASH) scoring systems. The radiographic evaluation included implant position and fixation, joint alignment, and degenerative changes in the nearby joints.

Prosthesis

The implant used for reconstruction of the distal radius was in all cases a CAD-CAM custom-made titanium endoprosthesis (Stanmore Implants Worldwide, Elstree, UK). The implant design was based on preoperative measurement films and 3-D CT reconstructions. All implants had a smooth stem for cement fixation in the residual radius, two bridging plates for screw fixation on the metacarpal bones, and a hydroxyapatite collar at the proximal and distal end to improve osseointegration and long-term fixation.

Surgery

Surgery was performed after standard antibiotic prophylaxis according to the institutional protocol, (1.5g of Cefuroxime at induction, followed by 750mg postoperative doses every 8 hours to complete 24h). Surgical access was obtained through a dorsal approach in all cases with longer incision allowing for metacarpal fixation of bridging plates.

The resection level of the distal radius was based on preoperative measurement films and scans. Custom made metal endoprosthesis was used for reconstruction, creating a fusion of the wrist joint. Proximal fixation at the residual radial shaft was obtained with polymethylmethacrylate

(PMMA) cement. Distally, the articular cartilage was removed from the scaphoid and lunate bones, to improve bone to implant contact at the first carpal row. Then the implant was fixed with screws and two bridging plates on the metacarpal bones. Positioning and design of bridging plates was done on an individual basis, taking into consideration soft tissue contracture after previous surgery, preoperative imaging studies and the anatomy of the patient. Centralization of the wrist was paramount for the postoperative functionality, hence the positioning of the bridging plates at different metacarpals. The operated limb was then immobilized in an above-elbow cast for 4 weeks, followed by a wrist splint for another 4 weeks.

Results

Patient Characteristics

There were two males and two females, with an average age of 42.5 years old (range 22 to 55 years old). All four cases were discussed at a sarcoma multidisciplinary team meeting in which available imaging and biopsy results were analyzed, and a treatment path was established.

Case 1

A 42-year-old right-hand-dominant female patient had previously undergone a right distal radius resection and reconstruction with a nonvascularized fibular graft for a primary giant cell tumor (GCT) of bone, 12 months prior. She then presented with extensive recurrent disease for which she underwent excision. This included en bloc resection of the fibular graft. The wrist was reconstructed with a custom-made endoprosthetic wrist arthrodesis, and the patient received 56 Gy of postoperative radiotherapy to prevent further local recurrence (►**Fig. 1**).

Case 2

A 22-year-old right-hand-dominant female patient presented with a localized high-grade osteoblastic osteosarcoma of the left distal radius, with a large soft tissue extension. She underwent neoadjuvant chemotherapy according to standard oncologic treatment protocols (EURAMOS-1). Resection of the distal radius was associated with en-bloc resection of the distal ulna to obtain wide surgical resection margins (►**Fig. 2**).

Case 3

A 54-year-old right-hand-dominant male patient presented with a primary GCT of bone in the left distal radius, for which he underwent resection and prosthetic reconstruction with a custom-made arthrodesis. No adjuvant treatments were applied in this case (►**Fig. 3**).

Case 4

A 50-year-old right-hand-dominant male patient had undergone a left distal radius resection and reconstruction with a nonvascularized fibular autograft for a primary GCT of bone. After 6 months, the fibular graft got infected, and the patient underwent a first stage revision with removal of the graft and implantation of an antibiotic-loaded cement spacer. After

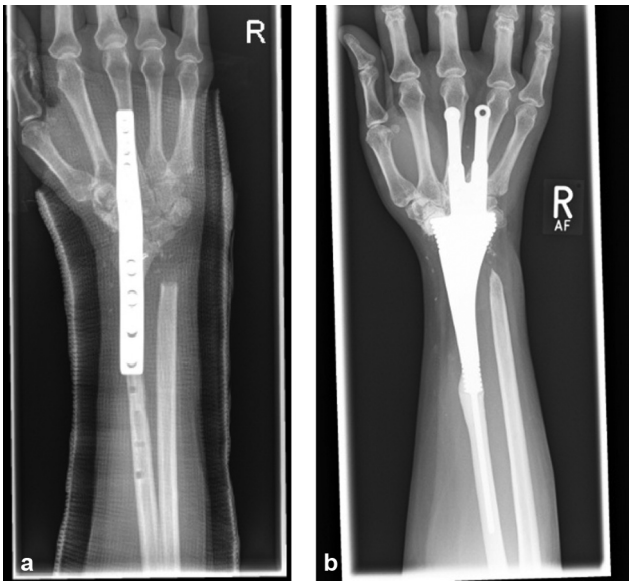

Fig. 1 (**a**) Showing nonvascularized fibular graft . Due to local recurrence, the fibula graft was later excised and a custom-made wrist arthrodesis was implanted (**b**).

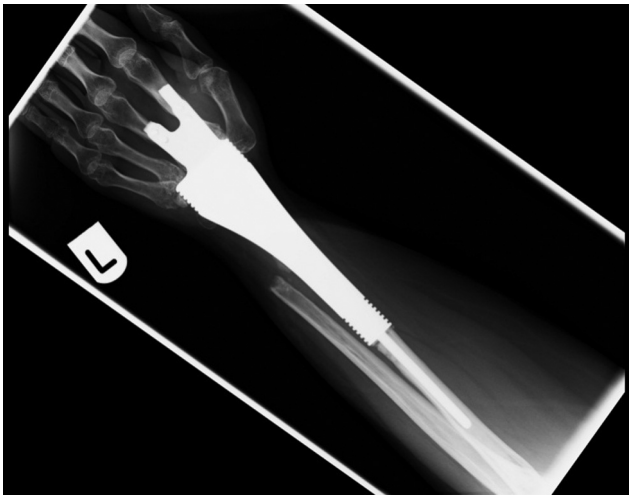

Fig. 2 Follow-up x-ray of the custom made wrist arthrodesis implant showing trimmed metacarpal bridging plates.

6 weeks of intravenous antibiotic treatment, all infection parameters returned to normal, and the patient underwent a second stage revision with a custom-made distal radius prosthetic arthrodesis (►**Fig. 4**).

Outcome

The average follow-up after arthrodesis with a custom made endoprosthetic implant was 50 months (range 22 to 70 months). No relapses were reported during the follow-up period. There were no perioperative complications. The wounds healed well in all cases and there were no signs of infection. All implants fused completely with the first carpal row, all wrists showed good alignment, and there were no radiological signs of stem loosening at the last follow-up. No patient complained of implant-related pain. However, in two cases, screws backed out from the bridging plates at the

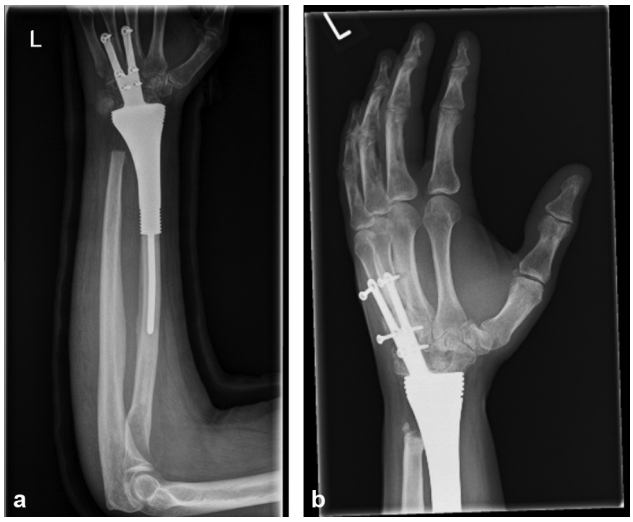

Fig. 3 (**a**) Postoperative x-ray of the custom-made wrist arthrodesis implant. (**b**) Follow-up x-ray showing protruding screws.

level of the metacarpal bones, causing skin problems at the dorsal side of the hand. Both these patients underwent removal of the screws in a day case procedure without sacrificing implant functionality or disruption of the arthrodesis between implant and carpal bones. In one of these cases, a protruding plate was also partially removed at the same time. The functional results of the four cases, according to the MSTS and DASH scores, are presented in ►**Table 1**.

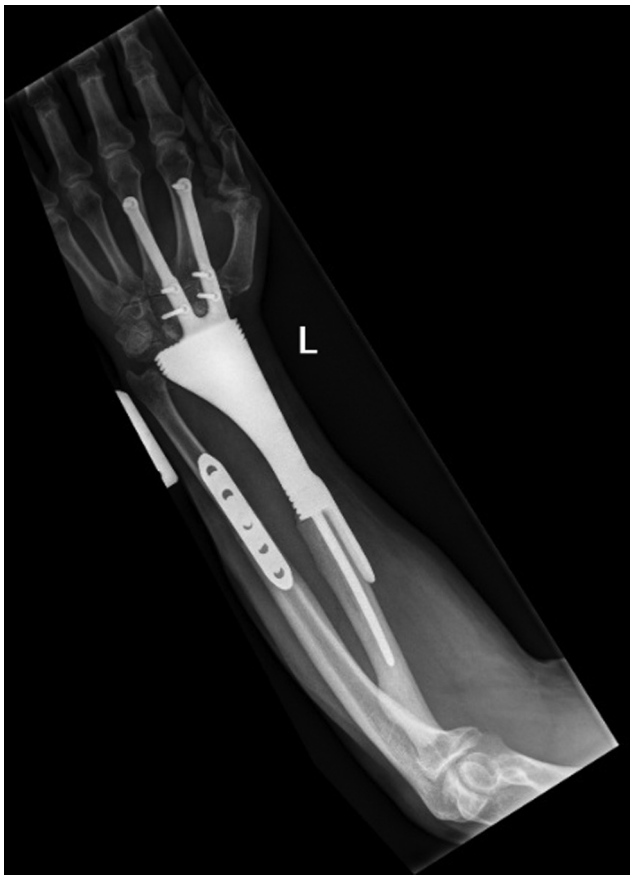

Fig. 4 Postoperative x-ray of the custom-made wrist arthrodesis implant.

Discussion

In the present study, we have assessed the functional outcomes of reconstruction of the distal radius in four patients using a custom made prosthesis, three of the patients having had resection of GCTs, one patient having had resection of osteosarcoma. Giant cell tumor of bone is a benign, locally aggressive bone tumor. The natural history of GCT is progressive bone destruction leading to joint deformity and disability. The distal radius is one of the most common locations of GCT, after the distal femur, the proximal tibia and the proximal femur.[2] Osteosarcoma is the most common primary malignant bone tumor, but $< 1\%$ arise in the distal radius.[3,4]

Grade II and III Campanacci GCTs, osteosarcomas and other tumors causing thinning or penetration of the cortex are particularly challenging to treat.

Resection of the distal radius is a rare surgical indication. It is considered to be the treatment of choice for aggressive bone tumors with large bony destruction and advanced presentation. Wide excision in such cases creates a defect at the distal end of the radius.

Numerous procedures aiming at reconstruction of the segmental bony defect and functionality of the upper limb are described in the literature. These include: vascularized and nonvascularized fibular autografts, massive segmental allografts, ulnar transposition, and custom made megaprosthesis of the wrist joint.[5–8] The limited literature on distal radius reconstruction provides no consensus regarding the best surgical reconstruction techniques. The choice of the reconstruction technique is generally based on tumor extension and patient characteristics (age, functional demand), but also on the availability of reconstructive resources. Massive allografts require a bone bank organization. The method of choice of reconstruction has generally tended to be using fibular grafts, either vascularized or nonvascularized. The advantages of fibular grafts include their anatomic similarity to the distal radius and, therefore, their potential ability to allow for preservation of motion at the wrist joint. Although studies have shown promising outcomes, vascularized fibular grafts require microsurgical expertise. One of the largest series of vascularized fibular graft reconstructions after resection of tumor in limb salvage procedures documented a sizeable risk of complications, including revision rates or need for additional surgery at 35%[9] Studies have also shown limited wrist range of movement and accelerated degenerative changes at the fibular-carpal joint in some series.[10–12] Osteoarticular allografts represent an attractive option with studies showing good outcomes. Custom-made 3D printed implants still remain a relatively expensive solution. The reconstruction type can either maintain joint movement or create a stable fusion of the wrist joint. Wrist arthrodesis can be subclassified in total arthrodesis (bridging the forearm to the

Table 1 The functional results of the four cases, according to the MSTS and DASH scores

NR	SEX	AGE (yearsold)	DIAGNOSIS	FOLLOW-UP (months)	SIDE	Dominance	MSTS (%)	DASH
1	F	42	GCT	70	RIGHT	RIGHT	57	63
2	F	22	OS	54	LEFT	RIGHT	57	37
3	M	54	GCT	56	LEFT	RIGHT	77	46
4	M	50	GCT	22	LEFT	RIGHT	73	20

Abbreviations: DASH, Disabilities of the Arm, Shoulder, and Hand; F, female; GCT, giant cell tumor; M, male; MSTS, Musculoskeletal Tumor Society; OS, osteosarcoma.

metacarpal bones) or a partial arthrodesis (fixing the distal radius to the first carpal row). Total wrist fusion has been regarded as the most predictable treatment concept, with the belief that it results in only limited functional disability.[13] Although the functional outcome is acceptable for most patients, some adaptation is necessary, because certain activities such as personal care and manipulating the hand in tight spaces are difficult.[14] It is not clear to which extent some motion of the wrist is useful or necessary. In most impairment tables, there is a linear relationship between motion of the wrist and impairment.[15]

Due to the rarity of the surgical indication, most reports that describe reconstructions of the distal radius after bone tumor resection include a very limited number of cases. Besides this, there is lack of information available on the functional outcome of these reconstructions.

Overall, there were no major implant-related complications like infection, nonunion or loosening. Two patients had to undergo further surgery for protruding metalwork, but this was easily removed in a day surgery setting.

Function was good according to the MSTS and DASH scores, and all patients returned to normal daily activity without major impairments.[16]

Conclusion

The majority of wrist fusion options presented in the literature following tumor resection involve biological fusions, whereas our fusions have been done using an anatomical prosthesis.

Our implants, along with having a bridging component for the missing/resected diaphysis, fuses the radius to the carpus. The carpometacarpal arthrodesis component of our prosthesis increases stability and prevents loosening of the components. This type of prosthesis benefits from the fact that it can be used as a salvage option when other treatments have failed, or it can be used as a primary option in cases in which there is limited bone stock after distal radius tumor resection. This type of custom-made reconstruction appears to be a promising solution in difficult cases; however, further studies with larger study groups and longer follow-up are required.

Conflict of Interests

The authors have no conflict of interests to declare.

The present study was performed in compliance with the World Medical Association Declaration of Helsinki on Ethical Principles for Medical Research Involving Human Subjects, and was reviewed by the Royal National Orthopaedic Hospital Institutional Review Board

References

1 Rabitsch K, Maurer-Ertl W, Pirker-Frühauf U, Lovse T, Windhager R, Leithner A. Reconstruction of the Distal Radius following Tumour Resection Using an Osteoarticular Allograft. Sarcoma 2013;2013:318767
2 Amanatullah DF, Clark TR, Lopez MJ, Borys D, Tamurian RM. Giant cell tumor of bone. Orthopedics 2014;37(02):112–120
3 Yamamoto T, Akisue T, Marui T, Nagira K, Kurosaka M. Osteosarcoma of the distal radius treated by intraoperative extracorporeal irradiation. J Hand Surg Am 2002;27(01):160–164
4 Messerschmitt PJ, Garcia RM, Abdul-Karim FW, Greenfield EM, Getty PJ. Osteosarcoma. J Am Acad Orthop Surg 2009;17(08): 515–527
5 Pollock R, Stalley P, Lee K, Pennington D. Free vascularized fibula grafts in limb-salvage surgery. J Reconstr Microsurg 2005;21(02): 79–84
6 Bianchi G, Donati D, Staals EL, Mercuri M. Osteoarticular allograft reconstruction of the distal radius after bone tumour resection. J Hand Surg [Br] 2005;30(04):369–373
7 Maruthainar N, Zambakidis C, Harper G, Calder D, Cannon SR, Briggs TW. Functional outcome following excision of tumours of the distal radius and reconstruction by autologous non-vascularized osteoarticular fibula grafting. J Hand Surg [Br] 2002;27(02): 171–174
8 Guedes A, Baptista PPR, Santili C, Yonamine ES, Garcia HRP, Martinez EC. Broad Resection and Fibular Transposition in the Treatment of GCT on Radius Distal End. Acta Ortop Bras 2009;17 (03):171–181
9 Hilven PH, Bayliss L, Cosker T, et al. The vascularised fibular graft for limb salvage after bone tumour surgery: a multicentre study. Bone Joint J 2015;97-B(06):853–861
10 Friedrich JB, Moran SL, Bishop AT, Wood CM, Shin AY. Free vascularized fibular graft salvage of complications of long-bone allograft after tumor reconstruction. J Bone Joint Surg Am 2008; 90(01):93–100
11 Minami A, Kato H, Iwasaki N. Vascularized fibular graft after excision of giant-cell tumor of the distal radius: wrist arthroplasty versus partial wrist arthrodesis. Plast Reconstr Surg 2002;110 (01):112–117
12 Murray JA, Schlafly B. Giant-cell tumors in the distal end of the radius. Treatment by resection and fibular autograft interpositional arthrodesis. J Bone Joint Surg Am 1986;68(05):687–694
13 Bowers WH. Distal radioulnar joint arthroplasty: the hemiresection-interposition technique. J Hand Surg Am 1985;10(02): 169–178

14 Hayden RJ, Jebson PJ. Wrist arthrodesis. Hand Clin 2005;21(04): 631–640
15 De Smet L. Does restricted wrist motion influence the disability of the upper limb? Acta Orthop Belg 2007;73(04):446–450
16 Hudak PL, Amadio PC, Bombardier CThe Upper Extremity Collaborative Group (UECG). Development of an upper extremity outcome measure: the DASH (disabilities of the arm, shoulder and hand) [corrected]. Am J Ind Med 1996;29(06):602–608

Preoperative Prediction of Gartland IV Supracondylar Fractures of Humerus: Is it Possible?*

Previsão pré-operatória de fraturas supracondilares de úmero Gartland IV: É possível?

Sitanshu Barik[1] Gobinder Singh[1] Subhajit Maji[1] Md Quamar Azam[2] Vivek Singh[1]

[1] Department of Orthopedics, All India Institute of Medical Sciences, Rishikesh, India
[2] Department of Trauma Surgery, All India Institute of Medical Sciences, Rishikesh, India

Address for correspondence Gobinder Singh, M.B.B.S., Junior Resident, Orthopedics, Room 84219, Building 84, AIIMS Rishikesh, Dehradun, Uttarakhand, India (e-mail: gobindergs@gmail.com).

Rev Bras Ortop 2021;56(2):230–234.

Abstract

Objectives The present study aims to identify preoperative characteristics of the patient, of the injury, as well as of imaging, which would point towards a type IV fracture. The present study shall help the operating team to predict more accurately the type IV pattern preoperatively, leading to improved counselling of the caregivers, planning of surgery, as well as preparedness regarding open reduction, if such situation arises.

Methods A retrospective study was conducted, including patients that met the following criteria: 1) age < 16 years old; 2) Gartland type-III and type-IV supracondylar fractures; and 3) with complete records. Demographic data like age, gender, laterality, mode of injury, hospital duration of the injury, history of previous attempts of closed reduction, open/closed fracture, distal neurovascular status, and radiographic data like angulation, translation, osseous apposition and fracture comminution were collected.

Results Hospital duration of the injury and previous attempts of closed reduction were the factors that had a statistically significant difference among types III and IV fractures ($p < 0.05$). A diagnosis of type IV supracondylar fractures was significantly more likely in the presence of valgus angulation of the distal fragment $\geq 17°$ (odds ratio [OR] $= 20.22$; 95% confidence interval [CI] $= 3.45–118.65$). Flexion angulation $\geq 10°$ (OR $= 5.32$; 95% CI $= 0.24–119.88$) of the distal fragment predicted Gartland type IV with a sensitivity of 41% and a specificity of 100%.

Conclusion The preoperative evaluation of suspected Gartland IV fractures can help the operating surgeon in predicting such injuries. Nonradiographic factors like increased hospital duration of the injury, attempts at previously closed reduction,

Keywords
- humeral fractures
- child
- elbow joint
- fracture fixation

* *Work developed at All India Institute of Medical Sciences, Rishikesh, India.*

received
April 28, 2020
accepted
September 17, 2020

DOI https://doi.org/10.1055/s-0040-1722578.
ISSN 0102-3616.

Thieme Revinter Publicações Ltda., Rua do Matoso 170, Rio de Janeiro, RJ, CEP 20270-135, Brazil

and radiographic parameters like valgus and flexion angulation were more likely to be associated with type IV fractures. Level of evidence III.

Resumo

Objetivos O presente estudo tem como objetivo identificar características pré-operatórias do paciente e da lesão, bem como da imagem que apontaria para uma fratura tipo IV. O presente estudo ajudará a equipe operacional a prever com mais precisão o padrão tipo IV pré-operatório, levando a um melhor aconselhamento dos cuidadores e planejamento da cirurgia, bem como a uma melhor preparação em relação à redução aberta, se tal situação surgir.

Métodos Um estudo retrospectivo foi realizado, incluindo pacientes que atendiam os seguintes critérios: 1) idade < 16 anos; 2) fraturas supracondilares Gartland tipos III e IV; e 3) com registros completos. Foram coletados dados demográficos como idade, gênero, lateralidade, modo de lesão, duração hospitalar de lesão, histórico de tentativas anteriores de redução fechada, fratura aberta/fechada, estado neurovascular distal e dados radiográficos como angulação, translação, aposição óssea e cominação de fratura.

Resultados A duração hospitalar de lesões e as tentativas anteriores de redução fechada foram os fatores com diferença estatisticamente significativa entre as fraturas tipo III e IV ($p < 0,05$). O diagnóstico de fraturas supracondilares tipo IV foi significativamente mais provável na presença de angulação em valgo de fragmento distal $\geq 17^{\circ}$ (odds ratio [OR] = 20,22; intervalo de confiança [IC] 95% = 3,45–118,65). A angulação de flexão $\geq 10^{\circ}$ (OR = 5,32; IC95% = 0,24–119,88) do fragmento distal previram Gartland tipo IV com sensibilidade de 41% e especificidade de 100%.

Conclusão A avaliação pré-operatória de suspeitas de fraturas de Gartland IV pode ajudar o cirurgião operacional a prever tais lesões. Fatores não radiográficos, como o aumento da duração da lesão hospitalar, tentativas de redução previamente fechada e parâmetros radiográficos como valgo e angulação de flexão foram mais propensos a estarem associados a fraturas tipo IV. Nível de evidência III.

Palavras-chave
- fraturas do úmero
- criança
- articulação do cotovelo
- fixação de fratura

Introduction

Supracondylar fractures are one of the common fractures around the pediatric elbow. They comprise about two-thirds of all pediatric trauma around the elbow requiring hospitalization, with an estimated incidence of 177.3 per 100000 children.[1] It is commonly noted in boys in the age range between 5 and 8 years old, with the nondominant arm being commonly involved.[2] The most frequently used system to classify these fractures is the Gartland classification, which has a good interobserver and intraobserver concordance.[3] Leitch introduced a type IV to the Gartland classification, in which the anterior and posterior periosteum are completely torn off, leading to instability both in flexion and extension.[4] These types of fractures are assumed to be diagnosable only intraoperatively.[1,5]

Although closed reduction and percutaneous pinning (CRPP) is the common modality of treatment for both type III and IV Gartland fractures, reduction in type IV cases may be difficult due to the inherent multidirectional instability. Type IV fractures may need more commonly an open reduction and percutaneous pinning (ORPP) when compared with type III fractures.[5] There is scant literature regarding the diagnosis and optimum treatment of type IV fractures. The present study aims to identify preoperative characteristics of the patient, of the injury, as well as of imaging that would point towards a type IV fracture. The present study shall help the operating team to predict more accurately the type IV pattern preoperatively, leading to improved counselling of the caregivers, planning of surgery, as well as preparedness regarding open reduction, if such situation arises.

Material and Methods

After obtaining institutional ethics committee approval for a retrospective observational study, the patient database for cases that presented to the orthopedics department for the treatment of supracondylar fractures was acquired from January 2016 to December 2019. Patients who were included in the study met the following criteria: 1) age < 16 years old; 2) Gartland type-III and type-IV supracondylar fractures; and 3) with complete records. Patients with 1) another concomitant injury in the same limb; 2) history of previous elbow trauma; 3) suspected skeletal dysplasia; and 4) incomplete records were excluded from the study.

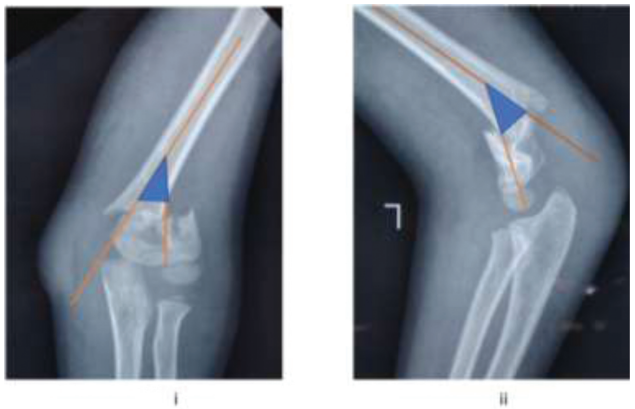

Fig. 1 (i, ii). Depiction of angulation in the coronal (i) and sagittal planes (ii) by lines along the mid diaphysis of the proximal fragment and a line perpendicular to the elbow joint in the distal fragment.

Age, gender, laterality, mode of injury, injury hospital duration, history of previous attempts of closed reduction, open/closed fracture, and distal neurovascular status were determined by reviewing the medical records.

Preoperative radiographs were evaluated to assess the following parameters: 1) angulation of the distal fragment in the sagittal plane; 2) angulation of the distal fragment in the coronal plane (►**Fig. 1**); 3) translation of the distal fragment in the coronal plane; 4) translation of the distal fragment in the sagittal plane (►**Fig. 2**); 5) osseous apposition between the proximal and distal fragments on the anteroposterior plane; 6) osseous apposition between the proximal and distal fragments on lateral radiographs (►**Fig. 2**); and 7) fracture comminution. Operative notes were scrutinized to determine the Gartland type of supracondylar fractures.

Data were analyzed using chi-squared tests or Fisher exact tests for categorical variables and the sample t-test for continuous variables. Odds ratios (ORs) were estimated and reported with associated 95% confidence intervals (CIs). ROC curves were exploited for comparison of the diagnostic performance of various radiographic parameters

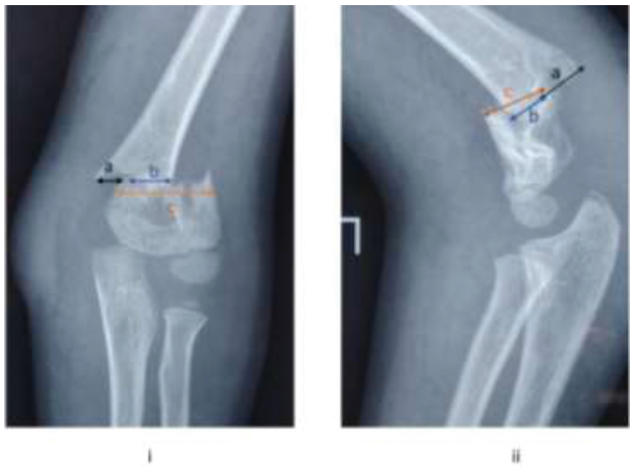

Fig. 2 (i, ii). Depiction of translation and osseous apposition in the coronal (i) and sagittal planes (ii). Translation = a / c. Osseous apposition = b / c.

in predicting Gartland type-IV fractures. Data analysis was performed using IBM SPSS Statistics for Windows, version 24.0 (IBM Corp., Armonk, NY, USA).

Results

Thirty-three patients (25 males, 8 females) who met the study criteria were included in the present study, with a mean age of 8.7 ± 3.1 years old (►**Table 1**). Injuries during sports practice and resulting from fall from height were the most common modes of injury. The fracture was closed in 96.9% ($n = 32$) of the cases. Among the patients included in the present study, 16 were Gartland III, and 17 were Gartland type IV.

Injury hospital duration and previous attempts of closed reduction were the factors having a statistically significant difference among types III and IV fractures (►**Table 1**). The mean injury hospital duration in type-III supracondylar fracture was 31.25 ± 43.09 hours, whereas in type-IV it was 52.59 ± 45.47 hours. A history of previous attempts of closed reduction was present in 11 patients (64.7%) with type IV supracondylar fractures, whereas it was present in 4 (25%) patients with type III fractures. Other demographic factors like age, gender, laterality, open/closed fracture, and

Table 1 Association between Gartland Type and Parameters

Parameters	Gartland Type		*p-value*
	Type 3 ($n = 16$)	Type 4 ($n = 17$)	
Age (years old)	8.62 ± 2.60	8.88 ± 3.69	0.818[a]
Gender			1.000[b]
Male	12 (75.0%)	13 (76.5%)	
Female	4 (25.0%)	4 (23.5%)	
Mode of Injury			0.071[b]
Fall from height	9 (56.2%)	6 (35.3%)	
Injury While practicing sports	5 (31.2%)	11 (64.7%)	
Road traffic accident	2 (12.5%)	0 (0.0%)	
Injury-Hospital Interval (hours)[***]	31.25 ± 43.09	52.59 ± 45.47	**0.029**[c]
Laterality			0.392[d]
Right	9 (56.2%)	12 (70.6%)	
Left	7 (43.8%)	5 (29.4%)	
Previous Attempts at Closed Reduction (present)[***]	4 (25.0%)	11 (64.7%)	**0.022**[d]
Type of Fracture			0.485[b]
Closed	15 (93.8%)	17 (100.0%)	
Open	1 (6.2%)	0 (0.0%)	
DNVS			0.335[b]
Intact	13 (81.2%)	16 (94.1%)	
Involved	3 (18.8%)	1 (5.9%)	

[***]Significant at $p < 0.05$, [a]: t-test, [b]: Fisher exact test, [c]: Wilcoxon test, [d]: Chi-squared test. DNVS, Distal neurovascular status.

Table 2 Comparison of the Diagnostic Performance of Various Radiographic parameters in Predicting Gartland Type 4 versus Gartland Type 3

Predictor	Odds ratio (95% CI)	AUROC (95% CI)	*p-value*	Sn	Sp	PPV	NPV
Angulation (sagittal plane) (degrees of extension)	5.32 (0.24–119.88)	0.557 (0.343–0.771)	0.587	41%	100%	100%	62%
Angulation (coronal plane) (degrees of valgus)	20.22 (3.45–118.65)	0.868 (0.741–0.994)	< **0.001**	88%	81%	83%	87%
Translation (coronal plane) (%)	0.94 (0.02–50.32)	0.557 (0.344–0.77)	0.588	71%	69%	71%	69%
Translation (sagittal plane) (%)	3.14 (0.75–13.16)	0.515 (0.316–0.714)	0.897	41%	69%	58%	52%
Osseous apposition (%)	3.14 (0.75–13.16)	0.557 (0.344–0.77)	0.588	71%	69%	71%	69%
Osseous apposition (Lateral) (%)	0.94 (0.02–50.32)	0.515 (0.316–0.714)	0.897	41%	69%	58%	52%

Abbreviations: AUROC, area under ROC curve; CI, confidence interval; DA, diagnostic accuracy; NPV, negative predictive value; PPV, positive predictive value; Sn, sensitivity; Sp, specificity.

distal neurovascular status were not statistically significant in differentiating types III and IV fractures.

A total of 33 preoperative radiographs were analyzed, and a diagnosis of type IV supracondylar fractures was significantly more likely in the presence of valgus angulation of distal fragment $\geq 17°$ (OR = 20.22; 95%CI = 3.45–118.65), with a sensitivity of 88%, and a specificity of 81% (►**Table 2**, ►**Fig. 3**). Flexion angulation $\geq 10°$ (OR = 5.32; 95%CI = 0.24–119.88) of the distal fragment predicted Gartland type IV with a sensitivity of 41% and a specificity of 100%. There was no significant association with fracture comminution, translation of the distal fragment over the proximal fragment in both planes and osseous apposition between the fracture fragments in both planes in predicting type IV supracondylar fractures on preoperative radiographs (►**Table 2**, ►**Fig. 3**).

Discussion

The multidirectionally unstable type of supracondylar fracture was first described by Leitch in 2006.[4] These fractures do not have any periosteal hinge, and the distal fragment is unstable in both flexion and extension. This type of fracture was renamed as Gartland type IV by the authors. The incidence of these fractures varies from 7 to 10% of all operated supracondylar fractures.[4] From the pool of unstable operated fractures included in the present study, ~ 50% ($n = 17$) were of type IV. The diagnosis of this type of fracture is possible intraoperatively, and the intrarater and inter-rater reliabilities remain undetermined. This instability may also be exaggerated during reduction attempts, and it further confounds the actual rate of occurrence.[4] Ultimately, the diagnosis of type IV fracture is extremely subjective and depends on the operating surgeon.

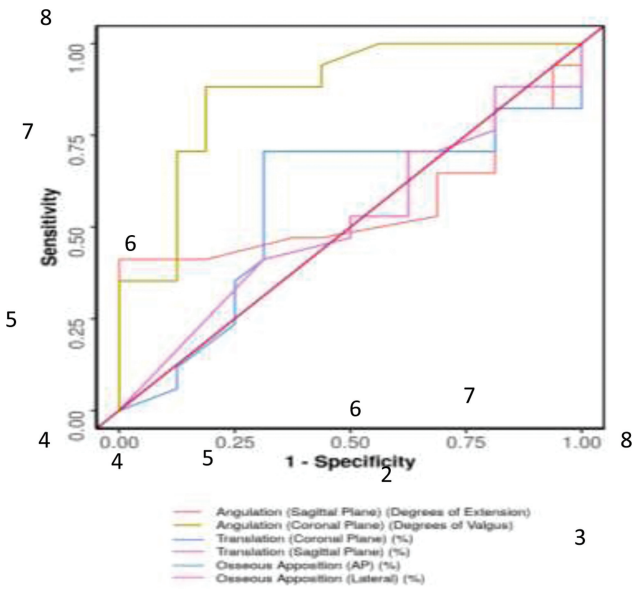

Fig. 3 ROC curve analysis of various parameters in predicting Gartland type 4 versus Gartland type 3.

The present study noted a significant difference in injury hospital duration and previous attempts of closed reduction in predicting type IV fracture from type III fracture. The mean injury hospital duration in type-III supracondylar fracture was 31.25 ± 43.09 hours, whereas in type-IV it was 52.59 ± 45.47 hours. A history of previous attempts of closed reduction was present in 11 patients (64.7%) with type IV supracondylar fractures, whereas it was present in 4 (25%) patients with type III fractures. Neurovascular injuries are not uncommon in type IV fractures, and their incidence varies ~ between 0 and 36%.[4,6] The present study had a single patient with type IV fracture with neurovascular injury. Other demographic factors such as age, gender, laterality, open/closed fracture, and distal neurovascular status were not statistically significant in differentiating types III and IV fractures.

The present study tried to identify preoperative radiographic parameters that would be more likely to be associated with type IV fractures. The most statistically significant factor was valgus angulation of the distal fragment (sensitivity of 88%, specificity of 81%). From the ROC curve, a valgus angulation $\geq 17°$ is more likely to be a type IV fracture. Flexion angulation of the distal fragment, though not statistically significant ($p < 0.05$), had a specificity of 100%. A flexion angulation of $\geq 10°$ is more likely to be a type IV fracture. Mitchell et al., in their study, had determined various preoperative radiological parameters in predicting type IV fractures.[5] A significant overlap between type IV fractures and the flexion type of supracondylar fractures was noted in the study. It also noted valgus angulation, lateral translation, and osseous

apposition as other factors in predicting type IV fractures. The present study could find only valgus angulation as statistically significant. Other factors, such as lateral translation and osseous apposition, were not found to be statistically significant.

The limitations of the present study are its retrospective nature and its sample size. Another inherent limitation of the present study is the lack of a gold standard diagnostic test in diagnosing type IV fractures. Multivariate regression analysis could not be performed due to the sample size. Another important limitation of the present study is that not all cases were operated by the attending pediatric orthopedic surgeon, but by pediatric orthopedic fellows. This factor might have an influence on the classification of the fracture. The strength of the present study is that it is one of the few studies determining predictive factors for type IV fractures. The present study is also the first study to employ ROC curves to determine a cutoff value for types III and IV fractures. Radiographic parameters were determined by two experienced observers (Singh G. and Singh V.), increasing the generalizability compared with a single observer approach.

Conclusion

In conclusion, the present study found several preoperative factors associated with Gartland type IV fractures. Nonradiographic factors such as increased hospital injury duration, previous attempts at closed reduction, and radiographic parameters such as valgus and flexion angulation were more likely to be associated with type IV fractures.

Conflict of Interests

The authors have no conflict of interests to declare.

References

1 Vaquero-Picado A, González-Morán G, Moraleda L. Management of supracondylar fractures of the humerus in children. EFORT Open Rev 2018;3(10):526–540
2 Cheng JC, Lam TP, Maffulli N. Epidemiological features of supracondylar fractures of the humerus in Chinese children. J Pediatr Orthop B 2001;10(01):63–67
3 Barton KL, Kaminsky CK, Green DW, Shean CJ, Kautz SM, Skaggs DL. Reliability of a modified Gartland classification of supracondylar humerus fractures. J Pediatr Orthop 2001;21(01):27–30
4 Leitch KK, Kay RM, Femino JD, Tolo VT, Storer SK, Skaggs DL. Treatment of multidirectionally unstable supracondylar humeral fractures in children. A modified Gartland type-IV fracture. J Bone Joint Surg Am 2006;88(05):980–985
5 Mitchell SL, Sullivan BT, Ho CA, Abzug JM, Raad M, Sponseller PD. Pediatric Gartland Type-IV Supracondylar Humeral Fractures Have Substantial Overlap with Flexion-Type Fractures. J Bone Joint Surg Am 2019;101(15):1351–1356
6 Silva M, Cooper SD, Cha A. The Outcome of Surgical Treatment of Multidirectionally Unstable (Type IV) Pediatric Supracondylar Humerus Fractures. J Pediatr Orthop 2015;35(06):600–605

Functional Evaluation and Pain Symptomatology of the Foot and Ankle in Individuals with Severe Obesity - Controlled Transversal Study*

Avaliação funcional e de sintomatologia dolorosa do pé e tornozelo em indivíduos com obesidade grave – Estudo controlado transversal

Glaucus Cajaty Martins[1,3] Pedro Henrique Gomes Fraga[1] Lucas Braga Teixeira[1] Bruno Rodrigues Guterres Valle[1] Luiz Felippe Martins Filho[1] Maurício de Pinho Gama[3]

[1] Orthopedics and Traumatology Service, Hospital Federal de Ipanema, Rio de Janeiro, RJ, Brazil
[2] Orthopedics and Traumatology Service, Hospital Universitário, Universidade Federal do Rio de Janeiro, RJ, Brazil
[3] Medical Statistics Service, Hospital Universitário, Universidade Federal do Rio de Janeiro, RJ, Brazil

Address for correspondence Glaucus Cajaty Martins, MD, PhD, Rua Jangadeiros, 67/69, Ipanema, Rio de Janeiro, RJ, 22420010, Brazil (e-mail: glaucusc@terra.com.br).

Rev Bras Ortop 2021;56(2):235–243.

Abstract

Objective The present study aims to evaluate the prevalence of foot and ankle pain complaints, radiographic parameters, and functional performance in subjects with severe obesity (body mass index [BMI] > 40) who are candidates to bariatric surgery.

Methods Forty severely obese patients were evaluated at a bariatric surgery outpatient facility. These severely obese subjects (BMI > 40) were divided into two subgroups: those with BMI < 50 (n $= 24$) and BMI > 50 (n $= 16$). These patients were compared with a control group of 42 volunteers with a mean BMI value of 24. The following parameters were assessed: foot pain (according to the visual analog scale [VAS]), functional performance (according to the American Orthopeadic Foot and Ankle Society [AOFAS] scale, including forefoot, midfoot and hindfoot domains), age, gender, hallux metatarsal-phalangeal angle, hallux intermetatarsal angle, talocalcaneal angle, calcanean pitch angle and Meary angle.

Results Incidence of foot pain was higher in the severely obese group compared with the control group ($p < 0.0001$; odds ratio [OR]: 4.2). Functional performance according

Keywords
- foot
- obesity
- pain
- AOFAS scale

* *Study developed at the Hospital Federal de Ipanema, Rio de Janeiro, RJ, Brazil.*

received
August 8, 2019
accepted
April 15, 2020
published online
October 29, 2020

DOI https://doi.org/10.1055/s-0040-1713757.
ISSN 0102-3616.

Thieme Revinter Publicações Ltda., Rua do Matoso 170, Rio de Janeiro, RJ, CEP 20270-135, Brazil

to the AOFAS scale was lower in obese subjects compared with the control group ($p < 0.0001$; OR for hindfoot, 4.81; OR for midfoot, 3.33).

Conclusion The incidence of foot pain was higher in the group of severely obese patients compared with the control group. According to the AOFAS scale, functional forefoot, midfoot and hindfoot performance was worse in severely obese individuals.

Resumo

Objetivo Avaliar a prevalência de queixas álgicas no pé e tornozelo, parâmetros radiográficos e o desempenho funcional de indivíduos com obesidade grave, Índice de Massa Corpórea (IMC) com valor > 40 e indicação de cirurgia bariátrica.

Métodos Foram avaliados 40 pacientes com obesidade grave acompanhados em ambulatório de cirurgia bariátrica. Este grupo de obesos graves (IMC > 40) foi subdividido em dois subgrupos: obesos com IMC < 50 (n = 24); e outro de obesos com IMC > 50 (n = 16). Foi realizada comparação com grupo controle de 42 indivíduo voluntários com IMC médio de 24. Foram avaliados a presença de dor no pé pela escala visual (EVA), o desempenho funcional pela escala da Associação Americana de Cirurgia do Pé e Tornozelo (AOFAS, na sigla em inglês) (domínios antepé, mediopé e retropé), idade, gênero, ângulo (âng) metatarso-falangeano do hálux, âng intermetatarsal do hálux , âng talocalcaneano, "pitch" calcaneano e âng de Meary.

Resultados Foi observada maior incidência de dor no pé no grupo de obesos graves em relação ao controle ($p < 0{,}0001$, razão de chances [*odds ratio,* OR]: 4,2). O desempenho funcional pela escala AOFAS foi inferior no grupo de obesos em relação ao controle ($p < 0{,}0001$, retropé com OR = 4,81; mediopé com OR = 3,33).

Conclusão Houve maior incidência de dor no pé no grupo de obesos graves em relação ao controle. Houve pior desempenho funcional pela escala AOFAS nas regiões do antepé, mediopé e retropé no grupo de obesos graves.

Palavras-chave
- pé
- obesidade
- dor
- escala AOFAS

Introduction

Today, obesity is one of the most challenging public health problems in modern society. It is estimated that there are currently over one billion overweight people in the world, with 300 million obese people.[1] This condition affects not only developed countries, but also developing countries, where carbohydrates ingestion is widespread due to their low cost.[2]

Population studies have shown that obesity is an independent risk factor for knee pain and arthrosis.[3–5]

In obese patients, feet pain incidence has been less studied in the literature than obesity-related knee pain.[3–5]

Obesity results in feet pain and biomechanical changes secondary to flat foot deformity, plantar fat alterations, decreased muscle strength and gait pattern abnormalities.[6] This process leads to loss of balance and risk of falling, interfering with the mobility of these individuals.[6,7]

Currently, there is a new strand of studies due to the discovery of visceral fat-generate proteins, the so-called adipokines. The best known adipokine is leptin, which plays a role in insulin action and inflammatory cytokines production by chondrocytes.[8] Recent studies have shown a higher incidence of knee pain and osteoarthritis related to high levels of serum adipokines and metabolic syndrome.[9]

The literature on pain incidence, functional performance level and foot and ankle radiographic alignment parameters in severely obese individuals, with a body mass index (BMI) > 40, is scarce. A compilation of these data is required to properly ascertain the importance of this problem. Clinical and imaging parameters that may indicate the need for early intervention are essential to formulate therapeutic and preventive strategies for this growing group of economically active people.

The main objective of the present study is to evaluate the prevalence of pain, determined by a visual analog scale (VAS), in a sample of severely obese individuals (BMI > 40) and compare it to a control group consisting of people with a mean BMI of 24. The secondary objectives are the determination of functional differences according to the American Orthopaedic Foot and Ankle Society (AOFAS) scale[10] and radiographic parameters for morphological evaluation of the foot in both groups. Our initial hypothesis is that a higher prevalence of pain and a lower functional performance are expected in people with severe obesity compared with the control group.

Methodology

The present study complies with the Declaration of Helsinki rules and it was approved by the hospital's Research Ethics Committee (CAAE 69073215.2.0000.5646, opinion 2.127.775). All participants (both from the obese and control groups) signed an informed consent form.

Table 1 Study group (obese patients)

	GENDER	AGE (years)	WEIGHT (kg)	CLASSIFICATION	HEIGHT (m)	BMI	VAS	SIDE	H	M	F	AMF	AIM°	APC°	ATC
1	Female	61	92	PATIENT	1.5	40.9	9	LEFT	47	79	93	normal	normal	NORMAL	FLAT
2	Female	42	110	PATIENT	1.64	40.9	9	RIGHT	49	60	95	mild	normal	NORMAL	NORMAL
3	Female	64	105	PATIENT	1.6	41	8	RIGHT	28	52	100	normal	normal	NORMAL	FLAT
4	Female	45	108	PATIENT	1.62	41.2	10	LEFT	65	53	74	normal	mild	NORMAL	NORMAL
5	Female	32	99	PATIENT	1.55	41.6	8	RIGHT	50	65	93	normal	moderate	FLAT	NORMAL
6	Male	27	158	PATIENT	1.95	41.6	8	LEFT	85	82	85	normal	normal	NORMAL	NORMAL
7	Female	47	97.5	PATIENT	1.52	42.2	7	RIGHT	67	64	95	normal	normal	NORMAL	NORMAL
8	Male	47	123	PATIENT	1.7	42.6	0	LEFT	80	85	85	normal	normal	NORMAL	NORMAL
9	Male	62	108	PATIENT	1.59	42.7	8	RIGHT	72	76	93	normal	moderate	NORMAL	NORMAL
10	Male	25	143	PATIENT	1.83	42.7	10	RIGHT	67	100	100	moderate	moderate	NORMAL	NORMAL
11	Male	30	128	PATIENT	1.73	42.77	7	RIGHT	82	100	73	normal	mild	NORMAL	NORMAL
12	Male	40	150	PATIENT	1.87	42.9	6	RIGHT	79	85	82	normal	normal	NORMAL	FLAT
13	Female	58	136	PATIENT	1.77	43.4	9	RIGHT	30	32	83	moderate	severe	NORMAL	NORMAL
14	Female	53	102	PATIENT	1.52	44.15	5	RIGHT	67	100	100	moderate	moderate	NORMAL	NORMAL
15	Female	19	109	PATIENT	1.57	44.2	8	RIGHT	67	49	100	moderate	mild	NORMAL	NORMAL
16	Female	38	122	PATIENT	1.66	44.3	9	LEFT	80	82	93	normal	mild	FLAT	NORMAL
17	Female	49	103	PATIENT	1.52	44.58	8	RIGHT	71	56	100	normal	normal	NORMAL	NORMAL
18	Female	47	124	PATIENT	1.65	45.5	7	RIGHT	72	60	77	normal	moderate	NORMAL	CAVUS
19	Female	53	97	PATIENT	152	45.8	0	RIGHT	88	89	90	normal	mild	NORMAL	NORMAL
20	Female	43	126	PATIENT	1.65	46.3	8	RIGHT	68	45	90	normal	normal	NORMAL	CAVUS
21	Female	63	116	PATIENT	1.58	46.5	7	RIGHT	52	87	100	normal	mild	CAVUS	NORMAL
22	Male	50	142	PATIENT	1.72	48	6	RIGHT	60	100	78	moderate	moderate	NORMAL	NORMAL
23	Female	63	115	PATIENT	1.55	48.87	8	LEFT	82	100	73	moderate	mild	FLAT	NORMAL
24	Female	33	140	PATIENT	1.68	49.6	5	RIGHT	67	89	70	mild	moderate	NORMAL	NORMAL
25	Female	52	130	PATIENT	1.61	50.2	3	LEFT	78	75	100	moderate	mild	NORMAL	NORMAL
26	Male	61	146	PATIENT	1.69	51.12	10	LEFT	57	100	57	mild	mild	NORMAL	FLAT
27	Female	45	120	PATIENT	1.53	51.26	3	RIGHT	73	62	100	moderate	moderate	NORMAL	NORMAL
28	Female	41	140	PATIENT	1.65	51.42	8	RIGHT	93	53	100	moderate	mild	NORMAL	NORMAL
29	Female	44	120	PATIENT	1.52	51.94	5	LEFT	84	82	100	mild	mild	FLAT	NORMAL
30	Female	55	116	PATIENT	1.48	52.16	8	LEFT	51	100	100	mild	moderate	NORMAL	NORMAL
31	Female	42	113	PATIENT	1.47	52.29	6	RIGHT	50	45	72	normal	normal	NORMAL	CAVUS
32	Female	36	123	PATIENT	1.53	52.59	5	LEFT	58	100	100	moderate	moderate	NORMAL	NORMAL
33	Female	27	135	PATIENT	1.58	54.08	7	RIGHT	41	61	100	normal	normal	NORMAL	NORMAL
34	Female	37	145	PATIENT	1.62	55.25	7	LEFT	64	100	100	mild	mild	NORMAL	NORMAL
35	Female	51	133	PATIENT	1.55	55.4	10	LEFT	29	39	90	normal	normal	NORMAL	NORMAL
36	Female	40	132	PATIENT	1.54	55.66	8	RIGHT	81	100	83	moderate	moderate	NORMAL	NORMAL
37	Male	40	165	PATIENT	1.72	55.77	5	LEFT	69	100	70	moderate	mild	NORMAL	NORMAL
38	Female	36	162	PATIENT	1.65	59.5	7	LEFT	88	73	95	normal	mild	NORMAL	NORMAL
39	Female	37	153	PATIENT	1.58	61.29	5	RIGHT	55	64	100	normal	normal	NORMAL	NORMAL
40	Male	59	181	PATIENT	1.79	71.6	7	RIGHT	89	100	100	normal	severe	NORMAL	NORMAL

Abbreviations: AIM, hallux intermetatarsal angle; AMF, hallux metatarsal-phalangeal angle; APC, calcanean pitch angle; ATC, talocalcaneal angle; BMI, Body mass index; H, M, F, hindfoot, midfoot, forefoot (respectively) functional performance according to the American Orthopeadic Foot and Ankle Society scale; VAS, visual analogue scale.

This was an observational, cross-sectional study. Data for the present research were collected by orthopedics residents from our service from June 2017 to April 2018.

Forty patients (►**Table 1**) from the bariatric surgery outpatient facility at our hospital were included. The sample consisted of 10 men and 30 women, with an average age of 45.45 years old (range, 25 to 63 years old).

The control group (►**Table 2**) consisted of volunteers (employees, resident physicians, and patients from the general, non-bariatric surgery outpatient facility) from matched gender and age for comparison with the obese group. The control group consisted of 42 people, including 12 men and 30 women, with an average age of 43.9 years old (range, 24 to 61 years old).

The inclusion criteria for the obese group were adult patients with BMI >40 who were candidates for bariatric surgery and consented to participate in the study. The exclusion criteria were previous performance of surgical

Table 2 Control group

	GENDER	AGE	WEIGHT (kg)	CLASSIFICATION	HEIGHT (m)	BMI	VAS	SIDE	H	M	F	AMF	AIM	APC	ATC	AM
1	Female	61	80	CONTROL	1.62	30.48	3	LEFT	49	66	100	normal	normal	CAVUS	NORMAL	CAVUS
2	Female	58	61	CONTROL	1.54	25.72	3	LEFT	41	58	100	moderate	mild	NORMAL	NORMAL	NORMAL
3	Female	45	62	CONTROL	1.54	26.14	0	RIGHT	100	100	100	normal	mild	NORMAL	NORMAL	NORMAL
4	Female	44	65	CONTROL	1.68	23.03	0	RIGHT	58	58	100	normal	moderate	FLAT	NORMAL	FLAT
5	Female	38	74	CONTROL	1.74	22.4	0	LEFT	60	90	90	normal	normal	NORMAL	NORMAL	NORMAL
6	Female	54	89	CONTROL	1.7	30.45	3	RIGHT	41	56	100	normal	moderate	FLAT	NORMAL	FLAT
7	Female	27	57	CONTROL	1.71	19.15	0	RIGHT	100	100	100	normal	normal	NORMAL	NORMAL	NORMAL
8	Female	38	59	CONTROL	1.63	22.21	5	LEFT	100	100	100	moderate	mild	NORMAL	NORMAL	NORMAL
9	Female	60	62	CONTROL	1.59	24.52	0	RIGHT	57	53	100	mild	mild	NORMAL	NORMAL	NORMAL
10	Female	35	69	CONTROL	1.71	23.6	0	RIGHT	100	100	100	mild	mild	NORMAL	NORMAL	NORMAL
11	Female	37	72	CONTROL	1.73	24.06	6	LEFT	100	100	100	mild	mild	FLAT	NORMAL	FLAT
12	Female	53	69	CONTROL	1.62	26.29	7	RIGHT	58	66	100	moderate	moderate	FLAT	NORMAL	FLAT
13	Female	41	72	CONTROL	1.7	24.91	4	LEFT	100	100	100	mild	mild	NORMAL	NORMAL	NORMAL
14	Female	20	54	CONTROL	1.59	21.36	0	RIGHT	100	100	100	normal	normal	NORMAL	NORMAL	NORMAL
15	Male	42	87	CONTROL	1.81	26.56	0	RIGHT	100	100	100	normal	normal	NORMAL	NORMAL	NORMAL
16	Male	30	70	CONTROL	1.71	23.66	0	RIGHT	100	100	100	moderate	moderate	NORMAL	NORMAL	NORMAL
17	Male	47	74	CONTROL	1.73	25.01	4	LEFT	100	100	100	normal	mild	NORMAL	NORMAL	NORMAL
18	Male	24	76	CONTROL	1.74	25.1	0	RIGHT	100	100	100	moderate	normal	NORMAL	NORMAL	NORMAL
19	Male	27	78	CONTROL	1.7	26.99	0	RIGHT	100	100	100	normal	normal	NORMAL	NORMAL	NORMAL
20	Male	35	76	CONTROL	1.69	26.61	6	LEFT	100	100	100	moderate	mild	NORMAL	NORMAL	NORMAL
21	Male	61	76	CONTROL	1.72	25.69	0	RIGHT	53	49	100	normal	normal	NORMAL	NORMAL	NORMAL
22	Male	56	92	CONTROL	1.79	28.71	3	RIGHT	100	100	100	mild	mild	NORMAL	NORMAL	NORMAL
23	Female	25	50	CONTROL	1.65	18.4	0	LEFT	100	100	100	normal	mild	NORMAL	NORMAL	NORMAL
24	Female	56	52	CONTROL	1.6	20.3	0	RIGHT	100	100	100	normal	normal	NORMAL	NORMAL	CAVUS
25	Female	35	55	CONTROL	1.53	23.5	0	RIGHT	100	100	75	moderate	normal	NORMAL	NORMAL	NORMAL
26	Female	50	57	CONTROL	1.6	22.3	3	RIGHT	100	90	100	normal	normal	NORMAL	NORMAL	CAVUS
27	Female	33	65	CONTROL	1.68	23	1	RIGHT	100	100	92	normal	mild	NORMAL	NORMAL	NORMAL
28	Male	34	79	CONTROL	1.81	24	0	RIGHT	100	100	100	normal	mild	NORMAL	NORMAL	CAVUS
29	Female	60	60	CONTROL	1.54	25.3	2	LEFT	88	100	100	normal	mild	NORMAL	NORMAL	NORMAL
30	Female	47	575	CONTROL	1.67	20.4	0	RIGHT	100	100	100	normal	normal	NORMAL	NORMAL	NORMAL
31	Female	61	57	CONTROL	1.53	24.3	0	RIGHT	100	100	100	normal	normal	NORMAL	NORMAL	NORMAL
32	Female	51	54	CONTROL	1.55	22.5	0	LEFT	100	100	100	normal	normal	CAVUS	NORMAL	CAVUS
33	Male	58	73	CONTROL	1.7	25.3	0	RIGHT	100	100	100	normal	normal	NORMAL	NORMAL	NORMAL
34	Male	52	83	CONTROL	1.8	25	0	LEFT	100	100	100	normal	normal	NORMAL	NORMAL	CAVUS
35	Female	40	62	CONTROL	1.71	21.2	0	LEFT	100	100	100	normal	mild	NORMAL	NORMAL	NORMAL
36	Female	42	58	CONTROL	1.55	24.1	5	LEFT	90	100	100	normal	normal	NORMAL	NORMAL	NORMAL
37	Female	53	60	CONTROL	1.57	24.3	2	RIGHT	87	92	92	moderate	moderate	NORMAL	FLAT	NORMAL
38	Female	60	49	CONTROL	1.55	20.4	6	LEFT	64	95	100	normal	normal	NORMAL	NORMAL	NORMAL
39	Male	27	82	CONTROL	1.79	25.2	0	RIGHT	100	100	100	normal	moderate	NORMAL	NORMAL	NORMAL
40	Female	43	54	CONTROL	1.53	23.1	0	LEFT	85	85	75	normal	moderate	NORMAL	NORMAL	NORMAL
41	Female	48	63	CONTROL	1.59	24.9	0	LEFT	75	72	75	moderate	severe	NORMAL	NORMAL	NORMAL
42	Female	35	75	CONTROL	1.75	24.5	0	LEFT	100	100	100	normal	mild	NORMAL	NORMAL	NORMAL

Abbreviations: AIM, hallux intermetatarsal angle; AM, Meary Angle; AMF, hallux metatarsal-phalangeal angle; APC, calcanean pitch angle; ATC, talocalcaneal angle; BMI, Body mass index; H, M, F, hindfoot, midfoot, forefoot (respectively) functional performance according to the American Orthopeadic Foot and Ankle Society scale; VAS, visual analogue scale.

procedures (orthopedic, vascular, dermatological, or plastic surgery) in any segment of the lower limbs (hip, knee, ankle, and foot). Individuals with sequelae from lower limb fractures or conditions with surgical indication, whether orthopedic (hip or knee arthrosis, ankle or foot arthrosis) or vascular (arterial or venous insufficiency, ulcers, digital or skin necrosis) were excluded from the research.

Weight and height were measured at the Bariatric Surgery Outpatient Facility. The BMI was calculated by dividing the weight in kilograms (kg) by the square of the height in meters. For classification purposes, a BMI < 20 is considered underweight, whereas values from 20 to 24.9 are normal, and between 25 and 29.9 indicate overweight; BMIs > 30, 40 and 50, respectively, represent obesity, morbid obesity, and superobesity.[7]

Anteroposterior (AP) and lateral radiographs from both feet from obese and control subjects were taken under load.

The following radiological parameters were measured:

1) hallux metatarsal-phalangeal angle (AMF) measured in AP radiographs: normal, < 15°; mild, 15 to 19°; moderate, 20 to 39°; severe, > 40°;
2) intermetatarsal angle (AIM) measured in AP radiographs: normal, < 9; mild, 9-11; moderate, 12-15; severe, > 16;
3) talocalcaneal angle (ATC) measured in AP radiographs: cavus foot, < 20°; normal, 20 to 30°; flat foot, > 40°;
4) Calcaneal pitch angle (APC) measured in lateral radiographs: flat foot, < 10; normal, 10-30; cavus foot, > 30;
5) Meary angle (AM) or talus-first metatarsal bone angle measured in lateral radiographs. A normal value would be zero. A plantar deviation > 10° indicates a cavus foot, whereas a dorsal deviation > 10° indicates a flat foot.

The AMF and the AIM assess and grade hallux valgus deformity. The ATC, APC and AM assess whether feet are normal or present deformities such as flat or cavus feet.

Pain in daily living activities (walking, going up and down stairs, rest) was assessed in a simple way by the VAS, with values ranging from 0 (no pain) to 10 (most severe pain possible). For a more objective assessment, a score from 1 to 3 was classified as mild pain, from 4 to 6, moderate pain, and from 7 to 10, severe pain. Values > 3 were noted as significant for odds ratio (OR).

The AOFAS scale[10] was used for functional evaluation of the feet. This classification addresses pain, function, use of shoes, distance covered, poor foot alignment and gait pattern. It analyzes the forefoot (hallux and small toes), midfoot and hindfoot/ankle as separate domains. The scale has decreasing values from 100 to zero for each domain (values < 70 are deemed unsatisfactory).

The following parameters from the study and control groups were statistically correlated: VAS, AOFAS scale (forefoot [F], midfoot [M] and hindfoot [H]), AMF, AM, ATC, APC and AIM. The relationship between the VAS and age and the VAS and gender was also assessed.

Visual analogue scale and BMI values were correlated.

Obese subjects were divided in two subgroups: patients with morbid obesity, with a BMI between 40 and 50, and those with superobesity, with a BMI > 50. These subgroups consisted of 24 and 16 subjects, respectively. Visual analogue scale and AOFAS scale parameters were evaluated comparatively between these two subgroups.

Data analysis was performed focusing on the most symptomatic limb (most responsible for VAS score). This methodology aims to avoid compromising the statistical analysis if both limbs (feet) are evaluated as separate statistical units, as previously described by Menz.[11]

Statistical Analysis

The G2 Wilks test was used to assess pain (VAS) in control and obese groups and between obese subgroups; in addition, it was used to determine the relationship between VAS score and gender and VAS score and age. This test was also used to analyze radiographic angles (AMF, AIM, APC, AM and ATC). The Mann-Whitney test was used to analyze AOFAS scale scores. A Pearson correlation matrix was used to ascertain the correlation between VAS and BMI scores. Significance was determined at $p < 0.05$.

Results

Foot pain was reported by 38 out of 40 (95%) obese patients and by 16 out of 42 (38%) control subjects (►**Figure 1**).

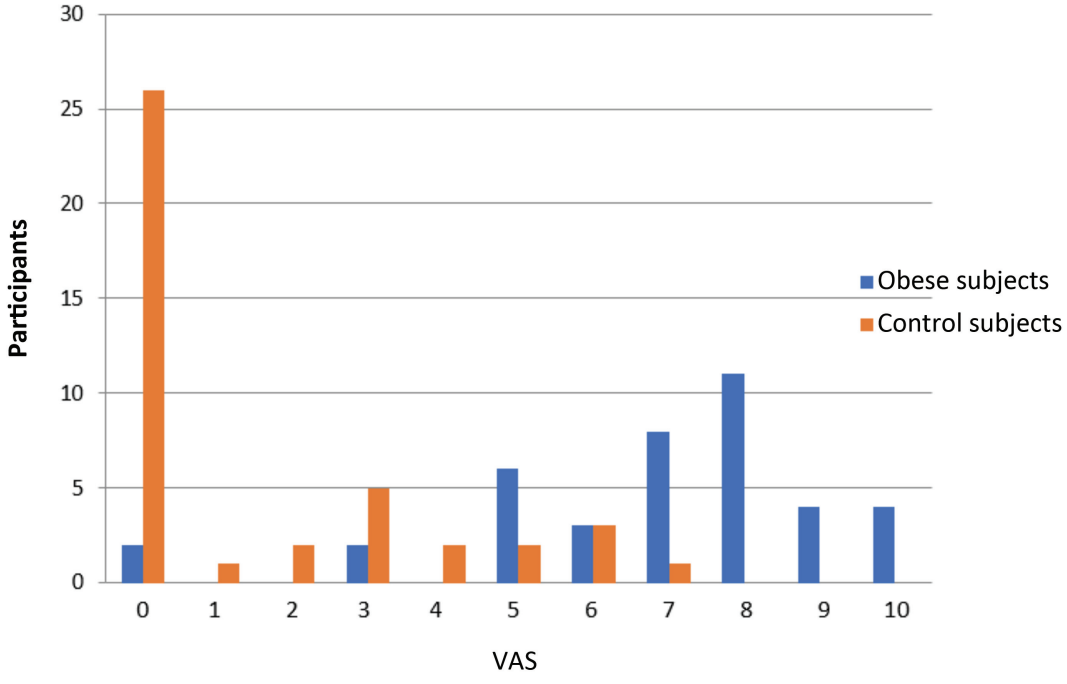

Fig. 1 Two-dimensional representation of visual analog scale (VAS) for pain in obese (*blue*) and control (*red*) subjects.

Table 3 Correlations in obese and control groups

PARAMETER	OBESE GROUP	CONTROL GROUP	STATISTICAL ANALYSIS
Gender	Male. 25%; Female. 75%	Male. 28.5%; Female. 71.5%	$p = 0.539$
Age	44.85	43.8 (Mean value)	$p = 0.3554$
VAS	95% with pain	40% with pain	$p = 0.0001$
AOFAS H (mean value)	65.87	88.23	$p < 0.0001$
AOFAS M (mean value)	76.1	91.19	$p < 0.0001$
AOFAS F (mean value)	89.59	97.59	$p < 0.0001$
APC	N = 87.5%	N = 85.71%	$p = 0.8585$
	C = 2.5%	C = 4.70%	
	F = 10%	F = 9.52%	
ATC	N = 82.5%	N = 97.6%	$p = 0.031$
	C = 7.5%	C = 0%	
	F = 10%	F = 2.6%	
AM	N = 67.5%	N = 76.2%	$p = 0.743$
	C = 12.5%	C = 14.3%	
	F = 17.5%	F = 9.5%	
AMF	N = 45%	N = 66.6%	$p = 0.743$
AIM	N = 30%	N = 42.85%	$p = 0.54$
Gender x VAS	————————————	————————————	$p = 0.33$ for obese subjects
			$p = 0.6417$ for control subjects
BMI X VAS	————————————	————————————	$p = 0.1407$ for obese subjects
			$p = 0.2343$ for control subjects

Abbreviations: AIM, hallux intermetatarsal angle; AMF, hallux metatarsal-phalangeal angle; APC, calcanean pitch angle; ATC, talocalcaneal angle; BMI, Body mass index; C, cavus; F, flat; H, M, F, hindfoot, midfoot, forefoot (respectively) functional performance according to the American Orthopeadic Foot and Ankle Society scale; N, normal; *p,* p-value, VAS, visual analogue scale.

Among obese patients, there were 19 (47.5%) cases of severe pain, 17 (42.5%) cases of moderate pain, 2 (5%) cases of mild pain, and 2 (5%) subjects referred no pain. In the control group, there were 8 (19.05%) cases of moderate pain, 8 (19.05%) cases of mild pain and 26 (61.90%) subjects referred no pain.

There was no difference between the obese and control groups regarding age and gender, as shown by *t*-student tests ($p = 0.3554$) and difference in proportion test ($p = 0.539$), respectively (►**Table 3**).

The referred pain scale (VAS) showed a higher prevalence of feet pain in the obese group compared with the control group according to the G2-Wilks test ($p = 0.0001$), with an OR value of 4.2.

The AOFAS scale in its three domains, that is, forefoot, midfoot and hindfoot, showed a lower functional performance in the obese group compared with control subjects according to the Mann-Whitney test ($p < 0.0001$) (►**Figure 2**). Odds ratios for hindfoot and midfoot were 4.810 and 3.33, respectively. The OR value for the forefoot could not be determined because no control subject presented a value < 70.

Pain, as assessed by the VAS, was not related to BMI in the obese or control groups, as shown by Pearson tests ($p = -0.1407$ and $p = 0.2343$, respectively.)

The ATC values were higher in the obese group, configuring a higher prevalence of flat feet, as shown by the G2 Wilks test ($p = 0.0317$).

There were no statistical differences between the obese and control groups regarding the remaining evaluated parameters (►**Table 3**).

Comparison between morbidly obese and supermorbidly obese subjects did not show statistical differences regarding the evaluated parameters (►**Table 4**).

Discussion

The present case series agrees with other studies from the literature[2,11] that show an increased prevalence of foot pain in obese individuals in relation to the general population. In this study, there was 95% pain in the obese group and 40% in the control group. Melo et al.[12] described similar data, with 85% pain in lower limbs from morbidly obese patients undergoing reduction gastroplasty. In the general

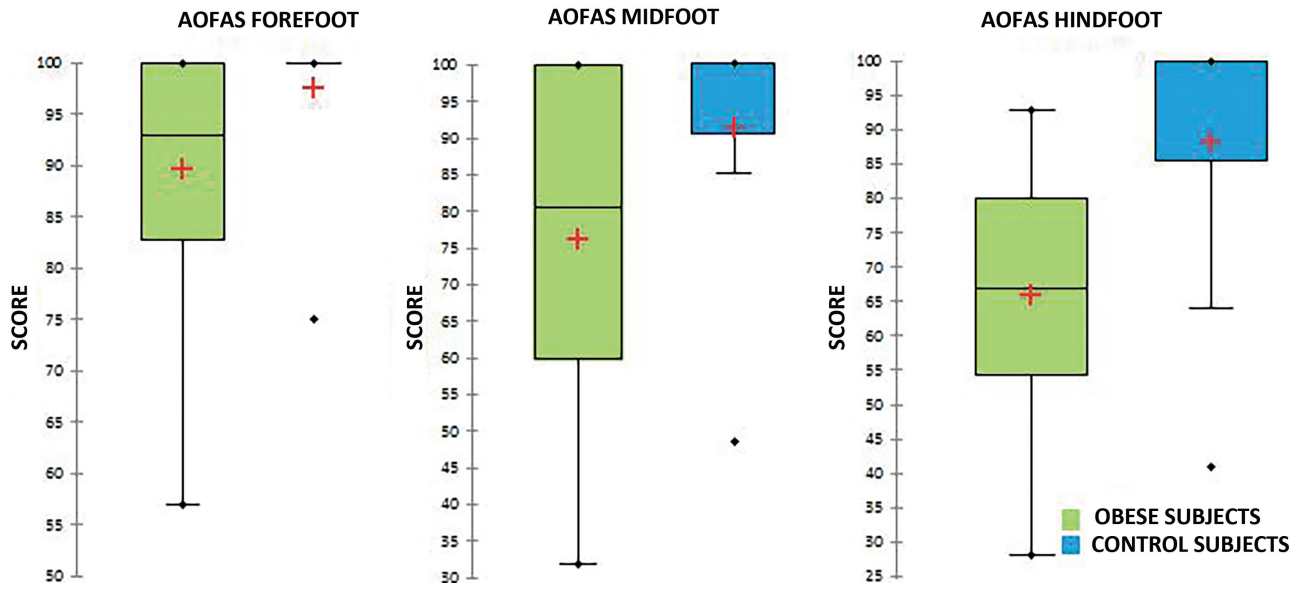

Fig. 2 Box plot graphs showing the American Orthopeadic Foot and Ankle Society (AOFAS) score for forefoot, midfoot and hindfoot domains in obese (*left*) and control (*right*) subjects.

Table 4 Correlations in subgroups with body mass index below or above 50

PARAMETER	OBESE BMI < 50	OBESE BMI > 50	STATISTICAL ANALYSIS
VAS	91.6	100%	$p = 0.075$
	Severe pain = 58%	Severe pain = 31.2%	
AOFAS Hindfoot domain	65.62	66.25	$p = 0.428$
AOFAS Midfoot domain	74.58	78.37	$p = 0.264$

Abbreviations: AOFAS, American Orthopeadic Foot and Ankle Society; BMI, body mass index; *p*, p-value; VAS, visual analogue scale.

population, these rates range from 14% in adolescents to 42% in people > 65 years old.[11] Our study revealed that a severely obese patient (BMI > 40) presents an OR of 4.2 for significant foot pain compared to a control group of people with a mean BMI of 24. In a meta-analysis, Butterworh et al.[2] described an OR of 3.1 for feet pain in obese patients compared with people with a BMI < 25.

All three domains from the AOFAS functional scale[10] were more altered in obese patients than in control subjects. This finding agrees with the higher report of calcaneal posterior pain by obese people,[2] as well as with the greater mechanical overload in the midfoot that result in local pain.[6,13] Compared to the control group, OR values corresponding to the hindfoot and midfoot from severely obese individuals (BMI > 40) of 4.81 and 3.33, respectively, ratify the higher incidence of poor functional performance for daily activities, quality of life and movement.

Even though the interplay between increased body weight and BMI and lower limb pain initially seems to result from biomechanical factors determined by increased load alone, new evidence relates joint pain to systemic metabolic syndrome.[2,14–16]

Visceral adipose tissue, as well as the truncal light fatty tissue, constitute true endocrine organs that secrete cytokines, interleukins, adipokines and leptins.[17] Leptin is reportedly related to pro-inflammatory effects and the destruction of chondrocytes.[14]

Our study showed no statistical relationship between referred pain (VAS) and BMI when comparing obese subjects. Other authors[2,11] reported that BMI would not be independently associated with foot pain. Butterworth et al.[2] emphasized that a high fat mass would be especially related to foot pain. Body mass alone would not be an independent factor for pain.[2,12] These observations suggest the presence of systemic, not just biomechanical, factors determining the onset of foot pain in obese individuals.

Case series[18,19] from the literature described a higher prevalence of flat feet in obese subjects. Our study showed a higher prevalence of increased ATC, consistent with flat feet, in obese individuals. There were no statistical differences between obese and control subjects regarding other studied angles. Some authors[20] reported that there is little relationship between joint pain and radiographic changes. Another factor to consider is that morbidly obese subjects are usually younger.[21] As a result, there was no time to develop radiological arthrosis or secondary deformities, and radiological changes would not be identified despite the pain.[21]

Our research showed no statistical difference regarding angular measurements in radiographs to assess the prevalence of conditions such as hallux valgus. A hallux valgus

deformity would not be necessarily associated with pain. However, data on its prevalence in obese people are conflicting. For Frey et al.,[22] hallux valgus would be related to normal BMI, and not to obesity. However, Cho et al.[23] correlated hallux valgus to increased BMI values. Nguyen et al.[24] reported that obesity and female gender would be protective factors for hallux valgus. This would be due to the fact that women with BMI < 25 tend to wear high heels, pointed toes shoes, whereas obese females, for having wider feet, wear flat shoes that do not compress the forefoot area.[24]

Menz et al.[25] described a higher prevalence of foot pain in women compared to men (25% versus 19%) in a general population from Framinghan, MA, USA. However, our study revealed no differences between severely obese men and women regarding both the prevalence and severity of feet pain.

Our case series showed no differences in feet functional parameters using the AOFAS scale and in the level of pain (VAS) when comparing morbidly and supermorbidly obese subjects. Our data disagrees from other authors who showed greater functional impairment in superobese individuals.[7] Further studies, including a larger number of individuals, may evidence such differences.

Our study is limited by its cross-sectional design; although the studied parameters may present correlations, it is not possible to determine a cause-effect relationship. Therefore, our statistical analysis cannot affirm that excessive obesity results in pain and low functional level or if these factors would have a reverse causal effect, that is, determining the occurrence of obesity due to the sedentary lifestyle. Another factor worth mentioning is the nondiscrimination of clinical comorbidities such as hypertension, diabetes, and other systemic diseases in obese and control subjects, which may have generated bias in data analysis. In addition, the sample studied was relatively small, which limits the scope of conclusions. However, it should be noted that the study group constitutes a very specific universe of people with extremely severe (morbid) obesity (BMI > 40) and indication for bariatric surgery, while most data from the researched literature[2,12] refer to overweight or mildly obese individuals.

A higher prevalence of foot pain and functional impairment was demonstrated in the studied obese population. The indirect relationship between increased BMI in severely obese patients and pain according to the VAS corroborates the suspicions that systemic mechanisms, not only biomechanical factors, determine pain and functional impairment. These findings reinforce the importance of further studying the involvement of the musculoskeletal system in people with severe obesity.

Our data will help to understand musculoskeletal conditions resulting from obese-related metabolic syndrome and to formulate preventive and therapeutic strategies in this special subgroup of individuals.

Conclusions

Severe obesity (BMI > 40) is related to a higher prevalence of foot pain. Severely obese people have a worse AOFAS functional score in the forefoot, midfoot and hindfoot regions.

Conflict of Interests
The authors have no conflict of interests to declare.

References

1 Thomas D, Elliott EJ. Low glycaemic index, or low glycaemic load, diets for diabetes mellitus. Cochrane Database Syst Rev 2009;(01): CD006296
2 Butterworth PA, Landorf KB, Smith SE, Menz HB. The association between body mass index and musculoskeletal foot disorders: a systematic review. Obes Rev 2012;13(07):630–642
3 Harms S, Larson R, Sahmoun AE, Beal JR. Obesity increases the likelihood of total joint replacement surgery among younger adults. Int Orthop 2007;31(01):23–26
4 Jinks C, Jordan K, Croft P. Disabling knee pain–another consequence of obesity: results from a prospective cohort study. BMC Public Health 2006;6:258
5 Martins GC, Martins Filho LF, Raposo AH, Gamallo RB, Menegazzi Z, Abreu AV. Radiographic evaluation and pain symptomatology of the knee in severely obese individuals - controlled transversal study. Rev Bras Ortop 2018;53(06):740–746
6 Mickle KJ, Steele JR. Obese older adults suffer foot pain and foot-related functional limitation. Gait Posture 2015;42(04):442–447
7 Fabris SM, Faintuch J, Brienze SL, et al. Are knee and foot orthopedic problems more disabling in the superobese? Obes Surg 2013;23(02):201–204
8 Sowers M, Karvonen-Gutierrez CA, Palmieri-Smith R, Jacobson JA, Jiang Y, Ashton-Miller JA. Knee osteoarthritis in obese women with cardiometabolic clustering. Arthritis Rheum 2009;61(10): 1328–1336
9 Li H, George DM, Jaarsma RL, Mao X. Metabolic syndrome and components exacerbate osteoarthritis symptoms of pain, depression and reduced knee function. Ann Transl Med 2016;4(07):133
10 Kitaoka HB, Alexander IJ, Adelaar RS, Nunley JA, Myerson MS, Sanders M. Clinical rating systems for the ankle-hindfoot, midfoot, hallux, and lesser toes. Foot Ankle Int 1994;15(07): 349–353
11 Menz H. Two feet, or one person? Problems associated with statistical analysis of paired data on foot and ankle medicine. Foot 2004;14(01):2–5
12 Melo IT, São-Pedro M. Musculoskeletal pain in lower limbs in obese patients before and after bariatric surgery. Arq Bras Cir Dig 2012;25(01):29–32
13 Walsh TP, Butterworth PA, Urquhart DM, et al. Increase in body weight over a two-year period is associated with an increase in midfoot pressure and foot pain. J Foot Ankle Res 2017;10:31
14 Gandhi R, Takahashi M, Smith H, Rizek R, Mahomed NN. The synovial fluid adiponectin-leptin ratio predicts pain with knee osteoarthritis. Clin Rheumatol 2010;29(11):1223–1228
15 Kalichman L, Li L, Kobyliansky E. Prevalence, pattern and determinants of radiographic hand osteoarthritis in Turkmen community-based sample. Rheumatol Int 2009;29(10):1143–1149
16 de Mello AP, Martins GCDS, Heringer AR, et al. Back pain and sagittal spine alignment in obese patients eligible for bariatric surgery. Eur Spine J 2019;28(05):967–975
17 Dumond H, Presle N, Terlain B, et al. Evidence for a key role of leptin in osteoarthritis. Arthritis Rheum 2003;48(11):3118–3129
18 Abdel-Fattah MM, Hassanin MM, Felembane FA, Nassaane MT. Flat foot among Saudi Arabian army recruits: prevalence and risk factors. East Mediterr Health J 2006;12(1-2):211–217
19 Otsuka R, Yatsuya H, Miura Y, et al. [Association of flatfoot with pain, fatigue and obesity in Japanese over sixties]. Nippon Koshu Eisei Zasshi 2003;50(10):988–998
20 Kinds MB, Welsing PM, Vignon EP, et al. A systematic review of the association between radiographic and clinical osteoarthritis of hip and knee. Osteoarthritis Cartilage 2011;19(07):768–778
21 Frilander H, Viikari-Juntura E, Heliövaara M, Mutanen P, Mattila VM, Solovieva S. Obesity in early adulthood predicts knee pain

and walking difficulties among men: A life course study. Eur J Pain 2016;20(08):1278–1287
22 Frey C, Zamora J. The effects of obesity on orthopaedic foot and ankle pathology. Foot Ankle Int 2007;28(09):996–999
23 Cho NH, Kim S, Kwon DJ, Kim HA. The prevalence of hallux valgus and its association with foot pain and function in a rural Korean community. J Bone Joint Surg Br 2009;91(04):494–498
24 Nguyen US, Hillstrom HJ, Li W, et al. Factors associated with hallux valgus in a population-based study of older women and men: the MOBILIZE Boston Study. Osteoarthritis Cartilage 2010;18(01): 41–46
25 Menz HB, Dufour AB, Casey VA, et al. Foot pain and mobility limitations in older adults: the Framingham Foot Study. J Gerontol A Biol Sci Med Sci 2013;68(10):1281–1285

Spastic Hips in Cerebral Palsy – Retrospective Study of Salvage with the McHale Procedure*

Quadris espásticos da paralisia cerebral – Estudo retrospectivo do salvamento com a cirurgia de McHale

Helder Henzo Yamada[1] Dante Galvanese Amato Neto[1] Juliano Mangini Dias Malpaga[1] Patricia Maria de Moraes Barros Fucs[1]

[1] Orthopedics and Traumatology Department, Faculdade de Ciências Médicas, Santa Casa de Misericórdia de São Paulo, São Paulo, SP, Brazil

Rev Bras Ortop 2021;56(2):244–250.

Address for correspondence Helder H. Yamada, Master, Rua Dr. Cesário Motta Jr., 112, São Paulo, SP, Brazil (e-mail: helderyamada@gmail.com; helder.henzo@gmail.com).

Abstract

Objective To perform a retrospective and cross-sectional assessment to determine the pain and positional improvement of all patients with spastic cerebral palsy (CP) and severe hip deformity who underwent a McHale procedure in our center. A second objective was to analyze the potential complications from the procedure.

Methods All consecutive patients treated between 1995 and 2017 were analyzed. Clinically, the patients should present pain on hip mobilization, difficulty in positioning for sitting and hygiene care, and medical records with complete data; functionally was assessed through the Gross Motor Function Classification System (GMFCS). In the preoperative radiographs, we analyzed the migration percentage (MP), the type of deformity according to the Melbourne Cerebral Palsy Hip Classification Scale (MCPHCS), and the type of deformity of the femoral head. After the surgery, we assessed the proximal migration of the proximal femoral fragment, implant changes and/or failure, and potential heterotopic ossification. The outcomes were reported as successful (D1) in patients presenting remission of pain, painless mobility, and improved positioning, or unsuccessful (D2) in those presenting procedural failure that required a new surgery.

Results In total, 47 patients (53 hips) were treated. Functionally, 43 patients were classified as GMFCS V (91%), 3 as GMFCS IV patients (6%), and 1 as GMFCS III (2%). The mean age was 13 years and 2 months. The follow-up ranged from 1 year to 15 years and 4 months, with an average of 4 years and 8 months. A total of 36 patients (41 hips) presented successful (D1) outcomes after the McHale procedure, corresponding to 77% of our cases, whereas 11 (23%) cases had unsuccessful (D2) outcomes.

Keywords
- cerebral palsy
- hip/deformities
- hip/surgery

* *Study performed by the Neuromuscular Diseases Group, Orthopedics and Traumatology Department, Faculdade de Ciências Médicas da Santa Casa de São Paulo, Santa Casa de Misericórdia de São Paulo, São Paulo, Brazil.*

received
September 17, 2019
accepted
April 15, 2020
published online
September 22, 2020

DOI https://doi.org/10.1055/s-0040-1713391.
ISSN 0102-3616.

Thieme Revinter Publicações Ltda., Rua do Matoso 170, Rio de Janeiro, RJ, CEP 20270-135, Brazil

Resumo

Conclusion The McHale procedure is a treatment option for GMFCS IV and V, but we must be aware of the potential complications.

Objetivo Fazer uma avaliação retrospectiva e transversal quanto à melhora da dor e do posicionamento de todos os pacientes portadores de paralisia cerebral (PC) espástica com deformidade grave no quadril submetidos ao procedimento de McHale em nosso centro. Secundariamente, objetivou-se analisar as possíveis complicações do procedimento.

Métodos Foram analisados todos os pacientes consecutivos tratados no período entre 1995 e 2017. Clinicamente, os pacientes deveriam apresentar dor à mobilização do quadril, dificuldade de posicionamento para se sentar e para os cuidados de higiene, e prontuário médico com dados completos; quanto ao grau de função motora, utilizou-se o Sistema de Classificação da Função Motora Grossa (Gross Motor Function Classification System, GMFCS, em inglês). A avaliação radiográfica no período pré-operatório analisou a porcentagem de migração (PM), o tipo de deformidade de acordo com a Escala de Classificação de Quadril na Paralisia Cerebral de Melbourne (Melbourne Cerebral Palsy Hip Classification Scale, MCPHS), e a deformidade da cabeça femoral. No período pós-operatório, analisaram-se a presença de migração proximal do fragmento do fêmur proximal, as alterações e/ou a falha do implante utilizado, e a possível ossificação heterotópica. Consideraram-se como desfechos: D1- satisfatório: remissão da dor, mobilidade indolor, melhora do posicionamento; e D2- insatisfatório: falha no procedimento, que necessitou de reabordagem cirúrgica.

Resultados No total, 47 pacientes (53 quadris) foram tratados. Funcionalmente, quanto à classificação no GMFCS, 43 pacientes eram GMFCS V (91%), 3 pacientes eram GMFCS IV (6%), e 1 paciente era GMFCS III (2%). A média da idade foi de 13 anos e 2 meses. O tempo de seguimento variou de 1 ano a 15 anos e 4 meses, com média de 4 anos e 8 meses. Quanto ao desfecho da cirurgia de McHale, ele foi satifatório (D1) em 36 pacientes (41 quadris), perfazendo 77% dos nossos casos, e insatisfatório (D2) em 11 (23%) casos.

Conclusão A cirurgia de McHale é uma opção no tratamento para os níveis IV e V, mas devemos estar alertas para as possíveis complicações.

Palavras-chave

- Paralisia cerebral
- Quadril/ deformidades
- Quadril/cirurgia

Introduction

Hip deformities occur in more than a third of children with cerebral palsy (CP), constituting the second most common deformity after equinus foot.[1–5]

The "spastic hip disease" results from muscle imbalance in a growing skeleton. Flexion and adduction gradually become contractures until a deformity is established. The deformity in flexion and adduction and the limitation in joint mobility prevent or hinder general hygiene care and sitting position, significantly compromising the quality of life of these patients. In addition, degenerative joint changes can become painful, worsening the condition of such individuals.[1,2]

The treatment of spastic hip deformities aims to maintain painless hip mobility and proper location, with a symmetrical range of motion compared to the contralateral side.[1,2,5]

Subluxation or dislocation are surgical indications for hip reconstruction.[2,4,6–13] However, femoral head deformity and joint incongruity mean that there is no opportunity for reconstruction. These cases require the so-called "salvage" procedures, including proximal femoral resection arthroplasty,[14] valgus osteotomy of the proximal femur with or without femoral head and neck resection (the McHale procedure),[15,16] hip arthrodesis,[17] total hip arthroplasty[18] and proximal femur prosthetic interposition arthroplasty.[1,13]

Even today, after several literature reviews on the subject[19–21] there is no consensus on the best treatment for these cases. This is true especially because the publications are often case series, with a lack of uniformity regarding the conditions and comorbidities of the patients, as well as the therapeutic environment, that makes comparison difficult.

It is known that the pain associated with hip deformity in spastic patients is directly related to their quality of life.[1,2,12] The main reason for treatment in patients with spastic CP with symptomatic and severe hip deformities who are no longer subject to reconstructive surgery is to improve pain and facilitate positioning.

The goal of the present study was to make a retrospective and cross-sectional evaluation of all patients with spastic CP with severe hip deformity undergoing the McHale procedure.

We performed a retrospective and cross-sectional assessment of all patients with spastic CP and severe hip deformity who underwent the McHale procedure[15] in our center and determine pain and positional improvement. A second objective was to analyze the potential complications from the procedure.

Patients and Methods

The present study was approved by the Ethics Committee of our hospital (under CAAE 94352318.9.0000.5479), and the patients' legal guardians signed the informed consent forms allowing the inclusion of clinical data in the research.

All consecutive patients undergoing the McHale procedure between 1995 and 2017 were analyzed by the Neuromuscular Diseases Group of our institution. The inclusion criteria were patients with spastic CP with subluxated or dislocated hips and femoral head deformity preventing joint reconstruction. Clinically, the patients presented pain during hip mobilization and difficulty in sitting and positioning for hygiene care; in addition, all of them had complete medical records. Patients with incomplete data and who did not return for outpatient evaluations were excluded.

No objective scale was used to assess the level of preoperative pain; the medical records informed that all patients had pain during mobilization of the affected hip and/or difficulties or intolerance to sit prior to the procedure. Since this is a retrospective evaluation, the improvement reported by the patient and/or caregiver at the last outpatient visit was considered. All patients are still being followed up in our service.

Radiographic evaluations were performed preoperatively and at the last outpatient evaluation, and they included an anteroposterior radiograph of the pelvis and panoramic posteroanterior and lateral views of the spine. Preoperatively, the radiographic pelvic analysis was performed using the following parameters: migration percentage (MP),[22] type of deformity according to the Melbourne Cerebral Palsy Hip Classification Scale (MCPHCS)[5] and the type of deformity of the femoral head.[1] Postoperatively, the proximal migration of a proximal femur fragment, implant alterations, and/or failure and potential heterotopic ossification were also determined. The Cobb angle was measured on a posteroanterior spine radiograph in supine position for the diagnosis of scoliosis; angles $\geq 40°$ were deemed moderately severe.[23] Angles and distances with up to 2 decimal places were determined with the MB-Ruler software, version 5.3 for Windows (MB-Softwaresolutions, Iffezheim, Germany). The radiographic measurements were made by two experienced and independent evaluators, and the interobserver intraclass correlation coefficient (ICC) was calculated.

In total, 8 patients (15 hips) had been previously submitted to surgical procedures, including 7 bilateral adductor tenotomies and 1 open hip reduction with variant osteotomy, proximal femur external rotation and unilateral Dega pelvic osteotomy, which was performed in another service.

The surgical technique, according to its original description (McHale et al.[15]), includes the following steps: with the patient in horizontal supine position, tenotomy of the adductors is performed by their route; the hip is exposed through an anterolateral (Watson-Jones) approach. With the femoral head exposed, an osteotomy is performed at the base of the femoral neck using a nitrogen saw. The femoral head is removed, while the ligament teres is preserved within the acetabulum. A bone wedge with a lateral base is removed from the proximal femur at the level of the lesser trochanter to promote an abduction of approximately 45°. The osteotomy is fixed using a straight dynamic compression plate (DCP) or locking compression plate (LCP) (Synthes, Solothurn, Switzerland) molded for distal fragment abduction for an average of 45°. The lesser trochanter is moved to the acetabulum. The ligament teres is then sutured in the tendon of the psoas muscle. A capsulorrhaphy is performed, and the lower part of the capsule often cannot be closed. Suture is performed by planes. Postoperative immobilization is not required.[15]

The postoperative complications were divided into minor and major events. Minor complications were defined as implant-related pain with or without implant exposure, fractures of operated lower limbs, and presence of heterotopic ossification. The major complications included further hospitalization and referral to another surgical procedure.

The final evaluation addressed two outcomes: a successful outcome (D1), in which the patients remained well (with less pain and able to sit) or presented minor complications after the procedure, and an unsuccessful outcome (D2), in which the patients presented major complications and subsequently underwent a new surgical procedure, the Castle procedure.[14]

Results

In total, 57 patients were treated, with 65 operated hips. We excluded 10 patients (12 hips) who did not return for the reassessment; as such, 47 patients (53 hips) comprised the study group.

A total of 19 patients were male, and 28 were female. Regarding laterality, the right hip was affected in 15 patients, whereas the left hip was affected in 26 individuals; there were 6 bilateral cases. According to the Gross Motor Function Classification System (GMFCS),[24] there were 43 level-V patients (91%), 3 level-IV patients (6%), and 1 level-III patient (2%). The mean age of the patients at the time of the surgery was 13 years and 2 months (median: 12 years and 8 months), ranging from 5 years and 4 months to 35 years and 10 months (►**Table 1**).

On average, the length of the hospital stay was of five days; consolidation of the osteotomy required six to eight weeks.

The follow-up period ranged from 1 year (12 months) to 15 years and 4 months (184 months), with a mean time of 4 years and 8 months (56 months) and a median time of 3 years and 10 months (46 months).

In the radiographic evaluation, the ICC was excellent, higher than 0.80; therefore, only the arithmetic mean value and the final median value were used. The initial MP ranged from 60% to 100%, with an average of 96.75% and a median value of 100%; 6 hips presented 33% to 89%, while 47 hips has MPs higher than 90%. According to the MCPHCS, 6 hips were

Table 1 Demographic data of the patients

Number of patients (number of hips)	47 (53)
Age (years and months)	mean value: 13 + 2 (163.28) minimum value: 5 + 4 (64) maximum value: 35 + 10 (430)
Gender	male: 19 female: 28
GMFCS	III – 1 IV – 3 V – 43
Previous surgeries	8 (15 hips): 7–bilateral adductor tenotomy 1–open reduction + femoral and pelvic osteotomy
Presence of scoliosis	35 (75%) cases
Follow-up years + months (months)	minimum time: 1 + 0 (12) maximum time: 15 + 4 (184) mean time: 4 + 8 (56) median time: 3 + 10 (46)

Abbreviation: GMFCS, Gross Motor Function Classification System.

Table 2 Radiographic outcomes

		Percentage
Migration percentage	33%–89% - 6 cases > 90% - 47 cases	11% 89%
Type of femoral-head deformity	TYPE 1 - 10 TYPE 2 - 22 TYPE 3 - 21	19% 41% 40%
MCPHCS Grade	Grade 5–6 cases Grade 6–47 cases	11% 89%

Abbreviation: MCPHCS, Melbourne Cerebral Palsy Hip Classification Scale.

grade 5 and 47 hips were grade 6. Regarding femoral head deformity, 10 hips (19%) were grade 1, 22 (41%) were grade 2, and 21 (40%) were grade 3. Among the 47 patients, 35 (75%) had scoliosis at the last reevaluation (►**Table 2**).

Clinically, there was no change in the functional level of the patients. In total, 25 individuals (53%; 29 hips) presented pain reduction or remission, in addition to free, painless mobility and improved positioning (►**Figure 1**).

Minor complications were reported in 11 patients (23%; 12 hips), including 8 patients subjects (9 hips) with pain and/or exposure of the implant material that required its removal. The average time between the 2 procedures was 1 year and 9 months; after the removal, the surgical wound healed with no complications or pain. Within this group, one patient was operated bilaterally, and the implant exposure occurred only on one side, in what was deemed a minor complication. Two patients had a fracture at the ipsilateral femoral shaft; one case was treated with open reduction and internal fixation with plate and screws, while the other was submitted to a closed reduction and plaster placement. Both progressed satisfactorily, with fracture consolidation. One last patient (one hip) presented painful dislocation of the contralateral hip and underwent a Castle procedure; the side operated according to the McHale technique was well, mobile and pain free. Therefore, 36 patients (41 hips) submitted to the McHale technique presented successful outcomes (D1), with no pain, free lower limb mobility and ability to sit in a wheelchair, corresponding to 77% of our cases.

Major complications were observed in 11 patients (12 hips), including 6 subjects (6 hips) who underwent implant removal and unilateral Castle procedure, 3 patients (4 hips) who underwent implant removal and bilateral Castle procedure, and 2 patients (2 hips) treated with a hip arthrodesis. Of the latter, one case (one hip) presented a femoral fracture, which was treated with external fixation and subsequent hip arthrodesis revision, whereas the other case underwent two hip arthrodesis revisions and evolved with no consolidation, requiring a Castle procedure. Due to procedural failure, the outcome was considered unsuccessful (D2) in 11 (23%) cases (►**Table 3**).

The postoperative radiographs showed no heterotopic ossification or proximal migration of the operated femur.

Patients still presenting pain were subsequently submitted to the Castle procedure, which resulted in pain remission and improved sitting position; however, this assessment is not within the scope of the present study (►**Figure 2**).

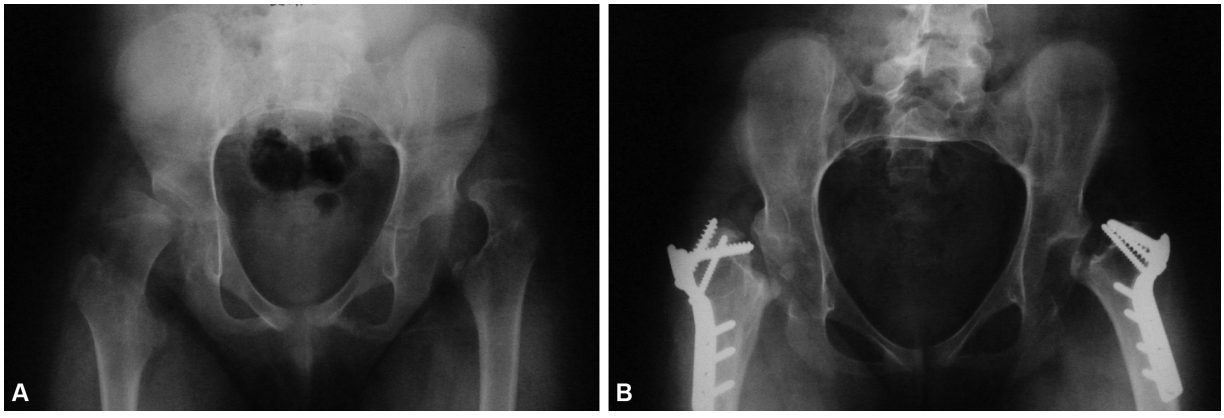

Fig. 1 Tetraparetic female patient, GMFCS grade V. (**A**) Pelvic radiograph at the initial follow-up, at 12 years and 2 months old. (**B**) Postoperative pelvic radiograph, 4 years and 2 months after the bilateral McHale surgery at 16 years old.

Table 3 Complications and outcomes

	Without complications	With complications	
Number of patients (hips)	25 (28) - 53%	22 (24) - 47%	
		Minor complications 11 (12) - 23%	*Major complications* 11 (12) - 23%
		8 (9) removals of implant	6 (6) implant removals and unilateral Castle procedure
		2 (2) ipsilateral femur fractures	3 (4) implant removals and bilateral Castle procedure
		1 (1) implant removal and contralateral Castle procedure	2 (2) hip arthrodeses
Outcomes	*D1–successful outcome*		*D2–unsuccessful outcome*

Discussion

Hip dislocation is common, and its incidence is directly related to the severity of the spasticity and the functional degree of the patient.[1,3,4,10–13,25] According to the literature, the incidence of dislocation associated pain ranges from 25% to 55%, reaching up to 90% in the most severe cases.[1,6,26] The same was verified in our patients, since most of them presented functional levels IV and V.

Since 79.5% of the cases present scoliosis,[7] sometimes it is difficult to identify whether pain was due only to the dislocation or to the scoliosis in these critically ill patients. The relationship between hip morphology and pain in subjects with CP is unclear and remains controversial. Some studies have reported high levels of pain in individuals with dislocated hips, and many adolescents require "salvage surgery", which is defined as hip joint loss.[1,2] The factors accounting for pain in dislocated hips can include degeneration of the articular cartilage, the associated inflammatory response, and an overload of pain mediators at the hip joint capsule.[27] The severity and frequency of the pain increased with the increase in physical disability, according to the GMFCS classification.[8] Regarding the MCPHCS,[5] due to the severity of the condition and the difficulties in accessing treatment in our health

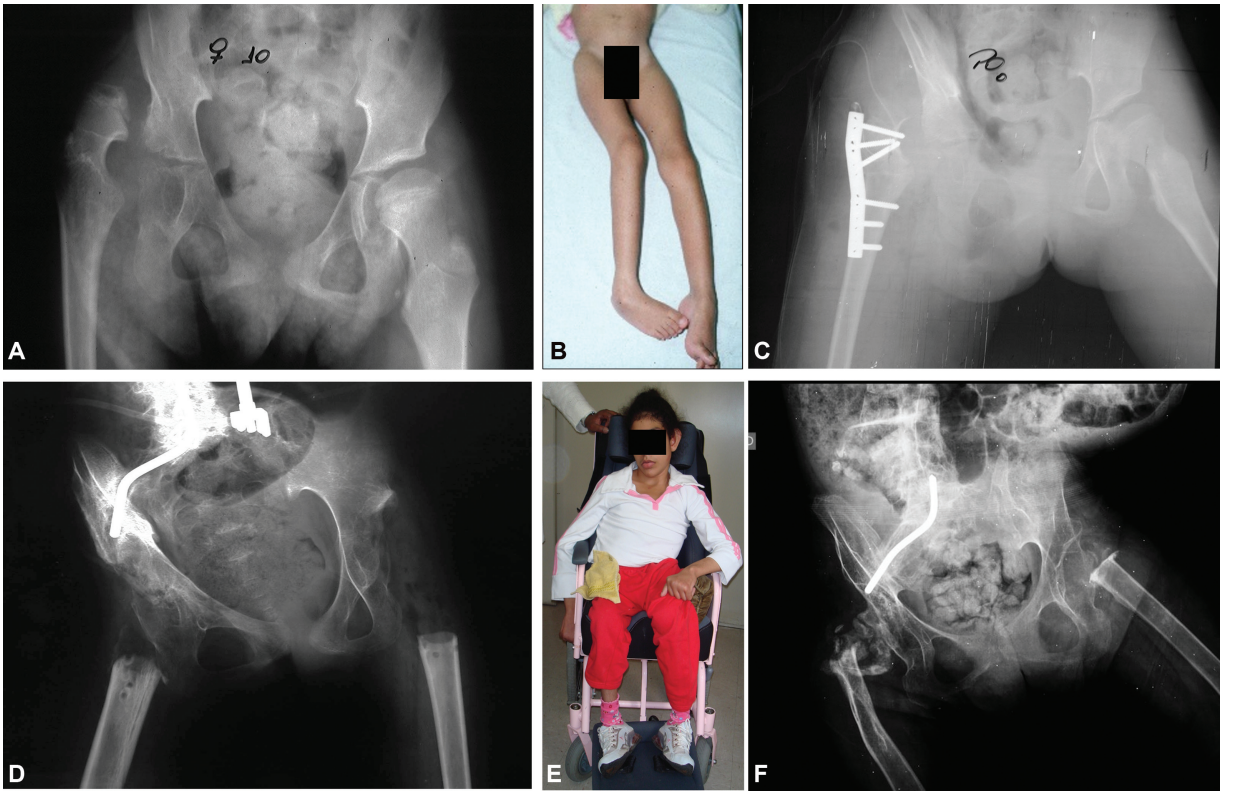

Fig. 2 Tetraparetic female patient, GMFCS grade V. (**A**) Pelvic radiograph at the initial follow-up, at 10 years and 2 months old. (**B**) Clinical image at the initial follow-up, at 10 years and 2 months old. (**C**) Pelvic radiograph soon after a McHale procedure on the right hip. (**D**) Pelvic radiograph soon after a bilateral Castle procedure at 14 years old. (**E**) Clinical image 7 years after a bilateral Castle at 21 years old. (**F**) Postoperative pelvic radiograph 14 years after a bilateral Castle technique, at 29 years old.

system, there were 10 hips at level 5 and 43 hips at level 6, indicating that salvage surgery was the only treatment option. The decision to perform the McHale procedure, except in cases of severe femoral head deformity, is made intraoperatively when more than 50% of the joint surface is injured. In cases with 30% and 50% of joint surface lesion, we perform a reconstructive surgery.

In dislocated hips, the lesser trochanter is usually positioned in front of the acetabular cavity, requiring only osteotomy of the proximal femoral valgus. Head resection improves abduction – in our opinion, it complements the first description of intertrochanteric valgus osteotomy by Schanz.[28] Tenodesis of the ligament teres in the psoas tendon, as in the original description, also provides greater stability to the construction and prevents proximal migration, which in fact happened in our cases.

In our patients, unilateral deformity had a special indication for the McHale procedure because, although it is a salvage procedure, it results in a more harmonious aspect of the pelvis. This new positioning reflects in the postoperative improvement of the patient's position, which was reported in our cases and in those of other authors.[29]

Regarding complications, in the original description of the McHale procedure,[15] with four patients, the authors mention postoperative pain, believing it to be the result of friction of the neck surface within the capsule of the closed joint. In our cases, the patients reported pain for a long period, on average for six months, and no anatomical explanation was found. These patients need close monitoring for pain control, which is performed with medication and physical therapy. Cases of protrusion of the osteosynthesis plate reaching the skin required the surgical removal of the implant material. Plate exposure generally occurs in patients with low weight, low muscle mass and poor nutritional support, often from the public health system, with difficult preoperative compensation; once treated with removal of the implant material and local care, the patients become asymptomatic. Adding the patients who remained with the implant and those who only underwent its removal due to the complication of plate exposure, 77% of the hips showed good evolution, with no other major postoperative complications, despite their functional severity.

Another complication in GMFCS-V patients, which is not uncommon, is lower limb fracture; in patients unable to walk, with visibly low bone mass (although undetermined) and joint contractures, any sudden movements during care represent important risk factors for fractures. Depending on the type and location of the fracture, the treatment can be closed or open, always considering the patient's functional aspect. A fracture episode does not imply that, after treatment, the goal of the McHale procedure has not been achieved. As such, fractures were considered minor complications.

For some patients, pain was an important limiting factor for daily care, even after the McHale procedure. These cases required an expanded resection and conversion into a Castle technique. The goal was always to relieve pain and improve patient positioning.

Another option for the two patients after failure of the McHale osteotomy was hip arthrodesis; in the first subject, with functional level V, this was an attempt for hip stabilization and pain resolution. However, the vertebral deformity worsened, and, after a vertebral arthrodesis, the patient was unable to sit; subsequently, a bilateral Castle procedure was successfully performed. The other patient, with functional level IV, despite having an ipsilateral femoral fracture that was treated with an external fixator, presented and still maintains a good position.

We agree with the literature[6,19,20,30] that the surgical treatment for painful and dislocated spastic hips in the context of CP is not perfect. A large percentage of failures remain, despite the numerous surgical techniques designed to treat this condition. We must consider that, even though the literature uses the GMFCS as an evaluation standard, spasticity homogeneity in patients with the same functional level is unclear. Furthermore, these patients often present comorbidities that influence the outcome of any surgical treatment.

The present study has some limitations. Since it was based on an analysis of medical records, it was not possible to reevaluate the patients regarding pain using validated scales. A questionnaire was also not applied to analyze patients' quality of life. The medical records included the description of the physical examination, the presence or absence of pain during hip movement and difficulties in patient positioning. On the other hand, all patients were treated by the same medical team, using the same treatment protocol, which in some way standardizes their assessment. Prospective studies prioritizing the impact on quality of life are required.

Conclusion

The present study shows that McHale procedure is an option to treat painful hips in cases of spastic CP with functional levels IV and V, leading to an improvement in pain and patient positioning; however, we must be prepared to address the potential complications, such as fractures and the persistence of pain.

Conflict of Interests

The authors have no conflict of interests to declare.

References

1 Miller F. Cerebral Palsy. New York: Springer Science; 2005
2 Horstmann HM, Bleck EE. Orthopaedic Management in Cerebral Palsy. London: MacKeith Press; 2007:344–379
3 Robin J, Graham HK, Baker R, et al. A classification system for hip disease in cerebral palsy. Dev Med Child Neurol 2009;51(03):183–192
4 Robin J, Graham HK, Selber P, Dobson F, Smith K, Baker R. Proximal femoral geometry in cerebral palsy: a population-based cross-sectional study. J Bone Joint Surg Br 2008;90(10):1372–1379
5 Howard JJ, Khot A, Graham HK. The hip in cerebral palsy. In: Alshryda S, Howard J, Huntley J, Schoenecker J, eds. The pediatric and adolescent hip. Basel, Switzerland: Spinger Nature Switzerland; 2019:467–530
6 Wright PB, Ruder J, Birnbaum MA, Phillips JH, Herrera-Soto JA, Knapp DR. Outcomes after salvage procedures for the painful dislocated hip in cerebral palsy. J Pediatr Orthop 2013;33(05):505–510

7 Knapp DR Jr, Cortes H. Untreated hip dislocation in cerebral palsy. J Pediatr Orthop 2002;22(05):668–671
8 Wawrzuta J, Willoughby KL, Molesworth C, et al. Hip health at skeletal maturity: a population-based study of young adults with cerebral palsy. Dev Med Child Neurol 2016;58(12):1273–1280
9 Terjesen T. The natural history of hip development in cerebral palsy. Dev Med Child Neurol 2012;54(10):951–957
10 Shore BJ, Yu X, Desai S, Selber P, Wolfe R, Graham HK. Adductor surgery to prevent hip displacement in children with cerebral palsy: the predictive role of the Gross Motor Function Classification System. J Bone Joint Surg Am 2012;94(04):326–334
11 Shore BJ, Graham HK. Management of moderate to severe hip displacement in nonambulatory children with cerebral palsy. JBJS Rev 2017;5(12):e4
12 Ramstad K, Terjesen T. Hip pain is more frequent in severe hip displacement: a population-based study of 77 children with cerebral palsy. J Pediatr Orthop B 2016;25(03):217–221
13 Silverio AL, Nguyen SV, Schlechter JA, Rosenfeld SR. Proximal femur prosthetic interposition arthroplasty for painful dislocated hips in children with cerebral palsy. J Child Orthop 2016;10(06): 657–664
14 Castle ME, Schneider C. Proximal femoral resection-interposition arthroplasty. J Bone Joint Surg Am 1978;60(08):1051–1054
15 McHale KA, Bagg M, Nason SS. Treatment of the chronically dislocated hip in adolescents with cerebral palsy with femoral head resection and subtrochanteric valgus osteotomy. J Pediatr Orthop 1990;10(04):504–509
16 Girdlestone GR. Acute pyogenic arthritis of the hip: an operation giving free access and effective drainage. Lancet 1943;241:419–421
17 Fucs PM, Yamada HH. Hip fusion as hip salvage procedure in cerebral palsy. J Pediatr Orthop 2014;34(Suppl 1):S32–S35
18 Root L, Goss JR, Mendes J. The treatment of the painful hip in cerebral palsy by total hip replacement or hip arthrodesis. J Bone Joint Surg Am 1986;68(04):590–598
19 Kolman SE, Ruzbarsky JJ, Spiegel DA, Baldwin KD. Salvage options in the cerebral palsy hip: a systematic review. J Pediatr Orthop 2016;36(06):645–650
20 de Souza RC, Mansano MV, Bovo M, et al. Hip salvage surgery in cerebral palsy cases: a systematic review. Rev Bras Ortop 2015;50 (03):254–259
21 Givon U. Management of the spastic hip in cerebral palsy. Curr Opin Pediatr 2017;29(01):65–69
22 Reimers J. The stability of the hip in children. A radiological study of the results of muscle surgery in cerebral palsy. Acta Orthop Scand Suppl 1980;184(184):1–100
23 Murphy RF, Mooney JF III. Current concepts in neuromuscular scoliosis. Curr Rev Musculoskelet Med 2019;12(02):220–227
24 Palisano R, Rosenbaum P, Walter S, Russell D, Wood E, Galuppi B. Development and reliability of a system to classify gross motor function in children with cerebral palsy. Dev Med Child Neurol 1997;39(04):214–223
25 Flynn JM, Miller F. Management of hip disorders in patients with cerebral palsy. J Am Acad Orthop Surg 2002;10(03):198–209
26 Soo B, Howard JJ, Boyd RN, et al. Hip displacement in cerebral palsy. J Bone Joint Surg Am 2006;88(01):121–129
27 Masłoń A, Jóźwiak M, Pawlak M, Modrzewski T, Grzegorzewski A. Hip joint pain in spastic dislocation: aetiological aspects. Dev Med Child Neurol 2011;53(11):1019–1023
28 Schanz A. Zur Behandlung der veralteten angeborenen Hüftverrankung. Munch Med Wochenschr 1922;23:930–931
29 Leet AI, Chhor K, Launay F, Kier-York J, Sponseller PD. Femoral head resection for painful hip subluxation in cerebral palsy: Is valgus osteotomy in conjunction with femoral head resection preferable to proximal femoral head resection and traction? J Pediatr Orthop 2005;25(01):70–73
30 Boldingh EJ, Bouwhuis CB, van der Heijden-Maessen HC, Bos CF, Lankhorst GJ. Palliative hip surgery in severe cerebral palsy: a systematic review. J Pediatr Orthop B 2014;23(01):86–92

Energy Required for Fracture in Synthetic Proximal Femoral Models After Synthesis Material Removal: a Biomechanical Study Using Cannulated Screws, Dynamic Hip Screws, and Proximal Femoral Nails*

Energia necessária para a ocorrência de fratura em modelos sintéticos de fêmur proximal após retirada de material de síntese: Um estudo biomecânico com parafuso canulado, parafuso dinâmico do quadril e haste femoral proximal

Anderson Freitas[1] Landwehrle de Lucena da Silva[2] Renilton Rodrigues Costa[2]
Lucas Sacramento Ramos[2] Marcos Norberto Giordano[3] Henrique Mansur Gonçalves[2]

[1] Instituto de Pesquisa e Ensino do Hospital Ortopédico e Medicina Especializada (IPE-HOME-DF), Brasília, DF, Brazil
[2] Hospital Regional do Gama, Brasília, DF, Brazil
[3] Hospital de Aeronáutica do Galeão (HFAG), Rio de Janeiro, RJ, Brazil

Address for correspondence Landwehrle de Lucena da Silva, MD, Hospital Regional do Gama, Área Especial n° 01, St. Central, Gama, Brasília, DF, 72405-901, Brazil (e-mail: landlucena@gmail.com).

Rev Bras Ortop 2021;56(2):251–255.

Abstract

Objective The present study aims to identify the energy required for synthetic proximal femoral fracture after removal of three implant types: cannulated screws, dynamic hip screws (DHS), and proximal femoral nail (PFN).

Methods Twenty-five synthetic proximal femur bones were used: 10 were kept intact as the control group (CG), 5 were submitted to the placement and removal of 3 cannulated screws in an inverted triangle configuration (CSG), 5 were submitted to the placement and removal of a dynamic compression screw (DHSG), and 5 were submitted to the placement and removal of a proximal femur nail (PFNG). All samples were biomechanically analyzed simulating a fall on the greater trochanter using a servo-hydraulic machine to determine the energy (in Joules [J]) required for fracture.

Keywords
- hip
- hip fractures
- fracture fixation
- device removal

* This study was developed by the Orthopedics and Traumatology Department, Hospital Regional do Gama, Brasília, DF, and Instituto de Pesquisa e Ensino do Hospital Ortopédico e Medicina Especializada (IPE-HOME), Brasília, DF, Brazil.

received
February 17, 2020
accepted
September 16, 2020
published online
September 25, 2020

DOI https://doi.org/10.1055/s-0040-1721832.
ISSN 0102-3616.

Thieme Revinter Publicações Ltda., Rua do Matoso 170, Rio de Janeiro, RJ, CEP 20270-135, Brazil

Results All samples presented basicervical fractures. The energy required for fracture was 7.1 J, 6.6 J, 6 J, and 6.7 J for the CG, CSG, DHSG and PFNG, respectively. There was no statistically significant difference (considering a 95% confidence interval) in energy among the study groups ($p = 0.34$).

Conclusion There was no statistically significant difference in the energy required to cause a synthetic proximal femoral fracture after removing all three implant types and simulating a fall over the greater trochanter.

Resumo

Objetivo Identificar a energia necessária para ocorrência de fratura do fêmur proximal em osso sintético após a retirada de três modelos de implantes: parafusos canulados, parafuso dinâmico do quadril (*dynamic hip screw*-DHS) e haste femoral proximal (*proximal femoral nail*-PFN).

Métodos Foram utilizados 25 modelos de ossos sintéticos da extremidade proximal do fêmur: 10 unidades de grupo controle (GC), 5 unidades após colocação e retirada de 3 parafusos canulados colocados em configuração de triângulo invertido (GPC), 5 unidades após colocação e retirada do parafuso de compressão dinâmico (GDHS) e 5 unidades após colocação e retirada da haste de fêmur proximal (grupo GPFN). Uma análise biomecânica foi realizada em todas as amostras simulando uma queda sobre o grande trocânter utilizando uma máquina servo-hidráulica com o objetivo de verificar a energia (em joules [J]) necessária até a ocorrência de fratura nos diferentes grupos.

Resultados Todos os grupos apresentaram fratura basocervical. Os grupos GC, GPC, GDHS e GPFN apresentaram, respectivamente, valores de 7.1J, 6.6J, 6J e 6.7J de energia até a ocorrência de fratura. Não houve diferença estatisticamente significativa (intervalo de confiança de 95%) na energia entre os grupos de estudo ($p = 0,34$).

Conclusão Não houve diferença estatisticamente significativa nos valores de energia necessária para ocorrência de fratura da extremidade proximal do fêmur após a retirada de três tipos de implantes utilizando modelos sintéticos simulando queda sobre o grande trocânter.

Palavras-chave
- quadril
- fraturas do quadril
- fixação de fratura
- remoção de dispositivo

Introduction

Life expectancy has increased worldwide, mainly due to improved social determinants of health. As a result, the higher number of elderly people proportionally increased the rate of chronic non-communicable diseases, including osteoporosis, which stands out as a global public health problem. Osteoporosis mainly affects the elderly population, especially female, postmenopausal patients. It is characterized by bone mineral density reduction, leading to a lower bone mechanical strength. It has an important socioeconomic impact due to the high incidence of proximal femoral fractures resulting from falls and low-energy traumas.[1,2]

These fractures are approached in a manner as to provide patients with conditions to resume normal activities as early as possible. Therefore, most cases are surgically treated with implants, such as proximal femoral nails (PFNs), cannulated screws (CSs), dynamic hip screws (DHSs), or even joint replacement (arthroplasty).[3]

Some complications associated with the surgical treatment of proximal femoral fractures may require implant removal. Synthesis material removal is indicated mainly in cases of persistent hip, gluteus, or thigh pain, and implant failure or infection.[4–6] Implant removal may predispose to femoral neck or intertrochanteric fractures, especially in elderly patients with low bone quality.[7]

Due to the various dimensions and positions of implants in proximal femoral fractures, we need to understand the biomechanical implications resulting from their removal to raising surgeons' awareness of the safety and consequences of performing such procedure.[8,9]

As such, this study aims to identify the required energy (in Joules) to cause a fracture in a synthetic proximal femur after removing three implant types: CSs, DHSs, and PFNs.

Materials and Methods

Twenty-five synthetic femurs (c1010 model manufactured by Nacional Ossos, Jaú, SP, Brazil), composed of cortical and spongy bone, with 10 pounds per cubic foot and a 12-mm spinal canal, were used. These femurs were divided into four groups: control group (CG), cannulated screw group (CSG), dynamic hip screw group (DHSG), and proximal femoral nail group (PFNG).

The CG was formed by 10 intact femurs (►**Figure 1**). For the CSG, 5 intact synthetic femurs were submitted to the placement of 3 7.5-mm cannulated screws configured in an inverted triangle. For the DHSG and PFNG, each group

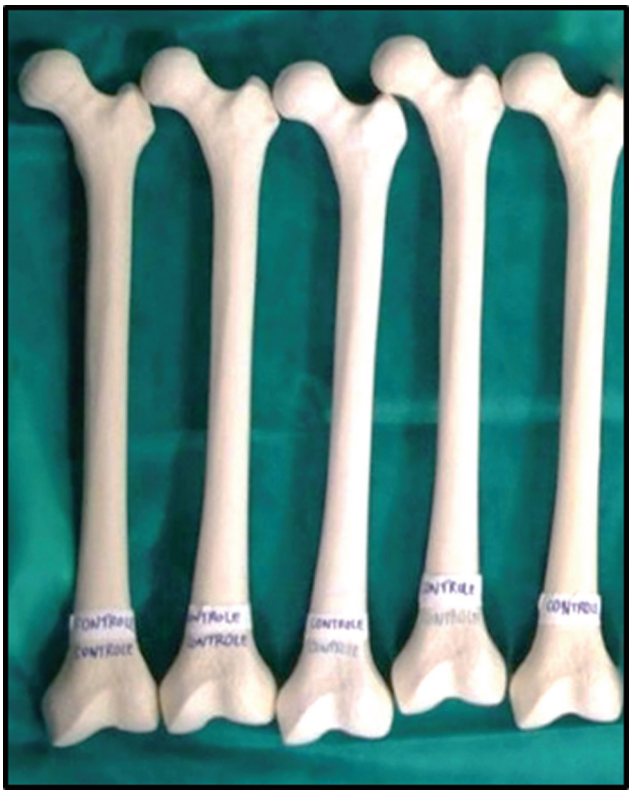

Fig. 1 Control group (CG) model.

consisted of five synthetic femurs submitted to implant fixation using the *Arbeitsgemeinschaft für Osteosynthesefragen* (AO) technique shown in ►**Figure 2**. The sliding screws had 12 mm in diameter for the DHSG and 10.5 mm for the PFNG. Eventually, all implants were removed, and the bones were sent to the biomechanical analysis laboratory.

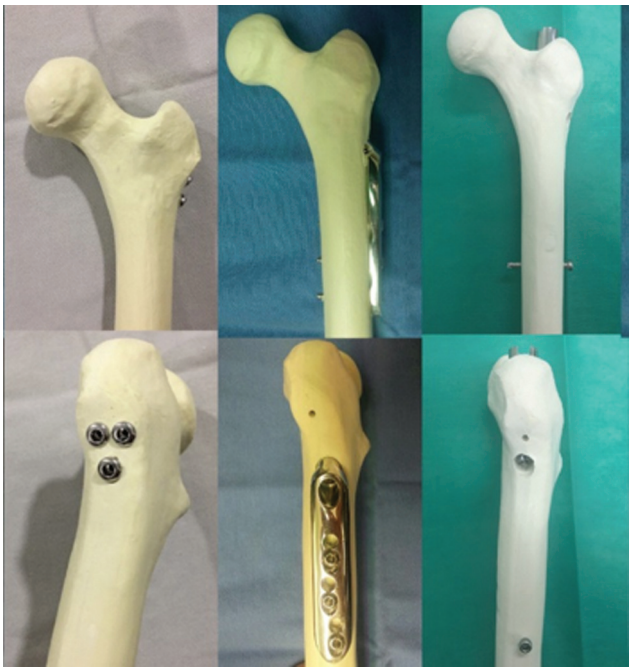

Fig. 2 Cannulated screw (CSG), dynamic hip screw (DHSG) and proximal femoral nail (PFNG) group samples after implant placement.

Fig. 3 Experimental model on the biomechanical test platform.

Tests were performed in static flexion using a servo-hydraulic machine (MTS 810 model, FlexTest 40, MTS Sistemas do Brasil Ltda., São Paulo, SP, Brazil) with a 100 kilonewtons power. Each femur was attached to the test device leaving 150 mm of its length outside the machine, towards the hydraulic piston at its base with a horizontal inclination of 10° and 15° in internal rotation according to a digital goniometer. The greater trochanter was supported by a silicone disk with 8×2-cm in diameter (►**Figure 3**). A preload of 40 Newtons was applied at a speed of 2 mm/s, followed by load applied to the femoral head until fracture (►**Figure 4**); the energy was determined in Joules (J).

The results were obtained through an inferential analysis using selected parameters data and submitted to a one-way analysis of variance (ANOVA) to detect a potential significant difference among the groups. Significance was set at 5%. The statistical analysis was performed using the IBM Statistical Package for the Social Sciences (SPSS) Statistics, version 20.0 (IBM SPSS Statistics, Armonk, NY, USA).

Results

All samples presented basicervical fractures.

Fig. 4 Experimental model after fracture.

Table 1 Energy (in Joules) required for fracture in each experimental model

Variable	n	Mean value	95% CI for mean value	Minimum value	Maximum value	*p*-value*
Energy (J)						
CG	10	7.1	5.5 - 8.6	4.4	10.4	
CSG	5	6.6	4.3 - 8.9	4	10	
GDHS	5	6	4.9 - 7.1	4	7	
GPFN	5	6.7	6.1 - 7.3	6.2	7.9	0.78

Abbreviations: CG, control group; CSG, cannulated screw group; DHSG, dynamic hip screw group; PFNG, proximal femoral nail group; CI, confidence interval; J, Joules.
*One-way analysis of variance (ANOVA).

The energy required for fracture was 7.1 J, 6.6 J, 6 J and 6.7 J for the CG, CSG, DHSG, and PFNG, respectively, as shown in ►**Table 1**.

A one-way ANOVA revealed that there was no statistically significant difference in the energy required for fracture ($p = 0.78$) among the study groups.

Discussion

Proximal femoral implant removal can result in local biomechanical changes. For instance, DHS removal can generate bone defects in the subtrochanteric area due to its position, while PNF removal causes a major bone defect in the greater trochanter. Therefore, before implant removal from the proximal femur, the surgeon must consider the biomechanical changes and the potential complications resulting from the procedure.[7–9]

In this study, synthetic bones were chosen to standardize the biomechanical properties between samples and to minimize bone-inherent differences (bone density, length, biochemical composition, age, diameter).[10] The simulated fracture mechanism, which was the fall over the greater trochanter, is accepted as the most common in this type of injury, especially in the elderly population.[11]

All fractures in our study were basicervical injuries. The literature suggests that, after implant removal, a bone failure aggravated by the low bone density in elderly patients may contribute to the weakening of the femoral neck region, making it more susceptible to stress and fracture.[12–14] Other studies have suggested that pain after fracture consolidation may have been misinterpreted, consisting in a clinical sign of stress injury at the femoral neck, which would contribute to fracture after implant removal.[15]

In addition, our results show a regular trend towards lower maximum energy in the CSG, DHSG, and PFNG when compared to the CG, even though there were no statistically significant differences. Yang et al., in a similar biomechanical study using 15 cadaveric femurs, also failed to demonstrate a significant difference in the maximum energy required for proximal femoral fractures after PFN and DHS removal.[6,9]

Other studies have tested femoral reinforcement with bone cement as a technique to protect osteoporotic proximal femurs from fractures after synthesis material removal. One of these studies used synthetic femurs divided into two groups, with or without bone cement reinforcement after DHS removal, and performed biomechanical tests to determine the maximum energy required for fracture. Interestingly, no statistical difference was found in the maximum energy required for fracture, suggesting that cementation after implant removal has no benefit.[8,16]

As limitations of our study, we realized that the load applied to the models was essentially a pure lateral compression force, although other variables, including rotational and axial forces, may play a role in vivo. Another important limitation was the use of a synthetic bone model. We know that it does not reproduce the true biomechanics of human bones, especially in the elderly population, which presents low bone mineral density and is most susceptible to proximal femoral fractures. In addition, morphological changes inherent to fracture healing, such as callus formation, remodeling and malunion, were not evaluated. Synthetic models do not allow for ethnicity, age, metabolic conditions, and lifestyle habits assessment. However, the iatrogenic aggression necessary to remove the synthetic material cannot be evaluated. Last, the sample was restricted to 25 bones, which is limited, due to the high cost of the models.

Conclusion

None of the evaluated bone models presented significant differences in the energy required for fracture when compared to the control group. Further studies are needed to corroborate our results, preferably with bone models that biomechanically resemble those of the population with a higher incidence of proximal femur fracture.

Conflict of Interests

The authors declare no conflict of interests; this research was not sponsored by any public or private entities.

References

1 Cosman F, de Beur SJ, LeBoff MS, et al. National Osteoporosis Foundation. Clinician's Guide to Prevention and Treatment of Osteoporosis. Osteoporos Int 2014;25(10):2359–2381
2 Burge R, Dawson-Hughes B, Solomon DH, Wong JB, King A, Tosteson A. Incidence and economic burden of osteoporosis-related fractures in the United States, 2005-2025. J Bone Miner Res 2007;22(03):465–475

3 Rozell JC, Hasenauer M, Donegan DJ, Neuman M. Recent advances in the treatment of hip fractures in the elderly. F1000 Res 2016;5: F1000
4 Holley K, Zelken J, Padgett D, Chimento G, Yun A, Buly R. Periprosthetic fractures of the femur after hip arthroplasty: an analysis of 99 patients. HSS J 2007;3(02):190–197
5 Onche II, Osagie OE, INuhu S. Removal of orthopaedic implants: indications, outcome and economic implications. J West Afr Coll Surg 2011;1(01):101–112
6 Hernandez AJ, Fávaro E, Laraya MH, Zumiotti AV. Fratura espontânea do colo do fêmur após retirada de PFN. Acta Ortop Bras 2009;17(03):187–189
7 Kovar FM, Strasser E, Jaindl M, Endler G, Oberleitner G. Complications following implant removal in patients with proximal femur fractures - an observational study over 16 years. Orthop Traumatol Surg Res 2015;101(07):785–789
8 Eberle S, Wutte C, Bauer C, von Oldenburg G, Augat P. Should extramedullary fixations for hip fractures be removed after bone union? Clin Biomech (Bristol, Avon) 2011;26(04):410–414
9 Yang JH, Jung TG, Honnurappa AR, et al. The Analysis of Biomechanical Properties of Proximal Femur after Implant Removal. Appl Bionics Biomech 2016;2016:4987831
10 Cristofolini L, Viceconti M, Cappello A, Toni A. Mechanical validation of whole bone composite femur models. J Biomech 1996;29 (04):525–535
11 Parkkari J, Kannus P, Palvanen M, et al. Majority of hip fractures occur as a result of a fall and impact on the greater trochanter of the femur: a prospective controlled hip fracture study with 206 consecutive patients. Calcif Tissue Int 1999;65(03):183–187
12 Taylor PR, Hepple S, Stanley D. Combination subcapital and intertrochanteric fractures of the femoral neck. Injury 1996;27 (01):68–71
13 Rosson J, Murphy W, Tonge C, Shearer J. Healing of residual screw holes after plate removal. Injury 1991;22(05):383–384
14 Buciuto R, Hammer R, Herder A. Spontaneous subcapital femoral neck fracture after healed trochanteric fracture. Clin Orthop Relat Res 1997;(342):156–163
15 Paiva LM, Macedo Neto SL, Souto DRM, Ferreira GNB, Costa HID, Freitas A. Static bending test after proximal femoral nail (PFN) removal - *in vitro* analysis. Rev Bras Ortop 2017;52 (Suppl 1):52–56
16 Freitas A, Breta JB, Júnior J, et al. Biomechanical Test Following Removal of a Dynamic Hip Screw: In Vitro Analysis. Cureus 2018; 10(12):e3680

Tips for Arthroscopic Anterior Cruciate Reconstruction without the Tourniquet*

Dicas para reconstrução artroscópica do cruzado anterior sem o torniquete

Iberê Pereira Datti[1]

[1] Knee Surgery Group, Clínica de Ortopedia e Traumatologia, Hospital do Servidor Público Municipal, Aclimação, São Paulo, SP, Brazil

Address for correspondence Iberê Pereira Datti, MD, Hospital do Servidor Público Municipal, Rua Castro Alves 60, Aclimação, São Paulo, SP, 01532-000, Brazil (e-mail: iberedatti@hotmail.com).

Rev Bras Ortop 2021;56(2):256–257.

Abstract

The arthroscopic reconstruction of the anterior cruciate ligament is a common surgery performed by the orthopedic surgeons willing to restore the knee stability of physically active patients. Despite the fact that it is usually an uneventful procedure, surgeons must always look for better post-operative results; in this scenario, the arthroscopic reconstruction of the anterior cruciate ligament without a tourniquet is a promising alternative. The aim of the present paper is to share with other orthopedic surgeons around the world our experience with this procedure and some technical tips that may be helpful.

Keywords

- anterior cruciate ligament reconstruction
- tourniquets
- anterior cruciate ligament injuries

Resumo

A reconstrução artroscópica do ligamento cruzado anterior é uma cirurgia comum realizada pelos cirurgiões ortopédicos dispostos a restaurar a estabilidade do joelho de pacientes fisicamente ativos. Apesar de ser geralmente um procedimento sem intercorrências, os cirurgiões devem sempre procurar melhores resultados pós-operatórios; neste cenário a reconstrução artroscópica do ligamento anterior sem torniquete é uma alternativa promissora. O objetivo deste artigo é compartilhar com outros cirurgiões ortopédicos ao redor do mundo nossa experiência com este procedimento e algumas dicas técnicas que podem ser úteis.

Palavras-chave

- reconstrução do ligamento cruzado anterior
- torniquetes
- lesões do ligamento cruzado anterior

Introduction

The arthroscopic reconstruction of the anterior cruciate ligament (ARACL) is one of the most performed orthopedic surgeries. In the Unites States, the incidence of ARACL is estimated to be over 130 thousand,[1] and it may reache over than 400 thousand worldwide.

The main goals of the ARACL are to restore knee stability and enable patients to return without restrictions to sports and daily life activities. Reaching these goals with diminished iatrogenic complications should be an effort made by all orthopedic surgeons.

* *Work performed at Hospital do Servidor Público Municipal, Aclimação, São Paulo, SP, Brazil.*

received
August 14, 2020
accepted
September 17, 2020

DOI https://doi.org/10.1055/s-0040-1722583.
ISSN 0102-3616.

Thieme Revinter Publicações Ltda., Rua do Matoso 170, Rio de Janeiro, RJ, CEP 20270-135, Brazil

Recently, ARACL without a tourniquet became an emerging trend worldwide, since the operative time does not seem to increase,[2,3] and the patients seem to fare better in the early postoperative weeks.[4,5] The supposed benefits of the reconstruction without a tourniquet are an earlier recovery of quadriceps strength, smaller thigh girth atrophy,[4] decreased blood loss,[2] smaller postoperative pain,[6] and fewer electromyographic effects.[5] The use of the tourniquet was also associated to postoperative tibial, femoral, and saphenous nerve palsy.[7,8]

In the last few years, due to the logistic difficulties in having a good working tourniquet in a public hospital in a developing country, our team performed a few ARACLs without tourniquets. Our anecdotal experience is similar to that of some other groups: patients subjected to an ARACL without tourniquet fare better than the ones subjected to the same procedure with a tourniquet.

Despite the potential benefits of the ARACL without a tourniquet, the perioperative period can be tricky due to the intra-articular bleeding, especially after drilling the bone tunnels. Blood makes it almost impossible for the surgeon to identify the structure in the first few minutes, and for those not prepared for this scenario the surgery may become strenuous. It is our intention with the present paper to share some tips acquired with the forced experience we have had, and maybe in the near future better trials comparing ARACL with or without the use of a tourniquet will help the orthopedic surgeon in the clinical decision.

Surgical Technique

Our tips are:

- Start trying with a deflated tourniquet in place, and, whenever you fill uncomfortable, inflate the tourniquet and go ahead.
- When harvesting the hamstring autograft, be sure to cut all of the vincula, and split the semitendinosus and the gracillis from the sartorius fasciae before using the tendon striper.
- Keep away from the Hoffa fat-pad as much as possible. The anterolateral portal should be made high and tight, the anteromedial portal should be made a bit more medial than usual.
- Be patient. The surgeon must keep calm throughout the first few minutes of bleeding. It will get better.
- Increase the pressure and the flow in the saline pump. If you do not use a pump, place the saline bag as high as possible.
- Cold saline is also a good option to decrease the bleeding
- Endovenous tranexamic acid (1 g) may be helpful.
- Prefer to shave the ligamentum mucosum instead of shaving the Hoffa fat-pad.
- Adrenaline at 1mg for each 1L of saline may be helpful, mainly in the first few minutes. If necessary, 1mg of adrenaline directly in the joint will definitely help.
- Start with the arthroscopic steps that do not require shaving of the synovia: inspection and meniscal tears.
- Avoid unnecessary bone shaving or bone curettage.
- Place both tibial and femoral guide pins in the desired location before drilling the bone tunnels.
- If you chose a femoral outside-in technique, try to not open thee capsule with the scalp.
- If you have chosen a transportal technique, start with the tibial guide pin before flexing the knee to place the femoral guide pin.
- Always start by drilling the femoral tunnel.

Final Considerations

Despite the fact that most surgeons do no0t feel comfortable with the ARACL without a tourniquet, it is a feasible and safe procedure that has potential short-term benefits to the patients. These elementary technical tips, will surely make the surgery easier and the surgeons more confident to no longer use the tourniquet.

Conflict of Interests
The authors have no conflict of interests to declare.

References

1 Mall NA, Chalmers PN, Moric M, et al. Incidence and trends of anterior cruciate ligament reconstruction in the United States. Am J Sports Med 2014;42(10):2363–2370
2 Kuo LT, Yu PA, Chen CL, Hsu WH, Chi CC. Tourniquet use in arthroscopic anterior cruciate ligament reconstruction: a systematic review and meta-analysis of randomised controlled trials. BMC Musculoskelet Disord 2017;18(01):358–358
3 Wu H, Chen LX, Li YL, et al. Tourniquet used in anterior cruciate ligament reconstruction: a system review. Eur J Orthop Surg Traumatol 2014;24(06):999–1003
4 Daniel DM, Lumkong G, Stone ML, Pedowitz RA. Effects of tourniquet use in anterior cruciate ligament reconstruction. Arthroscopy 1995;11(03):307–311
5 Arciero RA, Scoville CR, Hayda RA, Snyder RJ. The effect of tourniquet use in anterior cruciate ligament reconstruction. A prospective, randomized study. Am J Sports Med 1996;24(06): 758–764
6 Reda W, ElGuindy AMF, Zahry G, Faggal MS, Karim MA. Anterior cruciate ligament reconstruction; is a tourniquet necessary? A randomized controlled trial. Knee Surg Sports Traumatol Arthrosc 2016;24(09):2948–2952
7 Guanche CA. Tourniquet-induced tibial nerve palsy complicating anterior cruciate ligament reconstruction. Arthroscopy 1995;11 (05):620–622
8 Kornbluth ID, Freedman MK, Sher L, Frederick RW. Femoral, saphenous nerve palsy after tourniquet use: a case report. Arch Phys Med Rehabil 2003;84(06):909–911

Surgical Treatment of Multiple Osteoporotic Fractures of the Dorsolumbar Spine: Case Report*

Tratamento cirúrgico de fraturas osteoporóticas múltiplas da coluna dorsolombar: Relato de caso

Ricardo Ramalho Marques[1] Diogo Lino Moura[1] Paulo Lourenço[1]

[1] Orthopedics and Traumatology Service, Centro Hospitalar e Universitário de Coimbra, Portugal

Rev Bras Ortop 2021;56(2):258–262.

Address for correspondence Ricardo Ramalho Marques, Serviço de Ortopedia e Traumatologia, Centro Hospitalar e Universitário de Coimbra, Praça Mota Pinto, 3000-075 Coimbra, Portugal (e-mail: rmmarqueso@gmail.com).

Abstract

Osteoporotic vertebral fractures are a common type of fracture and affect a significant number of subjects with osteoporosis. Despite the high fracture risk, the concomitant occurrence of vertebral fractures at non-contiguous levels is very rare. We report the case of a patient with three burst dorsolumbar spine fractures at non-contiguous levels who was treated with percutaneous kyphoplasty and transpedicular posterior fixation. Six months after the surgery, the patient walks autonomously and without pain; in addition, there is no radiological evidence of fracture reduction loss.

Keywords

- osteoporosis
- fractures, bone
- kyphoplasty
- fracture fixation, internal

Resumo

As fraturas vertebrais osteoporóticas são um tipo comum de fratura e afetam um número significativo da população com osteoporose. Apesar do elevado risco de fratura, a ocorrência concomitante de fraturas vertebrais em níveis não contíguos é muito rara. Reportamos o caso de uma paciente com três fraturas explosivas da coluna dorsolombar em níveis não contíguos, tratada com cifoplastia e fixação posterior transpedicular por via percutânea. Seis meses após a cirurgia, a paciente tem marcha autônoma, sem dor, e, radiologicamente, não existem evidências de perda de redução das fraturas.

Palavras-chave

- osteoporose
- fraturas ósseas
- cifoplastia
- fixação de interna de fraturas

Introduction

Compression vertebral fractures classified as AO Spine type A are among the most relevant clinical consequences from osteoporosis, and their incidence in the older population is increasing.[1] They are potential causes for chronic pain, leading to functional limitation and having a significant impact on physical activities, quality of life, and mortality. Fractures can be spontaneous or due to a traumatic event, usually resulting from a compressive mechanism involving the vertebral body. These fractures often involve the middle third of the thoracic spine and the dorsolumbar region.

Although most of these injuries are stable and feasible to conservative treatment based on rest, pain control and immobilizing orthoses, a considerable number of fractures, particularly in the dorsolumbar transition, can result in progressive height loss and increase kyphosis deformity;

* *Study developed at the Orthopedics and Traumatology Department, Centro Hospitalar e Universitário de Coimbra, Portugal.*

received
May 24, 2020
accepted
September 17, 2020
published online
March 22, 2021

DOI https://doi.org/10.1055/s-0040-1721844.
ISSN 0102-3616.

Thieme Revinter Publicações Ltda., Rua do Matoso 170, Rio de Janeiro, RJ, CEP 20270-135, Brazil

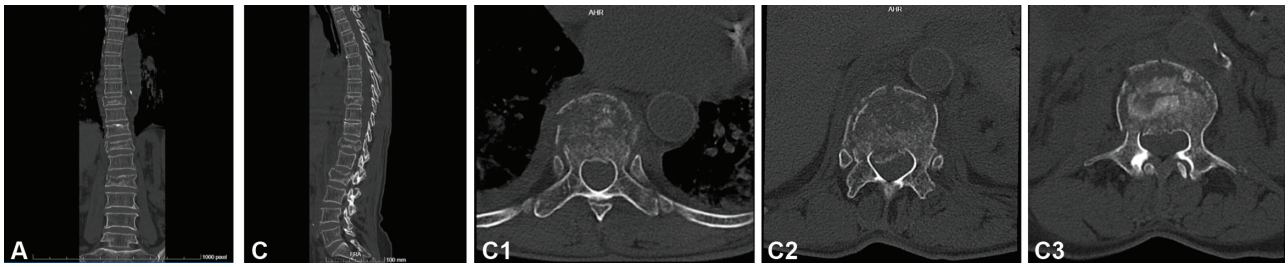

Fig. 1 Coronal (**A**), sagittal (**B**) and axial (**C**) computed tomography scans showing burst fractures at the D9, D12, and L2 levels in a 70-year-old woman resulting in slight posterior wall retropulsion.

others may cause posterior wall rupture, leading to neural compression and neurological deficit. As such, early surgical stabilization is warranted. However, published studies show high rates of complications in osteoporotic patients undergoing surgical procedures such as kyphoplasty and posterior instrumentation, with selected series reporting adjacent vertebral fractures and material failure in about one third of these patients.[2]

Case Description

We report the case of a very active 70-year-old woman with osteoporosis who suffered a fall from her own height at home following a syncope. She immediately presented pain at the dorsolumbar transition. After 3 days of intense, persistent pain, despite anti-inflammatory and analgesic medication, she went to the hospital. She had pain on palpation of the spinous apophysis of the dorsolumbar transition, no muscle strength deficit in the lower limbs and normal osteotendinous reflexes. Fractures of the D9, D12, and L2 vertebral bodies, classified as type A4 according to the AO Spine system, were diagnosed in an osteoporotic context (►**Figure 1**) in a subject with no associated conditions or chronically treated with osteoporosis-predisposing medications. The fractures showed signs of significant crushing of the intrabody bone trabeculae.

The patient underwent surgical treatment 4 days after hospital admission (►**Figure 2**). Kyphoplasty was performed at the D9, D12, and L2 levels using intrabody stents through a transpedicular percutaneous approach with high viscosity polymethylmethacrylate (PMMA) filling. Since the D9 vertebral body could not bear two stents, even in their smallest size (small), this level received a single stent and cement filling. A percutaneous transpedicular posterior D7-D8-D10-D11-L1-L3 vertebrae fixation was performed using bars molded according to the patient's anatomy in thoracic kyphosis and lumbar lordosis (VIPER system, DePuy/Synthes, Warsaw, IN, USA) (►**Figure 3**).

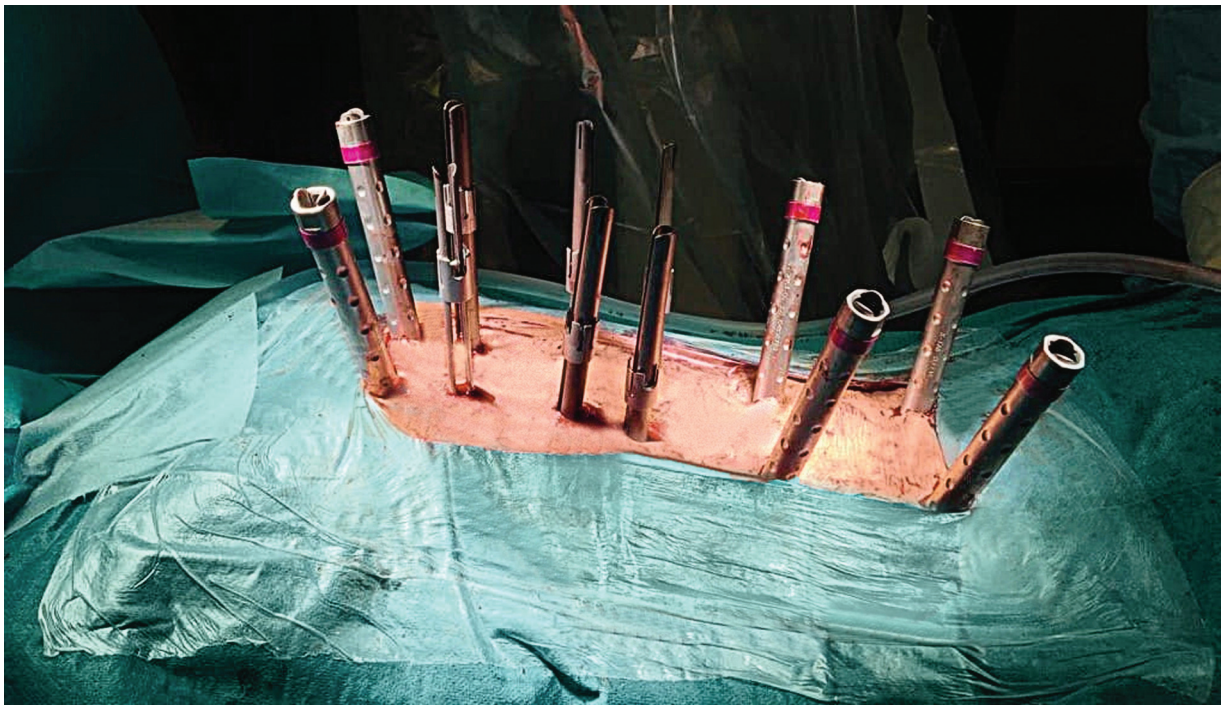

Fig. 2 Percutaneous posterior instrumentation for transpedicular D7, D8, D10, D11, L1, and L3 fixation after D9, D12, and L2 kyphoplasty (**A**).

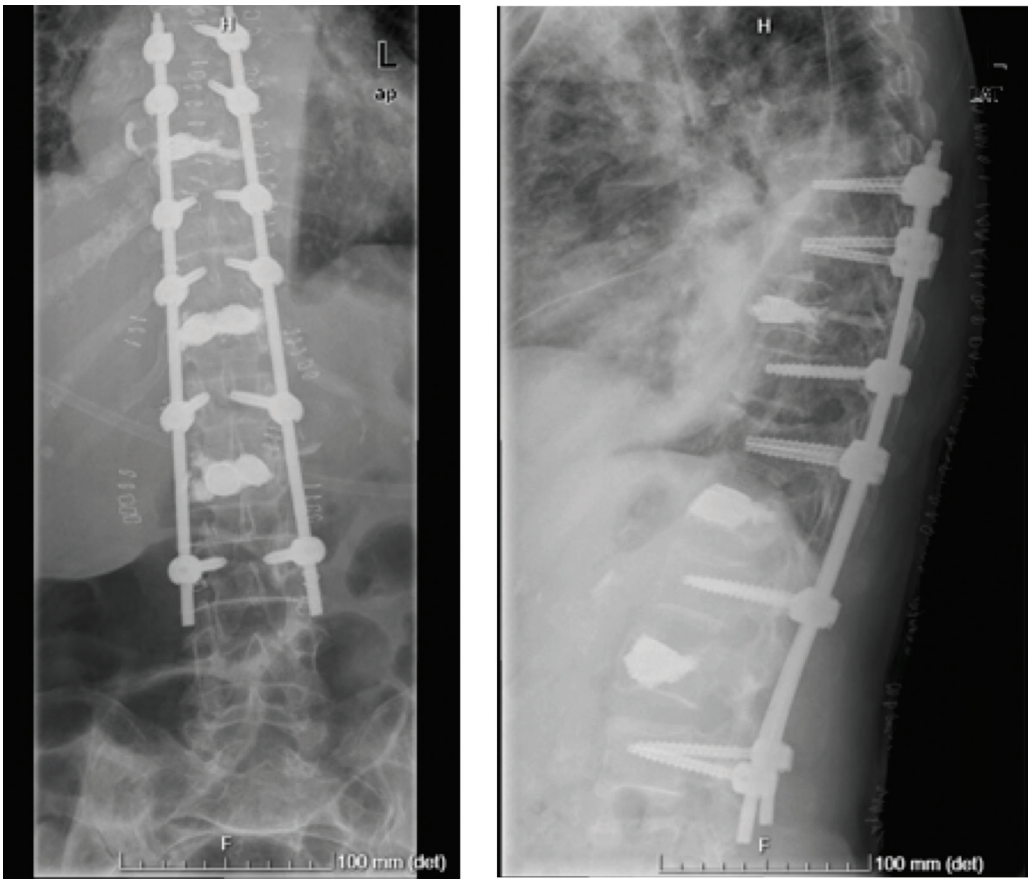

Fig. 3 Postoperative radiograph of posterior transpedicular D7, D8, D10, D11, L1, and L3 fixation following restoration of the height of fractured D9, D12, and L2 vertebrae at kyphoplasty.

The patient could stand up on the first postoperative day and then walked with a dorsolumbar support. Six weeks after the surgery, she could walk alone presenting only residual pain. Anti-osteoporotic treatment started with denosumab, and, 6 months after surgery, the patient walks alone, with no pain complaints or loss of fracture reduction, and with favorable healing (►**Figure 4**).

Discussion

The patient described in the present article presents a rare case of osteoporotic fractures of several non-contiguous levels of the dorsolumbar spine submitted to percutaneous treatment, assuring not only anterior support by kyphoplasty but also posterior tension band support through posterior fixation. This choice is justified by the high risk of progressive kyphosis development. Nevertheless, the instrumentation is considerably extent, and extraction may be considered after fractures consolidation.

The main risks in osteoporotic vertebral fractures include the progressive collapse of the vertebral body up to vertebra plana formation and gradual development of kyphotic deformities.[3] In fact, this sagittal balance disturbance is critical in elderly patients with osteoporosis due to the higher probability of progressive worsening of spinal sagittal changes. As a result, the paravertebral muscle tension increases, thus causing chronic pain, and sagittal imbalance may even lead to new fractures. In addition, a higher number of vertebral fractures will further anteriorly displace the spine's center of gravity.

Kyphoplasty with polymethylmetacrylate (PMMA) application is a well-documented procedure to correct and prevent collapse and deformities, with an important role in restoring harmony and overall sagittal balance of the spine.[4] However, in 10 to 30% of cases, the correction obtained by this type of procedure alone can gradually fail and increase kyphosis.[5] On the other hand, up to 25% of these cases develop fractures at an adjacent level, often the upper osteoporotic vertebra.[3]

In our case, the presence of three concomitant burst fractures in D9, D12, and L2, with a high risk of posttraumatic collapse, increased considerably the risk of complications of the posterior fixation alone. The strength of each posterior instrumentation fixation point is lower at the osteoporotic spine since the pullout force, the cut-out torque and the maximum insertion torque are directly proportional to the bone mineral density.[6] In patients undergoing spinal surgical treatment, osteoporosis has been associated with postinstrumentation vertebral fractures, pseudarthrosis, and secondary material failure.[7] Biomechanical studies have shown that insufficient anterior column support, along with the poor fixation provided by bones with low mineral

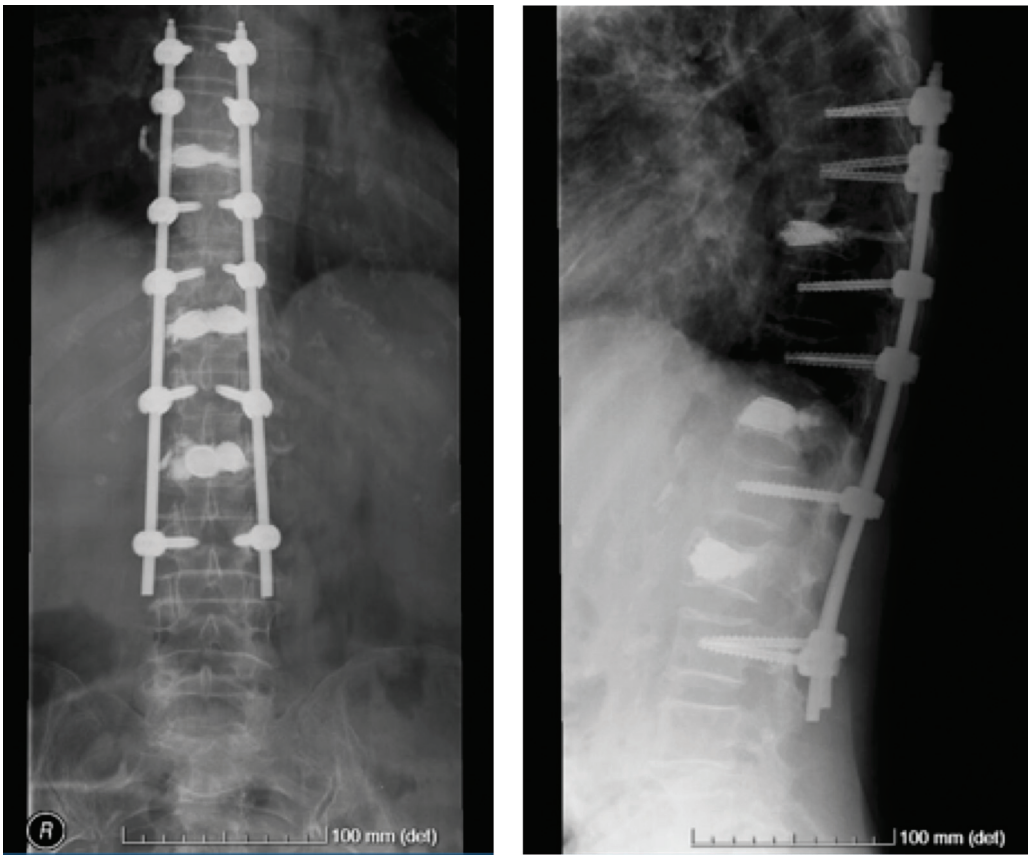

Fig. 4 Radiological follow-up 6 months after the surgery.

density, may account for these unsuccessful outcomes.[8] Furthermore, the cavity formed at the fractured vertebral body after distraction delays consolidation and favors reduction loss.[9] Thus, we decided to combine a kyphoplasty with stent and percutaneous posterior fixation. Stents were selected because they provide greater vertebral body rigidity and reduce the risk of cement overflow, since they create an intrabody cavity surrounded by the implant. In compressive fractures, this hybrid technique was associated with less pain during the immediate postoperative period and spared virtually the whole height of the fractured vertebral body, with a low risk of recurrent kyphosis.[10] Therefore, we believe that it mitigates the risk of anterior collapse due to the lack of anterior column support at the posterior fixation, as well as the risk of fixation material failure and adjacent osteoporotic fractures.

Conflict of Interests

The authors have no conflict of interests to declare.

References

1 Johnell O, Kanis JA. An estimate of the worldwide prevalence and disability associated with osteoporotic fractures. Osteoporos Int 2006;17(12):1726–1733

2 Goldstein CL, Brodke DS, Choma TJ. Surgical Management of Spinal Conditions in the Elderly Osteoporotic Spine. Neurosurgery 2015;77(Suppl 4):S98–S107

3 Frankel BM, Monroe T, Wang C. Percutaneous vertebral augmentation: an elevation in adjacent-level fracture risk in kyphoplasty as compared with vertebroplasty. Spine J 2007;7(05): 575–582

4 Papanastassiou ID, Phillips FM, Van Meirhaeghe J, et al. Comparing effects of kyphoplasty, vertebroplasty, and non-surgical management in a systematic review of randomized and non-randomized controlled studies. Eur Spine J 2012;21(09): 1826–1843

5 Komemushi A, Tanigawa N, Kariya S, et al. Percutaneous vertebroplasty for osteoporotic compression fracture: multivariate study of predictors of new vertebral body fracture. Cardiovasc Intervent Radiol 2006;29(04):580–585

6 Paxinos O, Tsitsopoulos PP, Zindrick MR, et al. Evaluation of pullout strength and failure mechanism of posterior instrumentation in normal and osteopenic thoracic vertebrae. J Neurosurg Spine 2010;13(04):469–476

7 DeWald CJ, Stanley T. Instrumentation-related complications of multilevel fusions for adult spinal deformity patients over age 65: surgical considerations and treatment options in patients with poor bone quality. Spine (Phila Pa 1976) 2006;31(19 suppl): S144–S151

8 Norton RP, Milne EL, Kaimrajh DN, Eismont FJ, Latta LL, Williams SK. Biomechanical analysis of four- versus six-screw constructs for short-segment pedicle screw and rod instrumentation of unstable thoracolumbar fractures. Spine J 2014;14(08):1734–1739

9 Knop C, Fabian HF, Bastian L, Blauth M. Late results of thoracolumbar fractures after posterior instrumentation and transpedicular bone grafting. Spine 2001;26(01):88–99

10 Zhang J, Liu H, Liu H, et al. Intermediate screws or kyphoplasty: Which method of posterior short-segment fixation is better for treating single-level thoracolumbar burst fractures? Eur Spine J 2019;28(03):502–510

A Simple Bone Cyst of the Acromion: Case Report*

Cisto ósseo simples do acrômio: Relato de caso

Recep Öztürk[1] Emin Kürşat Bulut[1] Ömer Faruk Ateş[2] Bedii Şafak Güngör[1]

[1] Department of Orthopedics and Traumatology, Dr. Abdurrahman Yurtaslan Ankara Oncology Training and Research Hospital, Ankara, Turkey
[2] Department of Radiology, Sakarya University, Training and Research Hospital, Sakarya, Turkey

Address for correspondence Recep Öztürk, MD, Dr. Abdurrahman Yurtaslan Ankara Oncology Training and Research Hospital, Demetevler Mahallesi, Vatan Cad., Yenimahalle, Ankara, 06200, Turkey (e-mail: ozturk_recep@windowslive.com).

Rev Bras Ortop 2021;56(2):263–267.

Abstract

Simple bone cysts rarely occur in the scapula, and, to our knowledge, they have not been reported in the acromion. In the present report, we present the case of a 24-year-old female patient who was successfully treated by curettage and grafting using xenografting. No recurrence findings were observed during the follow-up six months postoperatively, the patient had recovered full range of motion, and she was able to perform all routine activities satisfactorily.

Keywords
- bone cysts
- acromion
- scapula

Resumo

Cistos ósseos simples são raros na escápula, e, pelo que sabemos, não foram relatados no acrômio. Aqui, apresentamos uma paciente do sexo feminino, de 24 anos, submetida com sucesso ao tratamento composto por curetagem e xenoenxerto. Não foram observados achados de recidiva no acompanhamento pós-operatório de seis meses, quando a paciente apresentou amplitude total de movimento e foi capaz de realizar todas as atividades rotineiras de maneira satisfatória.

Palavras-chave
- cistos ósseos
- acrômio
- escápula

Introduction

Unilateral bone cysts (UBCs), which are also known as simple bone cyts, are benign lesions filled with fluid that involve the metaphyses of long bones.[1] On plain radiographs, they are well-contoured lytic lesions with a cyst wall covered by a fibrous membrane containing some yellow serous fluid.[2] They are lesions of unknown etiology, which are most frequently observed in the age range of 5 to 15.[3] Even though they have been reported in all bones, these cysts are quite common in the proximal humerus and proximal femur.[4–6]

The roentgenographic differential diagnosis of a cystic lesion in the scapula of an adolescent includes fibrous dysplasia, aneurysmal bone cyst, eosinophilic granuloma, osteoblastoma ,or an infectious process.[7,8]

There is no standard approach for the treatment. Apart from follow-up without treatment, injection of local corticosteroids, multiple drill holes, and curetage plus grafting, many other treatment modalities have been described.[6,7]

Herein, we report a case of simple bone cyst located in the acromion. We could not find in the literature any other case of symptomatic single radiolucent lesion located in the

* *Study conducted at the Department of Orthopedics, Dr. Abdurrahman Yurtaslan Ankara Oncology Training And Research Hospital, Ankara, Turkey.*

received
March 19, 2020
accepted
June 1, 2020
published online
September 22, 2020

DOI https://doi.org/10.1055/s-0040-1715516.
ISSN 0102-3616.

Thieme Revinter Publicações Ltda., Rua do Matoso 170, Rio de Janeiro, RJ, CEP 20270-135, Brazil

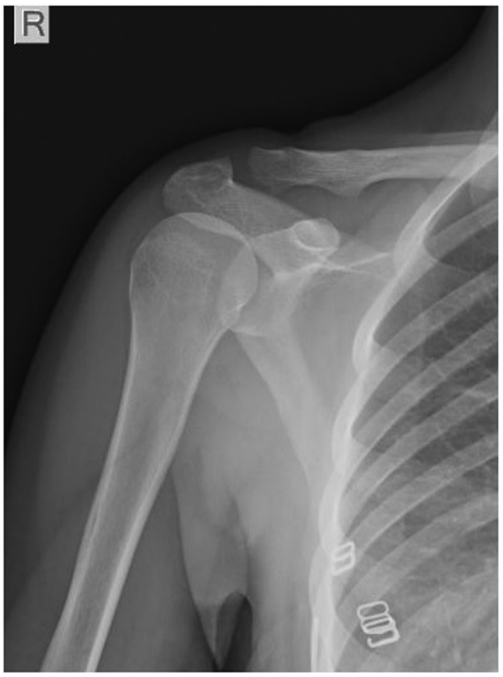

Fig. 1 Anteroposterior (AP) radiograph of the right shoulder showing a well-countered, minimally sclerotic lytic lesion, with no expansion in the acromion.

acromion. Our patient was successfully treated by curetage and grafting.

Case Report

A 24 year-old female patient presented to our orthopedic outpatient clinic with pain on the lateral side of the right shoulder. The patient reported that she had been having occasional pain for about one year, but the pain had exacerbated recently. She had no history of trauma or overuse. There was no systemic disease. On the physical examination, there was no edema or hyperemia on the lateral side of shoulder. Her pain was associated with limitation in the movement of the right shoulder. There was pain on palpation on the anterior acromion. The patient was asked if data concerning the case could be submitted for publication, and she consented.

The simple two-plane radiograph of the right shoulder revealed a well-contoured lytic benign lesion, with minimal sclerotic margins and narrow transition zone, which did not lead to expansion in the acromion. Suppressed T2-weighted magnetic resonance images showed a non-supressed homogenous, hypointense cystic lesion, with the same intensity as the fluid; on the T1-weighted series, after the injection

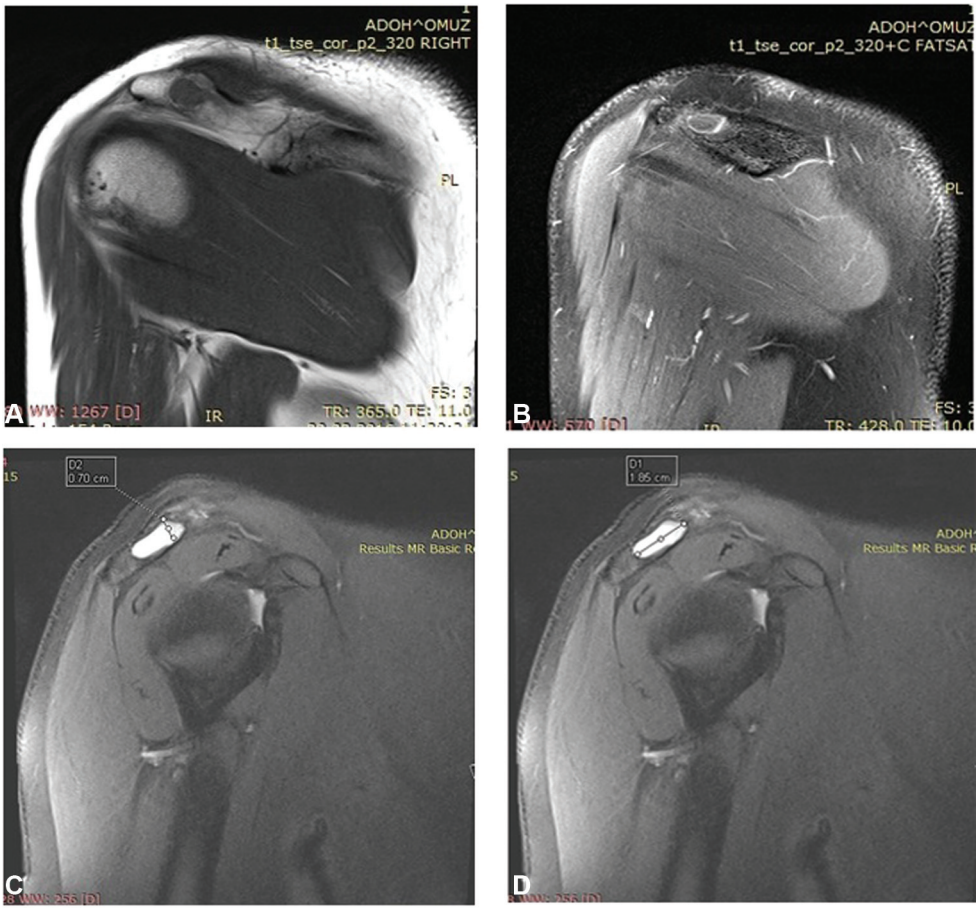

Fig. 2 (**A**) Coronal T1-weighted preoperative magnetic resonance imaging (MRI) scan of the right shoulder showing a well-countered homogenous hypointense lesion with no expansion in the acromion. (**B**) Coronal postcontrast T1-weighted preoperative MRI with peripheral thin contrast, but absence of the material in the center of the lesion. (**C-D**) Coronal lipid-suppressed T2-weighted preoperative MRI showing a homogenous hyperintense well-countered lesion with a thin sclerotic wall in the acromion.

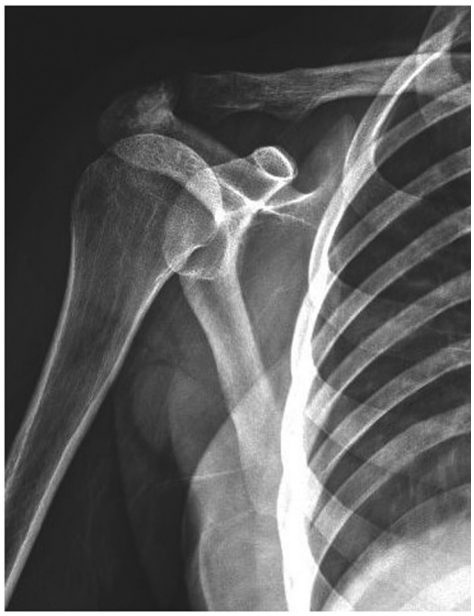

Fig. 3 Right-shoulder AP radiograph showing, the postoperative changes in the acromion, absence of a lytic lesion, and dense areas with rough contour related to the graft material.

of a contrast agent, there was a slight contrast enhancement in the wall, but no enhancement in the central region or the septa (►**Figures 1** and **2**).

An incisional biopsy was planned. On the intraoperative evaluation, a frozen section was obtained, since the macroscopic findings suggested a benign cystic lesion, as did the radiographs, which indicated a simple bone cyst; therefore, curettage of the cavity with high-speed burring of the wall was performed in the same session. The lesion was grafted with a 10-cm^3 xenograft (►**Figure 3**). The curretted material sent for histopathological examination confirmed the diagnosis of simple bone cyst.

The exercises of active range of motion of the shoulder were started three weeks postoperatively, and the patient recovered the full range of motion without pain. There was no recurrence in the magnetic resonance imaging scans and on the simple radiograph six months postoperatively (►**Figure 4**). During the follow-up at six months, there were no additional complications or pain. The patient was performing all routine activities satisfactorily (►**Figure 5**).

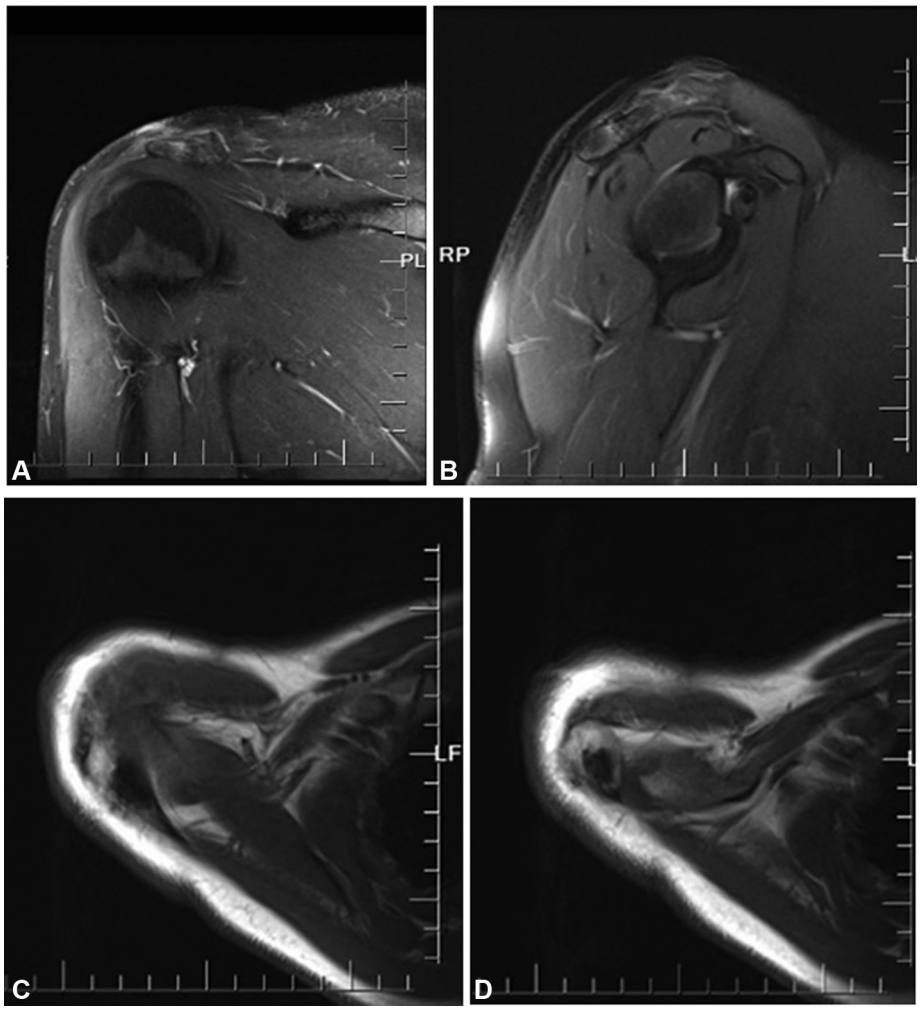

Fig. 4 (**A-D**) Magnetic resonance imaging scans of the 6th postoperative month: axial T1-weighted images showing an area with partial absence of a heterogenous hypointense signal related to the postoperative changes in the acromion. Coronal and sagittal lipid-suppressed T2-weighted images showing the postoperative granulation tissue, sclerosis, and a heterogenous hyperintense image with rough countour, secondary to the surgical graft material.

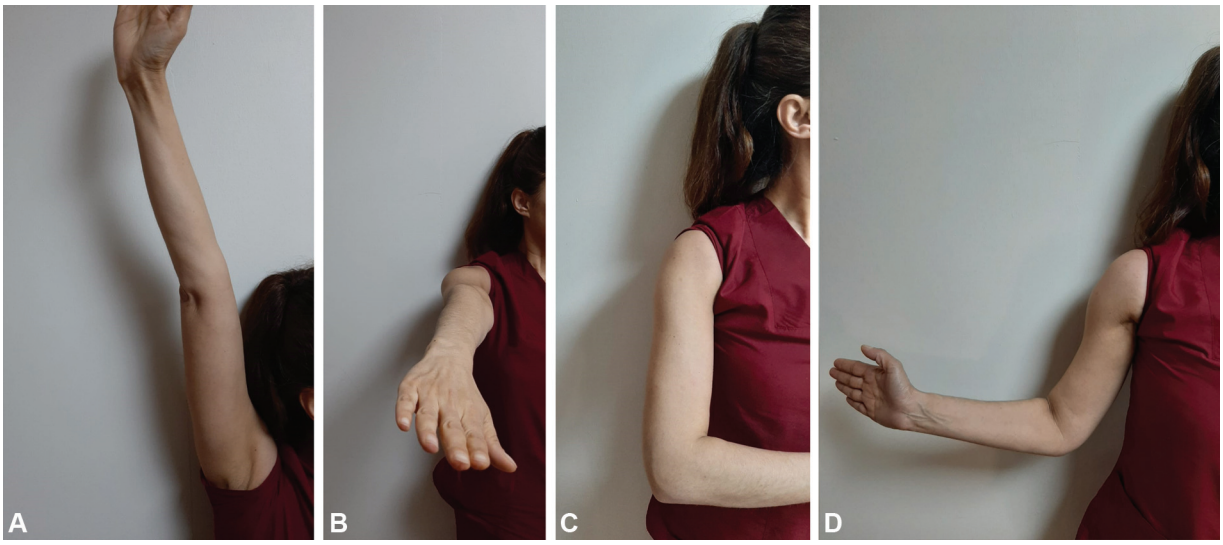

Fig. 5 (A-D) Clinical photographs showing the full range of motion of the shoulder at the final follow-up.

Discussion

Scapula tumors are rare and are frequently malignant. The benign and malignant lesions that may ocur in the scapula are frequently observed during childhood.[7,9] Males are affected twice as often as females.[1] Unlike all of these symptoms, the case herein presented, a benign tumour in an adult woman, is rare.

Simple bone cysts were described for the first time by Virchow in 1876.[10] Most simple bone cysts are frequently observed during childhood, and they are defined as a developmental/reactive lesions. The etiology is unknown.[3,6]

Simple bone cysts usually involve the metaphysis of long bones, and have a predilection for the proximal humerus and proximal femur. In older patients, the ilium and the calcaneus are also regions where cysts are frequently observed.[6] The involvement of the scapula is infrequent. The lesion in the present case was located in the acromion.

The patients usually present with pathological fractures or mild pain.[11]

According to other case reports in the literature,[12–15] benign and malignant tumours in the acromion are rare. Other cases have been reported in the past, such as cases of aneurysmal bone cyst, giant-cell tumors, chondroblastoma, and multiple myeloma.[12–15]

There is stil no consensus on whether there is a need for treatment (because there may be spontanous resolution) and on which treatment is the most appropriate for cases of simple bone cyst.[11] The main goal of the treatment is to prevent pathological fracture, provide cyst eradication, and relieve the pain. Local corticosteroid injections, autologous bone-marrow transplantation or demineralized bone-matrix injections, cortical-cancellous bone auto- and allografts, and many other procedures have been described in the literature.[6,7,10]

There are no defined principles on how to treat simple bone cysts, and each treatment method has its own specific success rates and complications.[11] The indications for surgery in the present case were the radiographic findings implying cystic lesion in the acromion and the clinical history related to the lesion.

To the best of our knowledge, no other unicameral bone cyst in the acromion has been reported in the literature.

Conflict of Interests

The authors have no conflict of interests to declare.

References

1 Campanacci M, Enneking WF. Bone and soft tissue tumors. 2nd ed. New York: Springer Verlag; 1999:791–811
2 Tey IK, Mahadev A, Lim KB, Lee EH, Nathan SS. Active unicameral bone cysts in the upper limb are at greater risk of fracture. J Orthop Surg (Hong Kong) 2009;17(02):157–160
3 Yilmaz G, Aksoy MC, Alanay A, Yazici M, Alpaslan AM. [Treatment of simple bone cysts with methylprednisolone acetate in children]. Acta Orthop Traumatol Turc 2005;39(05):411–415
4 Öztürk R, Arıkan ŞM, Bulut EK, Kekeç AF, Çelebi F, Güngör BŞ. Distribution and evaluation of bone and soft tissue tumors operated in a tertiary care center. Acta Orthop Traumatol Turc 2019;53(03):189–194
5 Elmadağ M, Ceylan HH, Erdil M, Bilsel K. Apophyseal avulsion fracture of the anterior inferior iliac spine due to a simple bone cyst. Acta Orthop Traumatol Turc 2015;49(02):213–216
6 Singh S, Dhammi IK, Arora A, Kumar S. Unusually large solitary unicameral bone cyst: case report. J Orthop Sci 2003;8(04):599–601
7 Jain SK, Nathan SS. An unusual presentation of a simple bone cyst in the scapula. Musculoskelet Surg 2012;96(03):227–231
8 Atalay İB, Yapar A, Öztürk R. Primary aneurysmal bone cyst of the scapula in adult patient: two case reports and a review of the literature. [published online ahead of print, 2019 Dec 20]Arch Orthop Trauma Surg 2019. Doi: 10.1007/s00402-019-03327-z
9 Öztürk R, Arıkan ŞM, Toğral G, Güngör BŞ. Malignant tumors of the shoulder girdle: Surgical and functional outcomes. J Orthop Surg

(Hong Kong) 2019;27(02):2309499019838355. Doi: 10.1177/2309499019838355
10 Erol B, Onay T, Çalışkan E, Aydemir AN, Topkar OM. Treatment of pathological fractures due to simple bone cysts by extended curettage grafting and intramedullary decompression. Acta Orthop Traumatol Turc 2015;49(03):288–296
11 Gündeş H, Şahin M, Alici T. Unicameral bone cyst of the lunate in an adult: case report. J Orthop Surg Res 2010;5(05):79
12 Mavrogenis AF, Rossi G, Rimondi E, Ruggieri P. Aneurysmal bone cyst of the acromion treated by selective arterial embolization. J Pediatr Orthop B 2011;20(05):354–358
13 Sherwani RK, Zaheer S, Sabir AB, Goel S. Giant cell tumor along with secondary aneurysmal bone cyst of scapula: A rare presentation. Int J Shoulder Surg 2008;2(03):59–61
14 Arıkan M, Toğral G, Yıldırım A, Irkkan Ç. A rare case of chondroblastoma of the acromion. Acta Orthop Traumatol Turc 2016;50(06):691–693
15 Mahajan A, John B, John MJ. Acromion tumour as the primary presentation of multiple myeloma: case report. Int J Basic Appl Sci 2014;3(02):134–136

Septic Arthritis of the Pubic Symphysis in Adult: A Case Report*

Artrite séptica da sínfise pubiana em adultos: Relato de caso

Pedro José Labronici[1] Augusto Khede Tavares[2] Luiz Henrique Penteado Silva[3] Robinson Esteves Santos Pires[4] Vincenzo Giordano[5] Fabrício Bolpato Loures[6]

[1] Orthopedics and Traumatology Service, Hospital Santa Teresa, Petrópolis, RJ, Brazil
[2] Orthopedics and Traumatology Service, Hospital Santa Teresa, Petrópolis, RJ, Brazil
[3] Trauma Service, Hospital do Trauma e Hospital Escola São Vicente de Paulo, Passo Fundo, RS, Brazil
[4] Universidade Federal de Minas Gerais, Belo Horizonte, MG, Brazil
[5] Orthopedics and Traumatology Service, Hospital Municipal Miguel Couto, Rio de Janeiro, RJ, Brazil
[6] Universidade Estadual do Rio de Janeiro, Rio de Janeiro, RJ, Brazil

Address for correspondence Pedro José Labronici, Av. Roberto Silveira, 187, apto 601, Petrópolis, RJ, 25685-040, Brazil (e-mail: plabronici@globo.com).

Rev Bras Ortop 2021;56(2):268–270.

Abstract

Septic arthritis of the pubic symphysis is a rare condition. Risk factors include trauma, low-grade infection, urological or gynecological procedures, malignant tumors of the pelvis, sports, and intravenous drug abuse. This report describes a case of septic arthritis of the pubic symphysis in a 23-year-old male patient with no history of pelvic surgery, previous infections, or intense physical activity. Arthritis was diagnosed by blood culture positive for *Enterococcus* spp. and yeasts, and the patient was treated with antibiotics. This case emphasizes the importance of complementary exams to aid the treatment of septic arthritis of the pubic symphysis and shows that an invasive procedure, such as pubic symphysis puncture biopsy, may not be required.

Keywords
- septic arthritis
- osteitis
- pubic symphysis

Resumo

A artrite séptica da sínfise púbica é uma condição rara. Os fatores de risco são trauma, infecção de baixo grau, procedimentos urológicos ou ginecológicos, tumores malignos da pelve, prática de esportes e uso de drogas intravenosas. O presente relato descreve um caso de artrite séptica da sínfise púbica em um paciente do sexo masculino, de 23 anos, sem história de cirurgias pélvicas, infecções prévias ou atividade física intensa. A artrite foi diagnosticada pela hemocultura que revelou crescimento de *Enterococcus sp* + leveduras, e o paciente foi tratado com antibioticoterapia. Este caso enfatiza a importância de exames complementares no auxílio do tratamento da artrite séptica da sínfise púbica, e demonstra que procedimentos invasivos, tais como a punção da sínfise púbica, podem não ser necessários.

Palavras-chave
- artrite séptica
- osteíte
- sínfise púbica

* *Study developed at the Orthopedics and Traumatology Department, Hospital Santa Teresa, Petrópolis, RJ, Brazil.*

received
May 21, 2020
accepted
September 17, 2020
published online
March 22, 2021

DOI https://doi.org/10.1055/s-0040-1721843.
ISSN 0102-3616.

Thieme Revinter Publicações Ltda., Rua do Matoso 170, Rio de Janeiro, RJ, CEP 20270-135, Brazil

Introduction

Septic arthritis of the pubic symphysis is a rare condition, usually caused by *Staphylococcus aureus* and *Pseudomonas aeruginosa*.[1–5] Infection may result from a secondary embolization due to bacteremia or contiguous spread of a soft-tissue infection. Risk factors include trauma, low-grade infection, urological and gynecological procedures, malignant tumors of the pelvis, practice of sports, and intravenous drug abuse.[5] Clinically, it presents as fever, abdominal, pelvic or groin pain, which increases when standing up and walking, pain at hip movement, and painful claudication.[2–4] The difficulty in suspecting pubic conditions, due to their rarity and atypical presentations, can delay diagnosis and therapy.[2,4] The present report aims to increase awareness of a rare infection focus at the pubic symphysis, assisting in its differential diagnosis from abdominal pain, thus enabling early treatment.

Case Report

A healthy, 23-year-old male patient, who worked as a teacher, was admitted to the emergency department on June 10, 2019, complaining of bilateral hip pain starting 11 days before. The pain started on the left hip, and the patient had reported fever for 8 days. He denied trauma, high-demand physical activities, and previous infections.

On physical examination, the patient was aware, oriented, with low-grade fever (38.8 C), tachycardic (108 beats per minute), and with no inflammatory signs at an ectoscopic examination of the pelvis and lower limbs; he complained of diffuse pain during bilateral palpation from the pubic symphysis to the anterolateral region of hip, which was accentuated on the left side. The patient also presented reduced muscle strength (M2) for hip flexion and leg extension, but no sensory changes or abnormalities in other muscle groups.

On June 03, 2019, a magnetic resonance image (MRI) of the patient's left hip showed signs of insertional peritendinitis of the gluteus minimus, but no changes at the pubic symphysis joint. Laboratorial tests requested at admission showed 18,100 white blood cells (WBC)/mm^3 with 18% of band neutrophils, an erythrocyte sedimentation rate (ESR) of 82 mm at the first hour, and a C-reactive protein (CRP) level of 162 mg/dL. On June 10, 2019, when the patient was admitted, a chest x-ray, blood cultures with four samples, a urine sedimentoscopy, and a urine culture were requested. A new MRI of the pelvis was consistent with septic arthritis of the pubic symphysis (►**Figure 1**). Treatment was instituted on the following day with intravenous ciprofloxacin, 400 mg, every 12 hours, and vancomycin. Blood cultures were positive for *Enterococcus* spp. and yeasts. Chest x-ray and urine cultures were negative.

On June 17, 2019, the patient presented significant improvement, including limb strength recovery, pain relief, and laboratory markers reduction; as such, we decided to continue the intravenous antibiotic therapy with ciprofloxacin and vancomycin. He improved up to the total remission of complaints on July 4, 2019 (►**Table 1**). After 4 weeks of intravenous antibiotic therapy, the patient was discharged with a prescription of oral ciprofloxacin (500 mg every 12 hours) for another 60 days and outpatient follow-up.

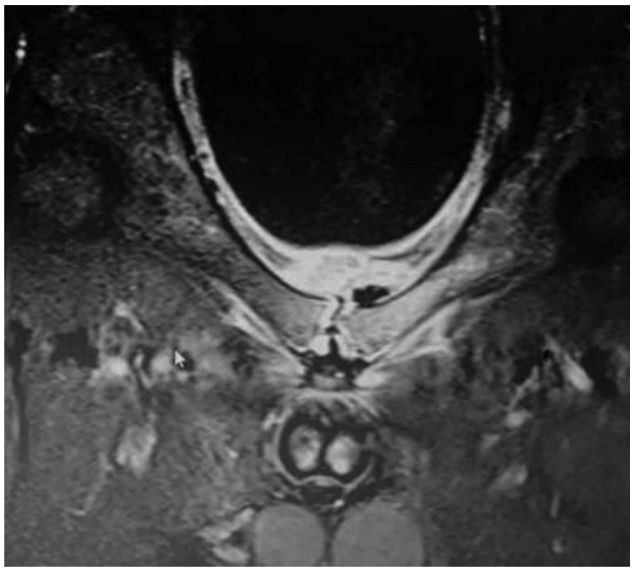

Fig. 1 Magnetic resonance imaging of the pelvis in short inversion time inversion recovery showing a fluid collection at the pubic symphysis region.

Discussion

The case report presently discussed demonstrates the importance of complementary exams to diagnose septic arthritis of the pubic symphysis with no need for invasive procedures.

Septic arthritis of the pubic symphysis is very different from osteitis pubis. Osteitis pubis is characterized by pelvic pain, broad-based gait, and bone lesion on the pubic symphysis edges. It is a self-limiting inflammation secondary to trauma, pelvic surgery, childbirth, or stress (often in athletes). Septic arthritis of the pubic symphysis must be suspected in patients with acute onset of pelvic pain, fever, and systemic symptoms.[4] Clinically, these symptoms include abdominal, pelvic, or inguinal pain, which increases when standing up or walking and can result in lameness. In addition, this diagnosis must be considered when testicular, perineal, or thigh pain is noted.[2–4] Although septic arthritis and inflammatory arthritis of the pubic symphysis present similar clinical presentations, the former is more severe and accompanied by pain and fever.[2–4]

Although conventional radiography takes 2 to 4 weeks to show signs of pubic symphysis joint impairment, it can help to exclude other causes.[1] The first signs of septic arthritis with pubic osteomyelitis are an unilateral injury with bone sequestration or stress fracture and eventual bone destruction.[1,2,4] Wilmes et al.[5] assessed the extent of pelvic abnormalities (with joint contrast injections) and performed symphysis aspiration guided by computed tomography (CT) for material analysis. Several authors recommend joint aspiration guided by ultrasonography or CT to diagnose an infection.[2–4] However, this invasive procedure may be prevented by positive blood cultures.[3] Magnetic resonance imaging is the gold-standard imaging method due to its excellent sensitivity (with specificity comparable to CT). Magnetic resonance imaging sequences

Table 1 Patient evolution per laboratorial findings

	June 10	June 11	June 12	June 17	June 24	July 03	July 05
White blood cells *(/mm^3)*	18,100	11,900	15,450	9,010	12,260	5,380	4,690
Band neutrophils *(%)*	18	7	8	1	2	5	2
C-reactive protein *(mg/dL)*	162.8	155.1		18.4	6.5		1.9
Erythrocyte sedimentation rate *(mm/1st hour)*	82	62	90	88	71		25

include fat suppression (fat sat, short inversion time inversion recovery) for improved visualization of the inflamed edges, aiding the diagnosis.[1]

The literature states that biopsy and culture are required to differentiate septic and inflammatory arthritis.[6,7] However, when blood culture is positive, antibiotic therapy can be started, and laboratory findings (complete blood count, CRP, ESR) will reveal clinical improvement. Ghislain et al.[8] reported that no randomized, controlled studies evaluated antibiotic guidelines for the treatment of septic arthritis of the pubic symphysis when puncture biopsy is negative. In the patient presently discussed, blood cultures were positive for *Enterococcus* spp. and yeasts, and we decided for an antibiotic therapy with ciprofloxacin and vancomycin with no pubic symphysis puncture biopsy for diagnosis confirmation.

The most common infectious agent is *S. aureus*, followed by *P. aeruginosa, Escherichia coli,* anaerobic bacteria, and *Salmonella, Streptococcus* and *Brucella* species.[8] Initial treatment with intravenous antibiotics must be followed by oral treatment for at least 4 weeks, and follow-up must continue until ESR normalization (which often takes 3 months). Pubic symphysis surgical debridement and curettage is indicated in patients with serious complications, including pelvic diastasis due to bone necrosis, bladder perforation, pelvic instability, and severe pain not responding to antibiotics.[9,10]

Septic arthritis of the pubic symphysis is rare and, depending on the results of complementary tests, such as positive blood culture, MRI, and inflammatory markers, patients can be treated conservatively with no need for an invasive procedure.

Conflict of Interests
The authors declare no conflict of interests.

References

1 Jarlaud T, Railhac JJ, Sans N, De Paulis F. Symphyse pubienne normale et pathologique: apport de l'imagerie. J Radiol 2001;82(3 Pt 2):425–436, quiz 437–438
2 Knoeller SM, Uhl M, Herget GW. Osteitis or osteomyelitis of the pubis? A diagnostic and therapeutic challenge: report of 9 cases and review of the literature. Acta Orthop Belg 2006;72(05): 541–548
3 Charles P, Ackermann F, Brousse C, Piette AM, Blétry O, Kahn JE. [Spontaneous streptococcal arthritis of the pubic symphysis]. Rev Med Interne 2011;32(07):e88–e90
4 Ross JJ, Hu LT. Septic arthritis of the pubic symphysis: review of 100 cases. Medicine (Baltimore) 2003;82(05):340–345
5 Wilmes D, Omoumi P, Squifflet J, Cornu O, Rodriguez-Villalobos H, Yombi JC. Osteomyelitis pubis caused by Kingella kingae in an adult patient: report of the first case. BMC Infect Dis 2012;12:236
6 Gamble JG, Simmons SC, Freedman M. The symphysis pubis. Anatomic and pathologic considerations. Clin Orthop Relat Res 1986;(203):261–272
7 Bouza E, Winston DJ, Hewitt WL. Infectious osteitis pubis. Urology 1978;12(06):663–669
8 Ghislain L, Heylen A, Alexis F, Tintillier M. Septic arthritis of the pubic symphysis: an atypical abdominal pain. Acta Clin Belg 2015;70(01):46–49
9 Fricker PA, Taunton JE, Ammann W. Osteitis pubis in athletes. Infection, inflammation or injury? Sports Med 1991;12(04): 266–279
10 Grace JN, Sim FH, Shives TC, Coventry MB. Wedge resection of the symphysis pubis for the treatment of osteitis pubis. J Bone Joint Surg Am 1989;71(03):358–364

Letter to the Editor - Viscosupplementation – Rezende MU, Campos GC. Rev Bras Ortop 2012;47(2):160-164

Iberê Pereira Datti[1]

[1] Knee Surgery Group, Clínica de Ortopedia e Traumatologia, Hospital do Servidor Público Municipal, São Paulo, SP, Brazil

Rev Bras Ortop 2021;56(2):271.

Address for correspondence Iberê Pereira Datti, Hospital do Servidor Público Municipal, Rua Castro Alves, 60, Aclimação, São Paulo, SP, 01532-000, Brazil (e-mail: iberedatti@hotmail.com).

Viscosupplementation with hyaluronic acid is a widely used treatment for degenerative joint disease. Several articles have shown that the molecular weight of the adopted hyaluronic acid is relevant for the lasting improvement of symptoms, high molecular weight hyaluronic acid performs better in long-term evaluation. In this scenario, the assistant physician needs to know the molecular weight of the chosen product, to set expectations and pick the best option for each case.

Unfortunately, it's usual to have difficulty in knowing the molecular weight of each available product in the market. In a published update of the RBO (Viscosuplementação – Rezende MU, Campos GC. Rev Bras Ortop. 2012;47(2):160–164).[1] Durolane® is considered to have an intermediate molecular weight (between 1 and 1.8×106 Da), which doesn't seem to be true, at least it is not in accordance with the Institut national d'excellence en santé et services sociaux (INESSS – Canada), equivalent to the ANVISA in Brazil, which characterize Durolane®as a very high molecular weight hyaluronic acid (over 100×106 Da) (Agence d'évaluation des technologies et des modes d'intervention en santé (AETMIS). Viscosupplementation for the Treatment of Osteoarthritis of the Knee. Report prepared for AETMIS by Pierre Dagenais and Alicia Framarin (AETMIS 07–06). Montréal: AETMIS, 2007.).

I couldn't find information from Bioventus®.
I think it would be helpful to revise this information.

Reference

1 de Rezende MU, de Campos GC. Viscosuplementação. Rev Bras Ortop 2015;47(02):160–164

DOI https://doi.org/10.1055/s-0041-1728704.
ISSN 0102-3616.

Thieme Revinter Publicações Ltda., Rua do Matoso 170, Rio de Janeiro, RJ, CEP 20270-135, Brazil

Revista Brasileira de Ortopedia

Author Instructions

Thank you for contributing to *Revista Brasileira de Ortopedia*. Please read the instructions carefully and observe all the directions given. Failure to do so may result in unnecessary delays in publishing your article.

APC Type	**2020 *Article Processing Charge* (APC)**
Regular	None (Society Funded)

Find out more about Open Access at Thieme at http://open.thieme.com

SUBMISSION CHECKLIST
All manuscripts must be submitted at the following link:
http://www.editorialmanager.com/rbo

☐ AUTHOR INFORMATION
- All authors: full name, department, affiliation
- Corresponding author: full name, degrees, department, affiliation, mailing address, telephone and fax number, e-mail address

☐ MANUSCRIPT FILE
- Must be digital - hard copy submissions are not accepted

☐ ABSTRACT AND KEYWORDS
- See the section Article Types for word limit

☐ REFERENCES
- Cited sequentially in AMA

☐ FIGURES AND TABLES
- Cited sequentially in the main document, must be saved separately from the main document

☐ ART FILES
- Must be saved separately from the main document

☐ PERMISSIONS
- Required if you plan to reproduce content from a published source or include a photograph of a patient
- Patient permission form forms available at www.thieme.com/journal-authors

CONTENTS

The Revista Brasileira de Ortopedia (RBO) is the Official Scientific Publication of the Brazilian Society of Orthopedics and Traumatology (Sociedade Brasileira de Ortopedia e Traumatologia, SBOT) and it aims to disseminate papers that contribute towards improving and developing the practice, research and teaching of orthopedics and related specialties. It is published bimonthly in February, April, June, August, October and December, and has been published regularly since its first edition in 1965. The journal is dedicated to orthopedists who are linked to the SBOT, healthcare professionals who are dedicated to similar activities and orthopedists in other countries.

MANUSCRIPT FORMAT

Article Types

The following graph shows what types of articles are accepted for publication, and what requirement they may have.

Article Type	Abstract Limit	Keywords Limit	Title Limit	Figures/Tables	Reference
Original Article (Up to 2,500 words)	Up to 250 words	6	not applicable	10 Figures e 6 Tables	Up to 30 References
Update Articles (Up to 4,000 words)	Up to 250 words	6	not applicable	3 Figures and 2 Tables	Up to 60 References
Systematic Reviews and Meta-analysis (Up to 4,000 words)	Up to 250 words	6	not applicable	3 Figures e 2 Tables	Up to 60 References
Case Report (Up to1,000 words)	Up to 250 words	6	not applicable	5 Figures	Up to 10 References
Technical Notes (Up to 1,500 words)	Up to 250 words	6	not applicable	5 Figures e 2 Tables	Up to 8 References
Letters to the Editor (Up to 500 words	N/A	N/A	not applicable	2 Figures	Up to 4 References
Editorial (Up to 500 words)	N/A	N/A	not applicable	N/A	N/A

- **Original Article**: It describes prospective or retrospective experimental research or clinical investigations, which may be randomized or double blind. It should have a Title, Structured Abstract (Objective, Methods, Results, and Conclusion), keywords, introduction, materials and methods, results, discussion, conclusions and references. Can have maximum of 6 authors. Maximum of 2,500 words, 30 references, 10 figures and 6 tables.
- **Update Articles**: These are reviews of the state of the art on a given topic, written by specialists on invitation from the Editor-in-Chief. They should have Title, Unstructured abstract keywords, and references. Maximum of 4,000 words, 60 references, 3 figures and 2 tables.
- **Systematic Reviews and Meta-analysis**: These have the purpose of examining the published bibliography on a given subject, in order to make a critical and systematized assessment on a certain specific topic and present the important conclusions based on this literature. They should have Title, an Unstructured abstract, keywords, and references. Maximum of 4,000 words, 60 references, 3 figures and 2 tables.
- **Case Report:** It should be informative and should not contain irrelevant details. Only clinical case reports of interest, either for its rarity as a nosological entity, or for the unusual form of presentation. It should have a title, unstructured abstract, keywords and references. Maximum of 1,000 words, 10 references, 5 figures. **Note: Case report articles will have a individualized editing time and will not follow the same evaluation and publication time of the other articles.**
- **Technical Note:** Intended for the disclosure of diagnostic method or experimental surgical technique, new surgical instruments, orthopedic implants, etc. Must have: Title; unstructured abstract; Keywords; Explanatory Introduction, Method, Material or Technique Description, Final Comments and References. Maximum of 1.500 words, 8 references, 5 figures and 2 tables. **Note: Technical note articles will have a individualized editing time and will not follow the same evaluation and publication time of the other articles.**
- **Letters to the Editor:** These have the aim of commenting on or discussing studies published in the journal or reporting on original research that is in progress. They will be published at the editors' discretion, with the respective reply, when appropriate.
- **Editorial**: These are written on invitation from the Editor-in-Chief, presenting comments on important studies in this journal, describing important published research or presenting communications from the editors that are of interest to the specialty.

General Guidelines

- You must submit a digital copy of your manuscript. Hard copy submissions are not accepted.
- Keep the format of your manuscript simple and clear. We will set your manuscript according to our style—do not try to "design" the document.
- The manuscript, including the title page, abstract and keywords, text, references, figure captions, and tables should be typewritten, double-spaced in 12-point font with 1-inch margins all around and saved as one file.
- Each figure should be saved as its own separate file. Do not embed figures within the manuscript file. This requires special handling by Thieme's Production Department.

- Keep abbreviations to a minimum and be sure to explain all of them the first time they are used in the text.
- The manuscripts should be written in consistent British or American English.
- The authors should use Système International (SI) measurements. For clarity, nonmetric equivalents may be included in parentheses following the SI measurements.
- Use generic names for drugs. You may cite proprietary names in parentheses along with the name and location of the manufacturer.
- Credit suppliers and manufacturers of equipment, drugs, and other brand-name material mentioned in the manuscript within parentheses, giving the company name and primary location.

Files/Information Checklist:

- One of the authors can be designated as the corresponding author. The e-mail address and full postal address should be included in the title page. For more details, please see below the section of Title Page.
- Manuscript:
  - Include Keywords
  - All relevant Figures and their Figure captions/legends
  - All Tables (including titles, description, footnotes)
  - Ensure all figure and table citations in the text match the files provided
  - Indicate clearly if color should be used for any figures in print Graphical Abstracts / Highlights files (wherever applicable)
  - Supplemental files (wherever applicable)
- Further considerations
  - Manuscript has been 'spell checked' and 'grammar checked'
  - All references mentioned in the Reference List are cited in the text, and vice versa
  - Permission has been obtained for use of copyrighted material from other sources (including the Internet)
  - A competing interests statement is provided, even if the authors have no competing interests to declare
  - Journal policies detailed in this guide have been reviewed
  - Referee suggestions and contact details provided, based on journal requirements

Language

Articles can be written in Portuguese or English.

Title Page

- This journal adheres to a double-blinded peer-review policy. The title page should **not** be included in the main document and should be provided as a separate document.
- Article Title: Concise and informative. Titles are often used in information-retrieval systems. Avoid abbreviations and formulae where possible.
- Authorship: A maximum of 6 authors, except to the multicenter studies where the number of authors may be greater, as follows:

- Two or three institutions, a maximum of 4 authors per institution;
- More than four institutions, a maximum of 3 authors per institution.
- Under no circumstances, the number of authors can be greater than 20.

- Indicate professional qualification, academic degree and affiliation of each author, separately. If there is more than one institutional affiliation, indicate only the most relevant. Please clearly indicate the given name(s) and family name(s) of each author and check that all names are accurately spelled. Present the authors' affiliation addresses (where the actual work was done) below the each name, followed by the respective ORCID (https://orcid.org/). Indicate all affiliations with a lower-case superscript letter immediately after the author's name and in front of the appropriate address. Provide the full postal address of each affiliation, including the city, state and country name and, if available, the e-mail address of each author. Author affiliations should be presented in increasing hierarchical order (e.g. Harvard University, Harvard Business School, Boston, USA) and should be written as established in its own language (e.g. Universit Paris-Sorbonne; Harvard University, Universidade de So Paulo).
- Corresponding Author: Clearly indicate who will handle correspondence at all stages of refereeing and publication, also post-publication. Ensure that the e-mail address is given and that contact details are kept up to date by the corresponding author.

Abstract and Keywords

See the section Article Types for word limits.

The abstract should briefly outline the content of the article and any conclusions it may reach. The keywords should be words a reader would be likely to use in searching for the content of the article.

A structured abstract, by means of appropriate headings, should provide the context or background for the research and should state its purpose, basic procedures (selection of study subjects or laboratory animals, observational and analytical methods), main findings (giving specific effect sizes and their statistical significance, if possible), and principal conclusions. It should emphasize new and important aspects of the study or observations.

The abstracts should be a maximum of 250 words and structured in the following format: Purpose: One or two sentences that simply state purpose with no background information. Methods: Provide details about the methods of the study, including data analysis. Results: Present most important findings of the study. Please provide numbers (means with standard deviations or medians with ranges) to support your findings, and results of significance tests, e.g. p-values. Conclusions: One

or two sentences that state only what your study identified and actually demonstrated. Please do not include comments or information not supported by the data of your study. Level of Evidence (for human studies) or Clinical relevance (basic science in-vitro or in-vivo study: why is this study important from a clinical standpoint?).

Immediately after the abstract, provide a maximum of 6 keywords in alphabetical order and separated by semicolon, to represent the content of the article. The descriptors or keywords should be based on the Health Science Descriptors (Descritores em Cincias da Sade, DECS), which are available at the electronic address http://www.decs.bvs.br; or on the Medical Subject Headings (MeSH), from www.nlm.nih.gov/mesh/ MBrowser.html.

Main Document

- This journal uses **double-blind peer-review**, which means the identities of the authors are concealed from the reviewers, and vice versa. To facilitate this, please include the following separately:
  - Title page (with author details): This should include the title, professional qualification, academic title and affiliation of each author, acknowledgements and any Declaration of Interest statement, and a complete address for the corresponding author including an e-mail address.
  - Blinded manuscript (no author details): The main body of the paper (including the references, figures, tables and any acknowledgements) should not include any identifying information, such as the authors' names or affiliations.
- Original Articles, Systematic Reviews and Meta-analyses, the text should be structured in the standard IMRAD (Introduction, Methods, Results, Discussion) format.
- Papers including human or animal subjects must include a statement of approval by appropriate agencies in the text.
- Use generic names of drugs or devices. If a particular brand was used in a study, insert the brand name along with the name and location of the manufacturer in parentheses after the generic name when the drug or device is first mentioned in the text.
- Quantities and units should be expressed in accordance with the recommendations of the International System of Units (SI), 8th edition 2006 (www.bipm.orgutilscommonpdfsi_brochure_8_en.pdf).
- When abbreviations are used, give the full term followed by the abbreviation in parentheses the first time it is mentioned in the text, such as inferior gleno-humeral ligament (IGHL).
- Please clearly distinguish the hierarchy of headings within the manuscript by using capital letters, underline, italic, and bold styles as necessary.
- As needed, use italic, superscripts, subscripts, and boldface, but otherwise do not use multiple fonts and font sizes.
- Do not insert page or section breaks except where noted in the Author Instructions.
- Use hard returns (the Enter key) only at the end of a paragraph, not at the end of a line. Allow lines of text to break automatically in your word-processing software. Do not justify your text.
- Use only one space, not two, after periods.
- Create tables using the Table function in Microsoft Word.

Thieme Editing Services

Thieme offers a language editing service for manuscripts, abstracts and theses in partnership with Enago, a world-leading provider of author services to researchers around the world. Authors can choose from a range of editing services and get their manuscripts edited by Enago's professional medical editors. Authors that wish to use this service will receive a 20% discount on all editing services. To find out more information or get a quote, please visit https://www.enago.com/thieme

Acknowledgments

Collate acknowledgements in a separate section at the end of the article before the references and do not, therefore, include them on the title page, as a footnote to the title or otherwise. List here those individuals who provided help during the research (e.g., providing language help, writing assistance or proof reading the article, etc.).

Formatting of Funding Sources

List funding sources in this standard way to facilitate compliance to funder's requirements:

Funding: This work was supported by the National Institutes of Health [grant numbers xxxx, yyyy]; the Bill & Melinda Gates Foundation, Seattle, WA [grant number zzzz]; and the United States Institutes of Peace [grant number aaaa].

It is not necessary to include detailed descriptions on the program or type of grants and awards. When funding is from a block grant or other resources available to a university, college, or other research institution, submit the name of the institute or organization that provided the funding.

If no funding has been provided for the research, please include the following sentence:

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Conflict of Interest

Please click http://www.icmje.org/conflicts-of-interest to download a Conflict of Interest form.

References

References should be the most recent and pertinent literature available. It is essential that they are complete and thoroughly checked. If the reference information is incomplete, good online sites to search for full details are the National Library of Medicine: www.nlm.nih.gov; Books in Print: www.booksinprint.com; PubMed: www.ncbi.nlm.nih.gov/PubMed/; or individual publisher Web sites.

- References must be listed in AMA style, using Index Medicus journal title abbreviations.
- References follow the article text. Insert a page break between the end of text and the start of references.

- References must be cited sequentially (NOT alphabetically) in the text using superscript numbers.
- List all author names, up to and including six names. For more than six authors, list the first three followed by et al.
- References should be styled per the following examples:

1. Citing a journal article:
   Borges JLP, Milani C, Kuwajima SS, Laredo Filho J. Tratamento da luxação congênita de quadril com suspensório de Pavlik e monitorização ultra-sonográfica. Rev Bras Ortop 2002;37(1/2):5-12
2. Citing a chapter in a book:
   Johnson KA. Posterior tibial tendon. In: Baxter D. The foot and ankle in sport. St Louis: Mosby; 1995. p. 43-51
3. Citing a book:
   Baxter D. The foot and ankle in sport. St Louis: Mosby; 1995
4. Citing a thesis:
   Laredo Filho J. Contribuição ao estudo clínico-estatístico e genealógico-estatístico do pé torto congênito equinovaro [thesis]. São Paulo: Universidade Federal de São Paulo. Escola Paulista de Medicina; 1968
5. Citing a government publication:
   Food and Drug Administration. Jin Bu Huan Herbal Tablets. Rockville, MD: National Press Office; April 15, 1994. Talk Paper T94-22
6. Citing an online article:
   Lino Junior W, Belangero WD. Efeito do Hólmio YAG laser (Ho: YAG) sobre o tendão patelar de ratos após 12 e 24 semanas de seguimento. Acta Ortop Bras [periodical on the Internet] 2005 [cited 2005, Aug 27];13(2):[about 5 p.]. Available from: http://www.scielo.br/ scielo
7. Citing a symposium article:
   Eisenberg J. Market forces and physician workforce reform: why they may not work. Paper presented at: Annual Meeting of the Association of American Medical Colleges; October 28, 1995; Washington, DC

Figure Captions

- Figures include photographs or radiographs, drawings, graphs, bar charts, flow charts, and pathways, but NOT lists or tables.
- Figures must be cited sequentially in the text. Number all figures (and corresponding figure captions) sequentially in the order they are cited in the text.
- Figure captions should be written after the reference list. Insert a page break between the end of references and the start of figure captions.
- Figure captions should include a description of the figure and/or each lettered part (A, B, etc.) and of any portions of the figure highlighted by arrows, arrowheads, asterisks, etc.
- For a figure borrowed or adapted from another publication (used with permission), add a credit line in parentheses at the end of each figure legend. This credit line should be a complete bibliographic listing of the source publication (as a reference), or other credit line as supplied by the copyright holder. For example (Reprinted with permission from Calfee DR, Wispelwey B. Brain abscess. Semin Neurol 2000;20:357.)

Tables

- Data given in tables should be commented on but not repeated in the text. Be sure that lists or columns of related data are composed in a word-processing program like the rest of the text.
- Do not intersperse tables in the text. Tables should appear after the figure captions. Insert a page break between the end of the figure captions and the start of the tables.
- Tables must be double-spaced and numbered in the same sequence they are cited in the text. A short descriptive title should be provided for each table.
- If a table contains artwork, supply the artwork separately as a digital file.
- For tables borrowed or adapted from another publication (used with permission), add a credit line as the first footnote beneath each table. This credit line should be a complete bibliographical listing of the source publication (as a reference), or other credit line as supplied by the copyright holder. For example, “Reprinted with permission from Calfee DR, Wispelwey B. Brain abscess. Semin Neurol 2000;20:357.” (“Data from . . .” or “Adapted from . . .” may also be used, as appropriate.)
- Other footnotes for tables should be indicated in the table using superscript letters in alphabetical order.
- Any abbreviations used in the table should be explained at the end of the table in a footnote.

Videos

- The following formats are acceptable: *.avi, *.mov and *.mpg.
- For supplementary videos, the length should not exceed 4 minutes, and a legend of no more than 40 words per video or per sequence is required (it should also be included in the main document).
- If including a voice over, it must be in clear English. Be precise, informative, and clear in your speech. Re-record audio in post-production for sound quality.

Supplementary Material

Supplementary material such as applications, images and sound clips, can be published with your article to enhance it. Submitted supplementary items are published exactly as they are received (Excel or PowerPoint files will appear as such online). Please submit your material together with the article and supply a concise, descriptive caption for each supplementary file.

If you wish to make changes to supplementary material during any stage of the process, please make sure to provide an updated file. Do not annotate any corrections on a previous version. Please switch off the 'Track Changes' option in Microsoft Office files as these will appear in the published version.

DIGITAL ARTWORK PREPARATION

General Guidelines

- It is best to use Adobe Photoshop to create and save images, and Adobe Illustrator for line art and labels.
- Do not submit art created in Microsoft Excel, Word, or PowerPoint. These files cannot be used by the typesetter.
- Save each figure in a separate file.
- Do not compress files.
- All black-and-white and color artwork should be at a resolution of 300 dpi (dots per inch) in TIFF format. Line art should be 1,200 dpi in EPS or TIFF format. Contact the Production Editor at Thieme if you are unsure of the final size.
- It is preferable for figures to be cropped to their final size (approximately 3½ inches for a single column and up to 7 inches for a double column), or larger, and in the correct orientation. If art is submitted smaller and then has to be enlarged, its resolution (dpi) and clarity will decrease.

  Note: Lower resolutions (less than 300 dpi) and JPEG format (.jpg extension) for grayscale and color artwork are strongly discouraged due to the poor quality they yield in printing, which requires 300 dpi resolution for sharp, clear, detailed images. JPEG format, by definition, is a lower resolution (compressed) format designed for quick upload on computer screens.

Black-and-White Art

- Black-and-white artwork can be halftone (or grayscale) photographs, radiographs, drawings, line art, graphs, and flowcharts. Thieme will only accept digital artwork.
- If possible, do not send color art for conversion to black-and-white. Do the conversion yourself so that you can check the results and confirm in advance that no critical details are lost or obscured by the change to black-and-white.
- For best results, line art should be black on a white background. Lines and type should be clean and evenly dark. Avoid screens or cross-hatching, as they can darken or be uneven in printing and lead to unacceptable printing quality.

Color Art

- All color artwork should be saved in CMYK, not RGB.

Art Labels

- Arrows, asterisks, and arrowheads (or other markers) should be white in dark or black areas and black in light or white areas, and large in size. If not, these highlighting marks may become difficult to see when figures are reduced in size during the typesetting process.
- Use 1-point (or thicker) rules and leader lines.
- Capitalize the first word of each label and all proper nouns. Consider using all capitals if you need a higher level of labels.
- Where there are alternate terms or spellings for a named structure, use the most common one and make sure it is consistent with what is used in the text.
- Avoid using multiple fonts and font sizes for the labels; use only one or two sizes of a serif font.

SUBMISSION PROCEDURE

Article Processing Charge (APC) & Open Access

This is a subsidized Open Access journal: all the articles after publishing online, will be immediately and permanently made free for everyone to read and download on Thieme-connect platform. The Brazilian Society of Orthopaedics and Traumatology (Sociedade Brasileira de Ortopedia e Traumatologia SBOT) pays for the publishing costs incurred by the journal. Authors do not have to pay any Article Processing Charge or Open Access Publication Fee. All peer- reviewed articles are published as open access in this journal. Permitted third party (re)use is defined by the following Creative Commons user licenses: *Creative Commons Attribution-Non Commercial-No Derivs (CC BY-NC-ND)*

For non-commercial purposes, lets others distribute and copy the article, and to include in a collective work (such as an anthology), as long as they credit the author(s) and provided they do not alter or modify the article.

Submission Procedure

- Consult the checklist on the first page of this document to ensure that you are ready to submit your manuscript.
- Manuscripts must be submitted electronically at the following link: http://www.editorialmanager.com/rbo
- Always review your manuscript before submitting it. You may stop a submission at any phase and save it to submit later. After submission, you will receive a confirmation email. You can also check the status of your manuscript by logging in to the submission system. The system converts your article files to a single PDF file used in the peer-review process. Editable files are required to typeset your article for final publication. All correspondence, including notification of the Editor's decision and requests for revision, is sent by e-mail. The Editor in Chief will inform you via email once a decision has been made.

Revision Procedure

- Should the editors decide that your article requires a revision, you will need to make the changes via a word-processing program and resubmit it electronically.
- Log In to the submission system and find your article, which will be marked for revision.

- The best way to make revisions to your manuscript is by enabling the Track Changes mode in Microsoft Word, which will automatically highlight and mark up revised text. Please submit both a marked up copy and a clean copy of your revised manuscript to the submission system.
- Your original files will still be available after you upload your revised manuscript, so you should delete any redundant files before completing the submission.
- You will also be provided space in which to respond to the reviewers' and editors' comments. Please be as specific as possible in your response.

PRODUCTION PROCEDURE

Page Proofs

Page proofs will be sent to you via email. The proofs will be in a PDF file format, which should be opened using Acrobat Reader software. You will receive further instructions with your proofs. Take this opportunity to check the typeset text for typographic and related errors. Elective alterations are difficult to accommodate owing to the associated time and expense of introducing them. Therefore, please be sure that when you submit your manuscript, it is accurate, complete, and final.

POLICY STATEMENTS

Statement on Liability

The legislation on product liability makes increased demands on the duty of care to be exercised by authors of scientific research and medical publications. This applies in particular to papers and publications containing therapeutic directions or instructions and doses or dosage schedules. We therefore request you to examine with particular care, also in your own interest, the factual correctness of the contents of your manuscript once it has been copyedited and returned to you in the form of galley proofs. The responsibility for the correctness of data and statements made in the manuscript rests entirely with the author.

Definition of Authorship

Authorship credit should be based on criteria established by the International Committee of Medical Journal Editors. Each author should have made the following contributions towards the completion of the manuscript:

1. Substantial contributions to conception and design, acquisition of data, or analysis and interpretation of data
2. Drafting the article or revising it critically for important intellectual content
3. Final approval of the version to be published

Contributors

Each author is required to declare his or her individual contribution to the article: all authors must have materially participated in the research and/or article preparation, so roles for all authors should be described. The statement that all authors have approved the final article should be true and included in the disclosure.

Changes to authorship

Authors are expected to consider carefully the list and order of authors **before** submitting their manuscript and provide the definitive list of authors at the time of the original submission. Any addition, deletion or rearrangement of author names in the authorship list should be made only **before** the manuscript has been accepted and only if approved by the journal Editor. To request such a change, the Editor must receive the following from the **corresponding author**: (a) the reason for the change in author list and (b) written confirmation (e-mail, letter) from all authors that they agree with the addition, removal or rearrangement. In the case of addition or removal of authors, this includes confirmation from the author being added or removed.

Only in exceptional circumstances will the Editor consider the addition, deletion or rearrangement of authors **after** the manuscript has been accepted. While the Editor considers the request, publication of the manuscript will be suspended. If the manuscript has already been published in an online issue, any requests approved by the Editor will result in a corrigendum.

Copyright Statement

Submitted manuscripts must represent original research not previously published nor being considered for publication elsewhere. The editors and Thieme combat plagiarism, double publication, and scientific misconduct with the software CrossCheck powered by iThenticate. Your manuscript may be subject to an investigation and retraction if plagiarism is suspected.

If you plan to reproduce text, tables, or figures from a published source, you must first obtain written permission from the copyright holder (usually the publisher). This is required even if the material is from your own published work. For material never before published and given to you by another person, you must obtain permission from that person. Serious delays to publication can be incurred if permissions are not obtained.

As the author, it is your responsibility to obtain all permissions, pay any permission fees, furnish copies of permissions to Thieme with your manuscript, and include a credit line at the end of the figure caption, beneath the table, or in a text footnote.

Upon publication of an article, all rights are held by the publishers, including the rights to reproduce all or part of any publication. The reproduction of articles or illustrations without prior consent from the publisher is prohibited.

Declaration of Interest

All authors must disclose any financial and personal relationships with other people or organizations that could inappropriately influence (bias) their work. Examples of potential conflicts of interest include employment, consultancies, stock

ownership, honoraria, paid expert testimony, patent applications /registrations, and grants or other funding. ***In addition to providing the duly filled and signed ICMJE COI Forms,*** authors must disclose any interests in two places:

1. A summary declaration of interest statement in the title page file. If there are no interests to declare then please state this: 'Declarations of interest: none'. This summary statement will be ultimately published if the article is accepted.
2. Detailed disclosures as part of a separate ICMJE COI Forms, as stated above - which forms part of the journal's official records. It is important for potential interests to be declared in both places and that the information matches.

Role of the Funding Source

You are requested to identify who provided financial support for the conduct of the research and/or preparation of the article and to briefly describe the role of the sponsor(s), if any, in study design; in the collection, analysis and interpretation of data; in the writing of the report; and in the decision to submit the article for publication. If the funding source(s) had no such involvement then this should be stated.

Statement of Ethics

This journal adheres to the ethical standards described by the Committee on Publication Ethics and the International Committee of Medical Journal Editors. Authors are expected to adhere to these standards.

For all manuscripts reporting data from studies involving human or animal participants, formal review and approval, or formal review and waiver (exemption), by an appropriate institutional review board (IRB) or ethics committee is required, as well as any necessary HIPAA consent, and should be described in the Methods section with the full name of the reviewing entity. All clinical trials must be registered in a public trials registry. Denote the registry and registry number.

Patient Permission Policy (www.thieme.com/journal-authors)

You must obtain a signed patient permission form for every patient whose recognizable photograph will be used. If you do not supply this, the identity of the patient must be obscured before the image is published; this could interfere with the instructive value of the photograph. Patient permission forms are available at www.thieme.com/journal-authors. Authors should include a statement in the manuscript that informed consent was obtained for experimentation with human subjects. The privacy rights of human subjects must always be observed. All animal experiments should comply with the local guidelines and the authors should clearly indicate in the manuscript that such guidelines have been followed.

Protection of Human and Animal Subjects

All manuscripts must include language either describing the steps taken to protect human and/or animal subjects, or a statement acknowledging that human and/or animal subjects were not included in the project, according to the Declaration of Helsinki. An example of basic language for human subjects protections would be: "The study was performed in compliance with the World Medical Association Declaration of Helsinki on Ethical Principles for Medical Research Involving Human Subjects, and was reviewed by XXX Institutional Review Board."

EDITORIAL CONTACTS

Please contact the Editors or Thieme Publishers with any questions.

Editor in Chief

Prof. Dr. Sergio L Checchia, MD, PhD
Sociedade Brasileira de Ortopedia e Traumatologia
Alameda Lorena, 427 - 2o. Andar - Jd. Paulista, SP, Brasil
rbo@sbot.org.br
T: +55 11 2137 5400

Thieme Publishers - Production Coordinator

Leonardo Vidal
Leonardo.vidal@thieme.com.br
T: +55 21 2563 9734

Thieme Publishers - Acquisitions Editor

Ana Paula Canel Bluhm, MSc., PhD
Ana.Bluhm@thieme.com.br
T: +55 11 3362 2464

Show your true contributions to science

Track and verify your peer review

https://publons.com/in/thieme/

Thieme Medical Publishers has partnered with **Publons** – the online service speeding up science by harnessing the power of peer review. Peer review is vital to ensuring sound scientific research, but the efforts of peer reviewers often go unnoticed.

The Publons movement is changing how we recognise research contributions by revealing researchers' previously hidden peer review efforts, while protecting reviewer anonymity.

Publons profiles help you show the full extent of your contributions to science by tracking, verifying and displaying your peer review activity. Publons is also for editors – who can track the manuscripts they handle, benefit from more motivated reviewers and access tools designed to find, screen, and contact reviewers.

How does Publons speed up science?

- Recognition for peer review leads to faster, more effective reviews
- Publons profiles help you advance your career by showing the full extent of your research contributions
- Our professional, verified reports of your review history can help with:
  - promotion and funding applications
  - self-verified CME

Publons is a completely free service for academics.

The Thieme-Publons partnership streamlines the process for tracking and verifying your reviews. Simply opt in when completing a review for any of Thieme's participating journals to have those reviews automatically added to your Publons profile.

publons

@thiemepublishers @ThiemeNY @thieme-publishers @thieme.ny

Thieme