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Operative Techniques in
Orthopaedics

Complications After Transgenicular Osteotomies

AQ: 1 **Tim Rose, MD, and Andreas B. Imhoff**

AQ: 2 High tibial osteotomy (HTO) has been criticized because of a high rate of complications, a loss of effectiveness over time, and the difficulty of conversion to a total knee arthroplasty secondary to patella baja. Several risk factors associated with poor clinical results after high tibial osteotomies have been identified by many authors, such as older age, poor bone quality, degree of compartment osteoarthritis, ligament instability, and inadequate valgus correction.[1,2] Complications after transgenicular osteotomies are not rare. The incidence of complications of 1000 surgeries was as follows: death 4.3%, severe vascular damage 2.1%, pulmonary embolus 8.6%, and deep vein thrombosis 18.4%. Several local problems have been reported: superficial infection (42.4%), deep infection (5.6%), nonunion (14%), and tibial plateau fracture (14%).[3] The appearance rate of the complications correlate to the HTO technique. The traditional closed wedge osteotomies are more technically demanding and prone to promote less-predictable angular corrections.[2,4] In contrast, the intraoperative accurate adjustments of the varus/valgus angulation or the tibial slope correction are better to perform during open wedge osteotomies. Because of the procedure's limitations, the wide range of complications, and the evolution and clinical success of total knee arthroplasty, the indications for HTO have narrowed. However, the HTO is still an appropriate therapy for medial or lateral osteoarthritis in physiologically young, active patients.

The loss of correction has a high association with bad clinical results.[5] The reason of the loss of correction after the bony healing could be the progrediency of the arthrosis and the adduction muscle strength. In contrast, the loss of correction before bony healing is the result of an unstable fixation, mostly in cases with the breakage of the opposite cortex[6]; however, the breaking or loosening of the hardware also can lead to a early loss of correction (Fig. 1). Delayed union, early weight-bearing activity, an insufficient fixation method, or infection could lead to a early loss of correction. In cases of an unstable situation, a reosteosynthesis should be performed to avoid a prolonged healing periode or a nonunion. A delayed union of the osteotomy can lead to a fatigue fracture of the screws or plates during weight bearing (Fig. 2). We also have seen that low compliance by the patient can result in a hardware failure (Fig. 3).

F1 F2 F3

Fractures

Fractures during the osteotomy procedure can occur ether in medial open wedge osteotomies and in lateral closed wedge osteotomies. Recognizing this potential problem and maintaining stability can minimize the rate of malunion and nonunion. When this complications does occur, fractures must be appropriate reduced and stabilized.[7]

Breakage of the Opposite Cortex

The intact lateral cortex in open wedge osteotomies and the intact medial cortex in lateral closed wedge osteotomies is an essential point for the protection of the correction angle.[8,9] However, in cases in which the angle is more than 8° the rate of fractures of the opposite cortex is more than 90%, because of the limitation of the plasticity of the cortical bone (Fig. 4).[6] During closed wedge osteotomies, a secondary breakage of the medial cortical bone can occur when the distal cortical screws are tightened. The cause could be the lateral shift of the distal part of the tibia toward to the plate. The secondary lateralization of the distal tibia caused by the tightened screws could be avoided through the implantation of a stable augmentation between bone and plate. An additional problem through the lateralization of the distal tibia is the missing support between the proximal and the distal cortex. The result could be the loss of the correction angle and revarization.[10] As a result of this study, postoperative weight-bearing activity without additional plaster cast fixation is recommended only in patients with undisplaced fragments. A biomechanical study by Kessler and coworkers[11] concluded that open wedge osteotomy offers no advantage over lateral closed wedge osteotomy in terms of the maximal obtainable correction angle without failure of the far cortex.

F4

Fracture of the Articular Surface

The fracture within the articular surface of the tibia is a more severe problem because of the articular incongruency. Both lateral closed wedge and medial open wedge are at risk for a

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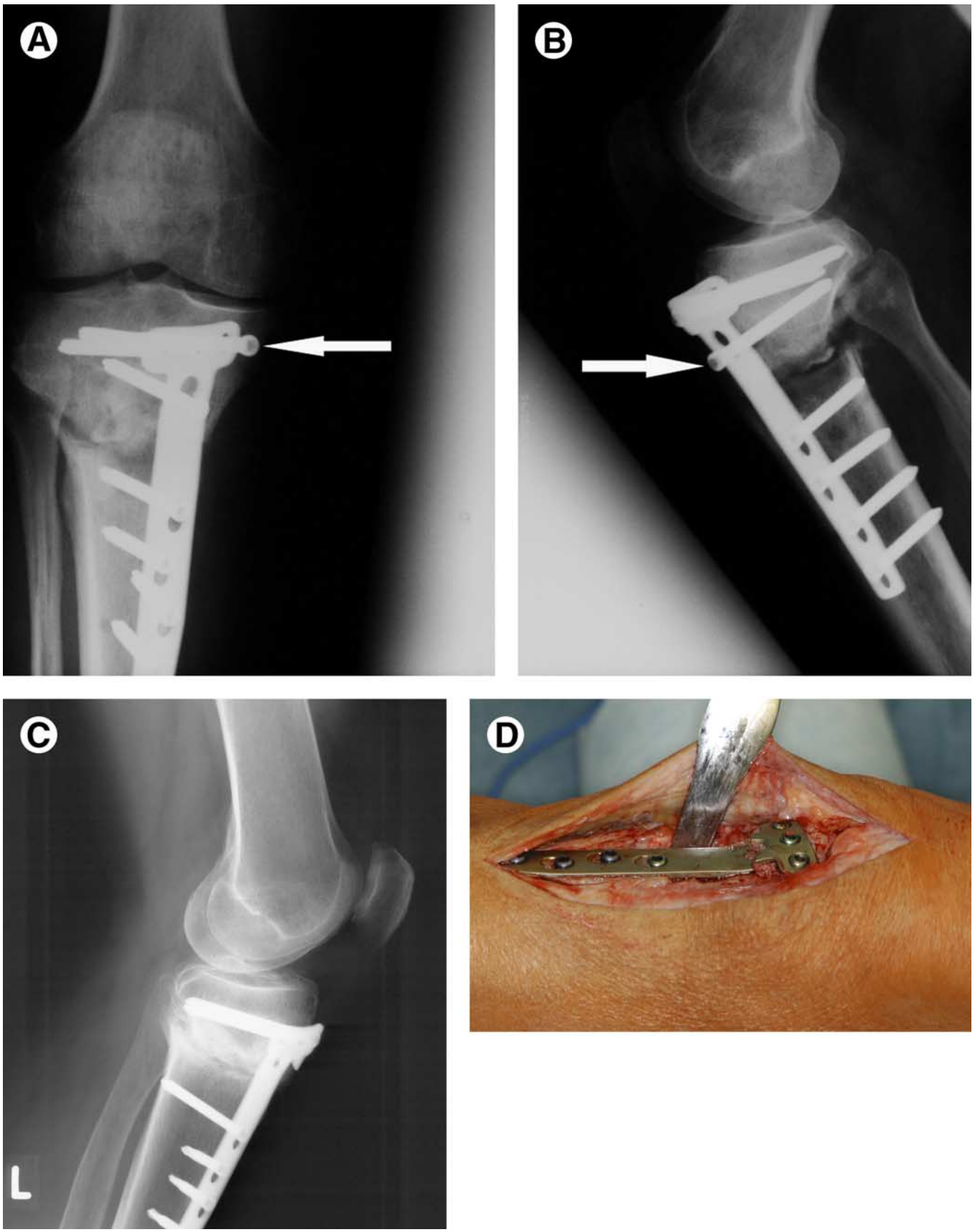

Figure 1 (A and B) Loosening of a proximal locked screw 6 weeks after medial HTO wedge osteotomy. (C) Broken tibial locking plate after HTO. The fracture line crosses the hole, where no screw was placed. (D) The intraoperative situs with displacement of the 2 parts of the plate and loss of correction.

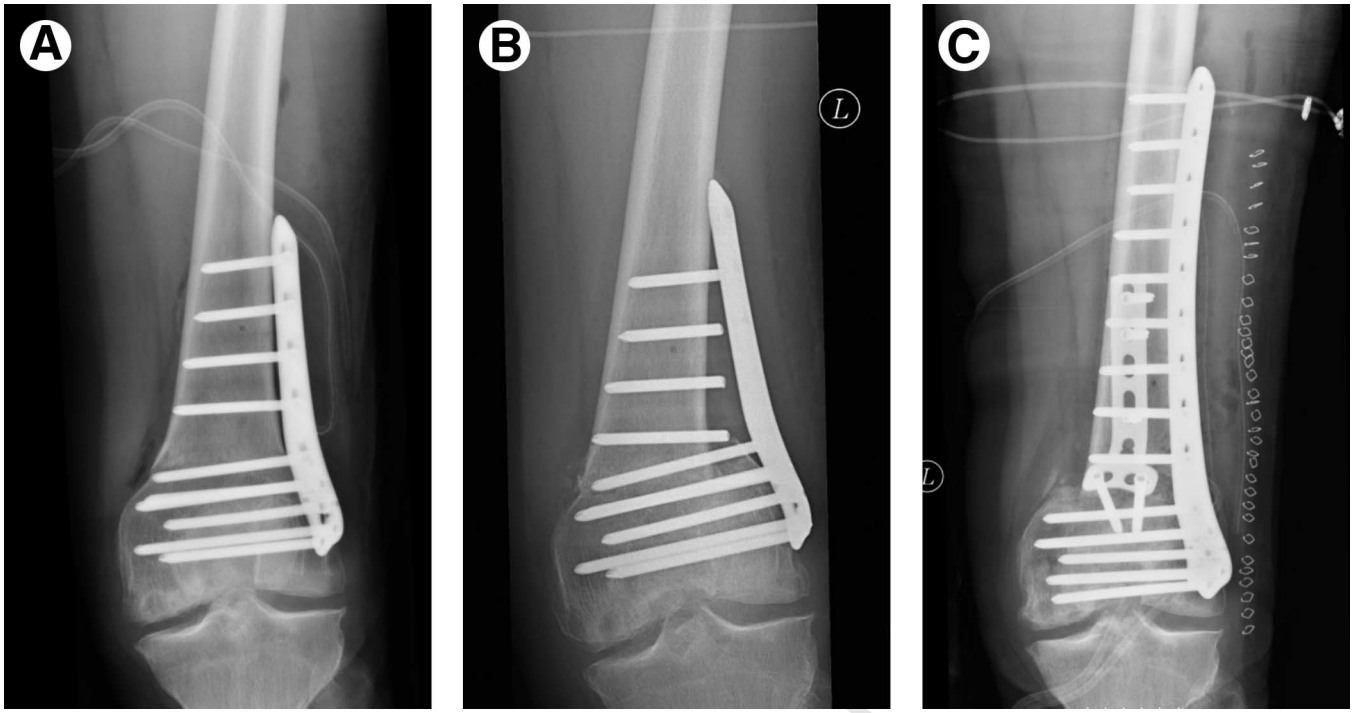

Figure 2 (A) Supracondylar osteotomy for a 20° deflection and 7° varization of the distal femur. (B) Broken all proximal locked screw after increased weight-bearing activity after 12 weeks' follow-up. (C) Reduction and re-osteosynthesis with a locked lateral plate and a anterior buttress plate.

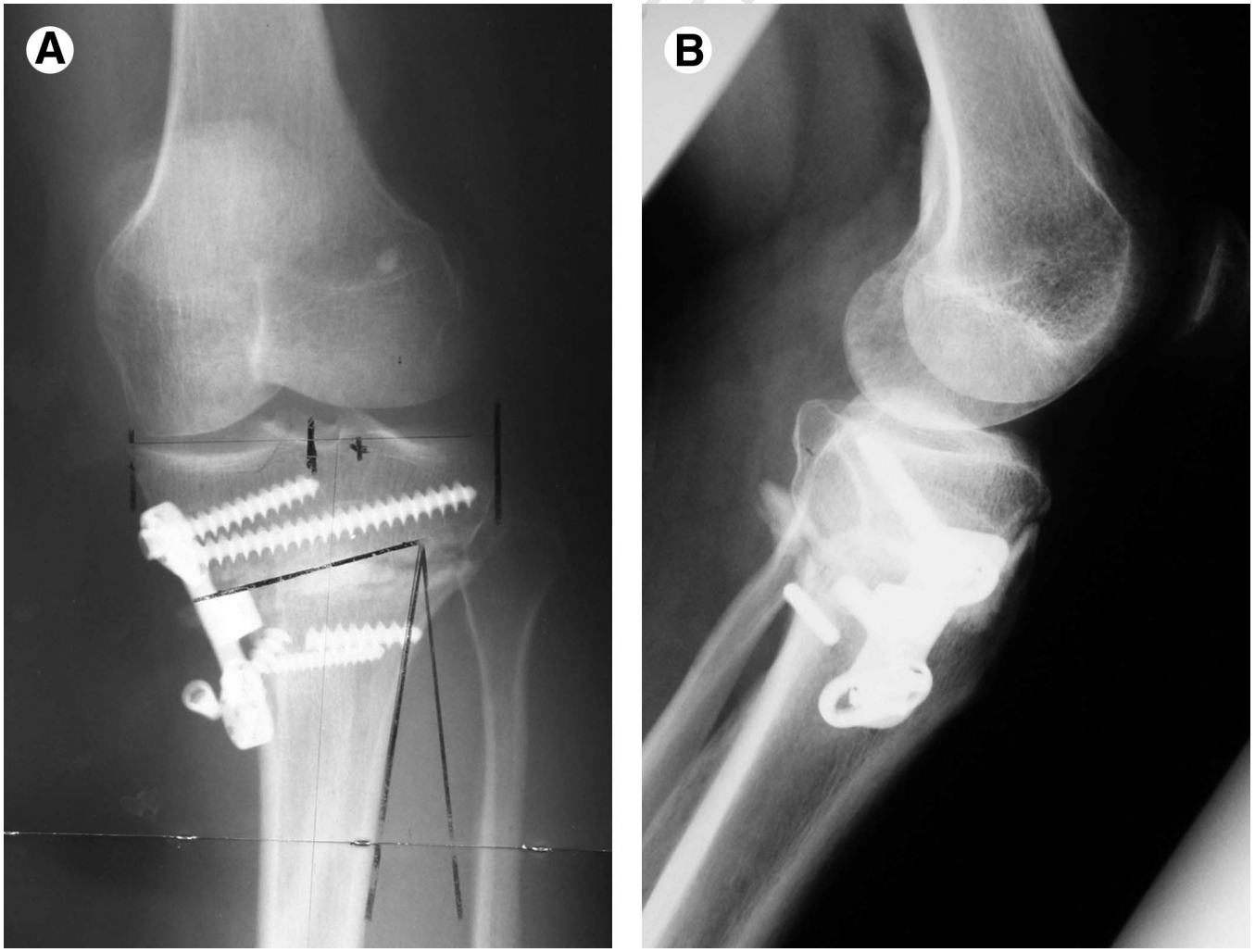

Figure 3 (A and B) Fracture of the distal screws and a total loss of correction after medial opening wedge osteotomy.

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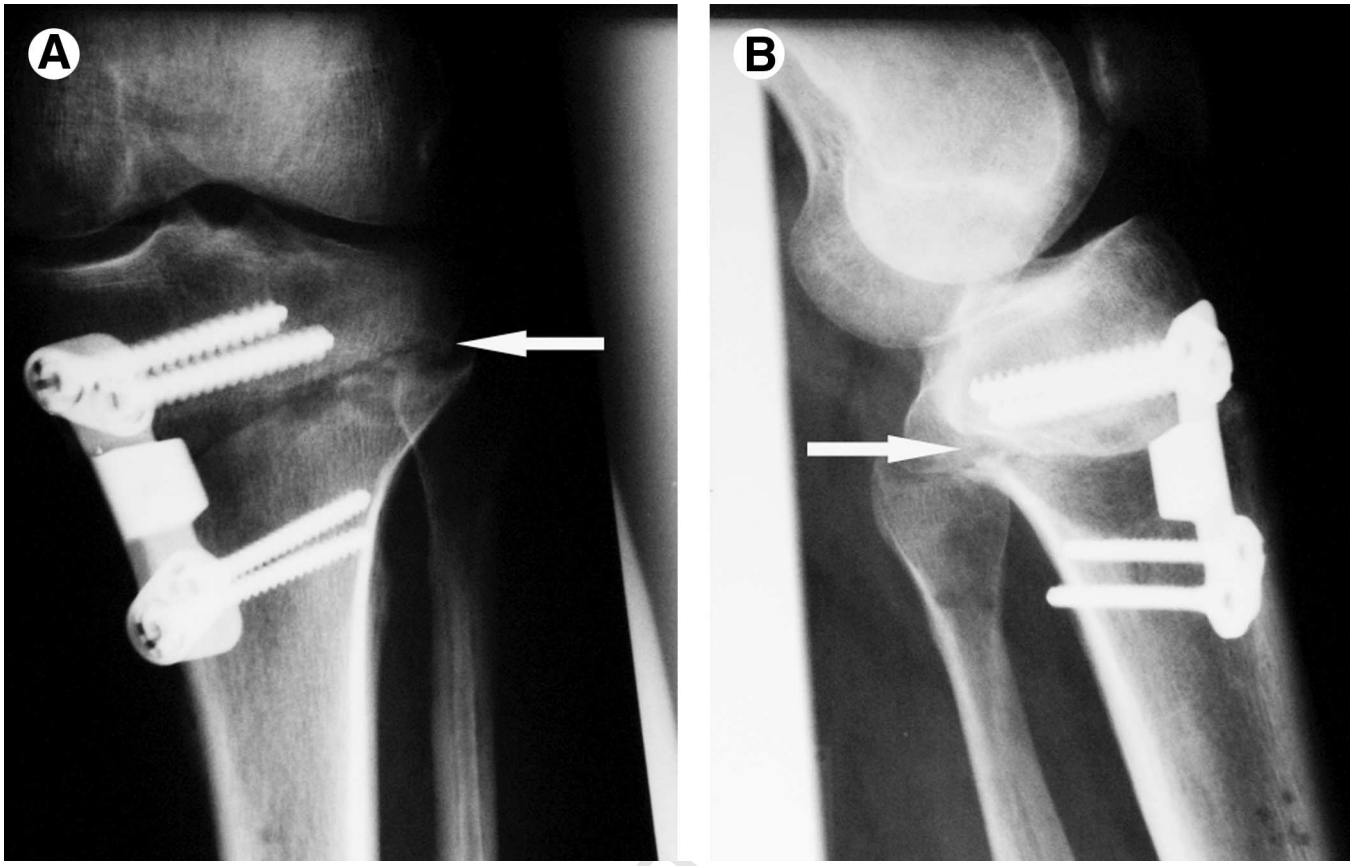

Figure 4 (A and B) Fracture of the opposite cortex following medial opening wedge osteotomy with correction (valgisation) of 12°.

intraarticular fracture. The incidence for lateral closed wedge osteotomy has been reported to be 10% to 20%,[12] and the incidence of intraarticular fracture during medial closed wedge osteotomy has been reported to be as high as 11%.[13] The risk for intraarticular fractures can be minimized by placing the osteotmoy line more distally. A minimum distance between the osteotomy and the joint line should be at least 15 mm. Another trick is to place 2 k-wires along the resection line and perform the osteotomy distally in contact to the 2 k-wires until 10 mm to the far cortex. When this complication occurs, the fracture must be reduced and sufficiant stabilized with appropriate hardware. If the fracture across the joint line, the problem is more serious because of the incongruency of the articular surface and the potential risk for arthritis.

Delayed Union–Nonunion

The incidence of nonunion after HTO has been reported to be less than 1%.[14] The delayed union rate is greater in cases in which the osteotomy is performed distal to the tibial tubercle (3.6%) compared with the osteotomy proximal to the tibial tubercle (14%).[15] The nonunion is less common in closing wedge osteotomies because of the excellent healing potential of the 2 metaphysial cancellous surfaces that are in stable, direct apposition with each other.[7] It seems there is a distinct advantage of the lateral closing wedge osteotomy over the medial opening wedge osteotomy. However, resent studies have shown that the delayed and nonunion rate after medial open wedge osteotomy is comparable to the rate in closed wedge osteotomies.[16] Therefore, a large angular correction is not a contraindication for the open wedge procedure. Risk factors for nonunion and a relative contraindication include tobacco use and diabetes mellitus. It seems that the bony healing of the open wedge osteotomy is less potential when using a stiffer fixation method. Therefore, a delayed union could be more common in these cases (Fig. 5). F5

Several advantages of porous hydroxyapatite have been reported to close the bony defect and to prevent nonunion or delayed union: neither toxicity nor inflammatory reaction has been detected to date, and incorporation at the interface between bone and hydroxyapatite with ingrowth of new bone into the pores has been confirmed histologically not only in animal models but also in studies of humans.[17,18] We found no advantage when using artificial bone structures to fill the bony defect with hydroxyapatite. In some cases we have seen complications with dislocation of this material (Fig. 6). However we also have never seen serious problems like F6 infection, allergy or nonunionwhen using hydroxyapatite.

Patella Baja

Patella baja can occur with a high incidence after lateral closed wedge osteotomies.[19] In these cases, the lowering of

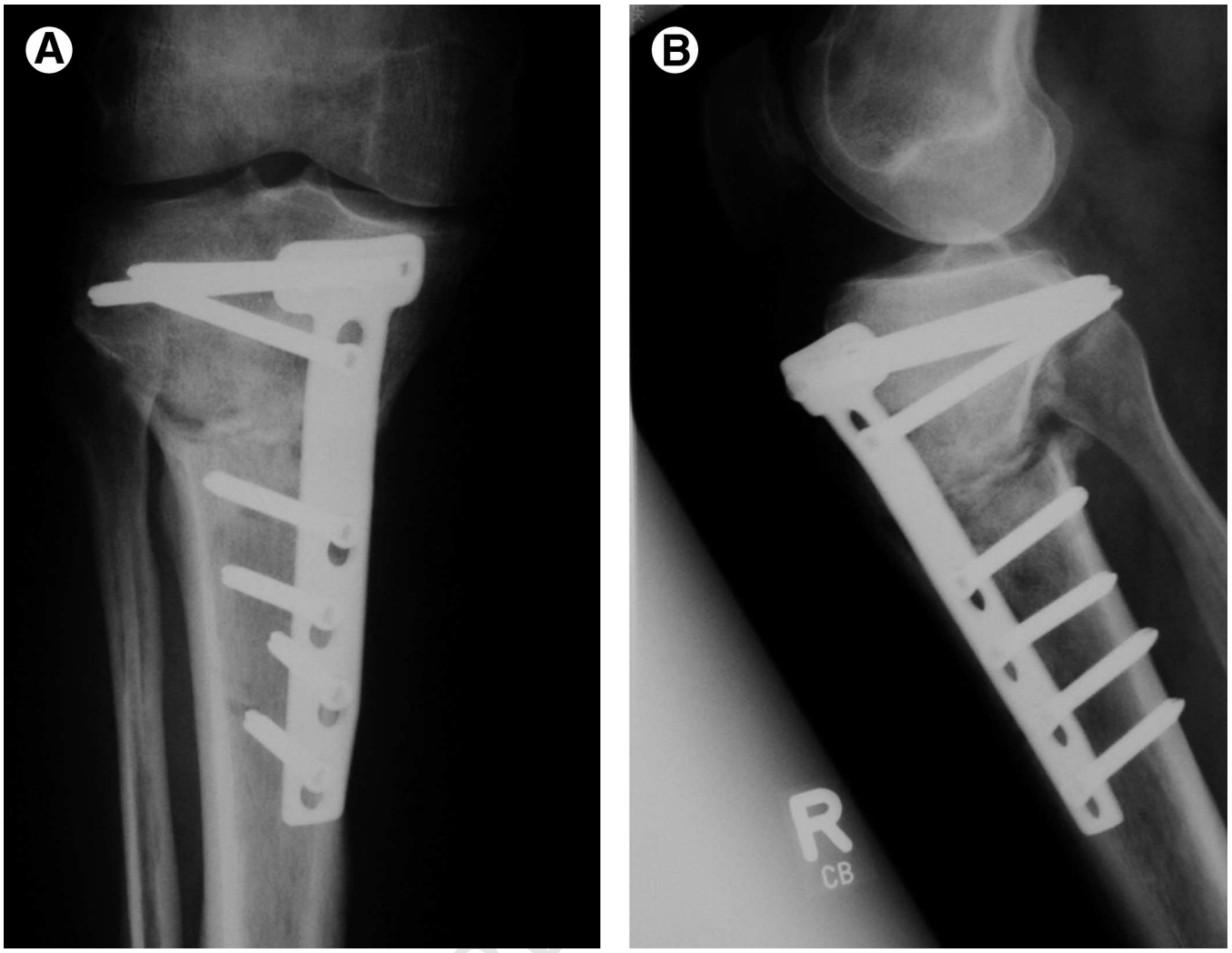

Figure 5 (A and B) Delayed union after 7 months of a medial opening wedge osteotomy (Locked plate screws were used for fixation).

the batella is a result of the contracture of the patellar tendon. Cast immobilization was used in clinical series that documented this high incidence. However, several studies have shown that a more aggressive rehabilitation period in combination with a rigid internal fixation can eliminate the patellar tendon contraction after lateral closed wedge osteotomy of the proximal tibia.[20]

However, the architecture of the proximal tibia after HTO after medial open wedge osteotomy results in a lowering of the patella without shortening of the patellar tendon by raising of the femorotibial joint line.[21] After medial opening wedge proximal tibial osteotomy, the patella infera may have deleterious effects on patellofemoral biomechanics or may complicate subsequent total-knee arthroplasty. In contrast, the lateral closed wedge osteotomy leads to a patella alta when no contraction of the patellar tendon occurs.

Nerve Palsy

During the lateral closed wedge osteotomy of the proximal tibia, a fibular osteotomy or a disarticulation of superior tibiofibular joint should be performed. Numerous authors maintain that this maneuver is essential to prevent the splinting effect of the fibula. The high fibular osteotomy and the disarticulation of the tibiofibular joint share the same advantage of being done through the same incision. However, this procedure has a greater risk to the common peroneal nerve compared with the low fibular osteotomy. The incidence of neurological damage varies depending on the series and the techniques used but is always nearly present and varies from 0%[22] to 11.9%.[23] The incidence is clearly increased with high division of the fibula. The osteotomy of the fibula >15 cm distal to the head has a lower rate of peroneal nerve palsy. However, the nerve palsy also can occur without any fibular surgery. In addition, during disarticulation of the proximal tibiofibular joint, where the nerve is protected from direct trauma, a neuroilogical deficit can occur.[5] Medial opening wedge osteotomy does not eliminate the potential for peroneal nerve deficits. One series indicated a 15.7% incidence of neurological complications after medial opening wedge osteotomies.

Therefore, further mechanism for the nerve palsy after HTO exist. A nerve lesion after compartment syndrom be-

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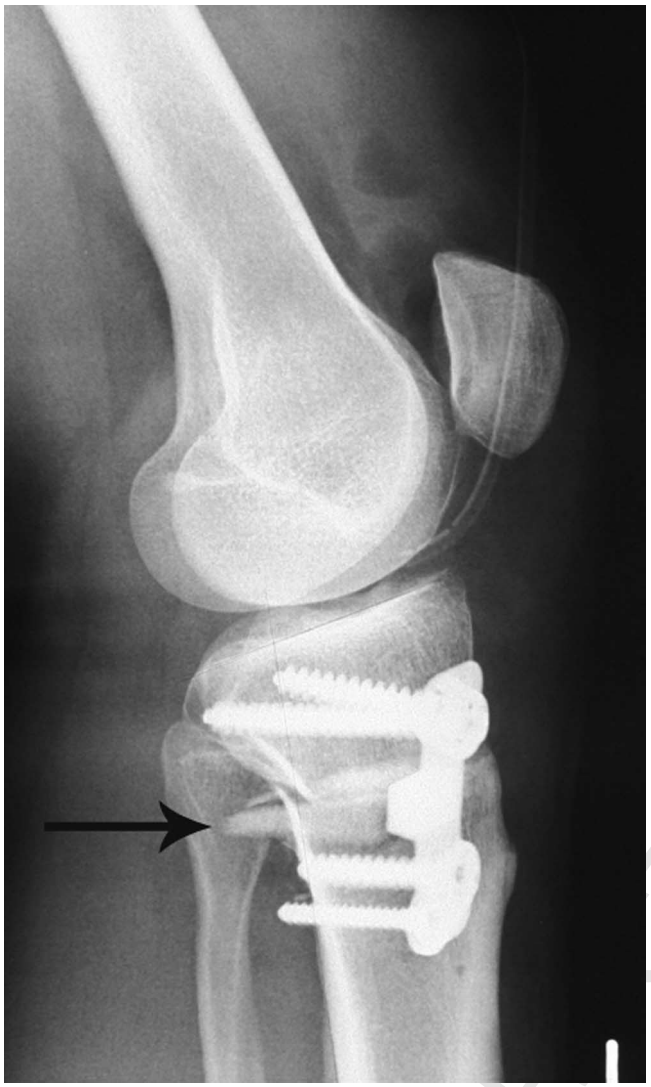

Figure 6 Dorsal dislocation of a hydroxyapatite wedge.

cause of a inadequade hemostasis or ineffective drainage is a possible technical failure. Some authors suspect a intraoperative stretching of the nerve, because of the proximal fixation of the nerve and its collateral branches at the fibula neck and distally to the muscle.[3] Furthermore, the ischemia as the result of using a pneumatic tourniquet probably sensitizes the nerve to stretching. The tourniquet causes neurological changes by 2 mechanism, ie, local compression by the tourniquet to the nerve and prolonged ischemia of the nerve itself. In addition, some postoperative peroneal deficits may be related to increased pressure in the anterior compartment.[24]

Vascular Damage

The popliteal artery is protected, at the level of the osteotomy, behind the popliteus and tibialis posterior muscles. To protect the artery, we place a Hohman retractor between the posterior cortex of the tibia and the muscles at the level of the osteotomy. Damage to the popliteal artery can occur only by placing the Hohman retractor behind the muscles. The insertion of the muscles is very close to the periosteum and should be separated with a rasparatorium.

Compartment Syndrome

Although the exact incidence is still unclear, it is well known that the pressure of the compartment increase after HTO. Clinical studies have shown that the use of a drain can decrease the anterior compartment pressure.[24] The combination of the HTO with an arthroscopically assisted ligament reconstruction may increase the risk of a compartment syndrome. Some reasons exist why the pressure in the anterior compartment increase after HTO: edema on deflation of the tourniquet, muscular injury during dissection or due to retraction, hematoma caused by poor hemostasis or by bleeding at the metaphyseal osteotomy site. The pressure of the anterior compartment after HTO increase up to 50 mm Hg without drain and remained under 30 mm Hg with drain.[24] However, there was no correlation between the high compartment pressures and clinical or electrophysiological deficits. Because of potential for regional anesthesia to mask compartment syndrome, it may be best to avoid prolonged postoperative epidural analgesia after HTO.

Infection

The deep infection rate after HTO ranges from 0 to 4%.[20,25] When using an external fixation in opening wedge osteotomies, the superficial infection with pin tract infections have been reported in as many as 25-50% of these patients. However, associated septic arthritis and delayed-onset chronic osteomyelitis also have been reported.[26]

Thromboembolism

The venographic incidence of deep vein thrombosis following HTO is reported for 41%.[27] Only 15% of the cases were diagnosed clinically, all in the calf veins. Cases of proximal thromboses[3] and mixed-vein thromboses[12] were only revealed by venography. Fatal pulmonary embolism has been reported after HTO.[14] On the basis of these data, it is reasonable to consider employing deep vein thrombosis prophylaxis measures after HTO, similar to those used after total knee arthroplasty.

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