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ORIGINAL STUDY

Distal Femoral Cortical Irregularity in children

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Cortical abnormalities at the distal postero-medial femoral metaphysis may be relatively common. We reviewed the plain radiographs of 197 knees in 130 children aged between 5 and 12 years to investigate the incidence of distal femoral cortical irregularities (DFCI) and their association with symptoms. An adductor magnus lesion was found in 15% of cases, with an even number of irregular and cystic lesions. A medial gastrocnemius lesion was found in 5% of cases, but no association was found between symptoms and the lesion. Overall, lesions were found in 25% of cases aged 5 to 9 years, but in only 13% of cases aged 12 and 13 years. Boys showed a higher incidence of both adductor magnus and medial gastrocnemius lesions. DFCI is a benign, self-limited entity and a relatively common radiologic finding. Regardless of whether or not symptoms are present, imaging findings should be carefully interpreted to avoid unnecessary diagnostic and invasive therapeutic procedures.

Keywords : femur ; cortical irregularity ; adductor magnus ; gastrocnemius ; children ; classification ; diagnosis.

INTRODUCTION

Cortical abnormalities at the distal postero-medial femoral metaphysis may be relatively common and consists of a small, radiolucent fibro-osseous lesion with surrounding sclerosis. Because this condition has mainly been described in radiological journals, orthopedic surgeons are often unaware of its existence and can therefore sometimes fail to diagnose it correctly.

In 1941, Sontag and Pyle first reported cortical irregular lesions in the distal femur and called these metaphyseal cysts (*13*). Other authors later published additional studies on this lesion, but a full description is still lacking (*4,5,8,12,16*). Previous reports employed a variety of diagnostic terms, including fibrous cortical defect, cortical desmoid and metaphyseal cortical irregularity (*8,12*). The most appropriate term for this lesion remains to be established, but in the present work we will refer to it as distal femoral cortical irregularity (DFCI) (*16*).

In this study we reviewed approximately 200 plain radiographs of children's knees to investigate the incidence of DFCI and its association with symptoms. One case underwent curettage of the lesion and we discuss the etiology and treatment of this case in detail.

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MATERIALS AND METHODS

To determine the incidence of symptomatic and asymptomatic DFCI, we investigated plain radiographs of 197 knees in 130 children aged between 5 and 12 years. Cases with tumor, infection or fracture were excluded from the study. There were 83 boys and 47 girls. All patients complained of knee symptoms and radiographs were taken to compare the affected and healthy side. If point tenderness matched the radiological lesion, a diagnosis of symptomatic DFCI was made. We modified the radiographic classification proposed by Resnick and Greenway (*11*) and by Suh *et al* (*14*). Lesions were divided into two types according to location at the insertion of the adductor magnus (AML) or at the origin of the medial gastrocnemius muscle (MGL). AML lesions were more often irregular and cystic (Fig. 2).

RESULTS

The results are summarized in Table II. AML was found in 15% of cases, with an even number of irregular and cystic lesions. MGL was found in 5% of cases, but no association was found between symptoms and the lesion. Overall, lesions were found in 25% of cases aged 5 to 9 years, but in only 13% of cases aged 12 and 13 years. Boys showed a higher incidence of both AML and MGL.

CASE PRESENTATION

Case presentation with symptomatic medial gastrocnemius lesion

This case was our first experience of DFCI. An 11-year-old girl visited our hospital for left knee pain experienced during the preceding 6 months. She had no history of trauma. Tenderness was present only on the postero-medial aspect of the distal femur. Plain radiography showed an irregular, radiolucent lesion with clear margins in the antero-lateral view. The right knee showed normal radiographic findings.

Computed tomography (CT) revealed a cortical, irregular lesion at the origin of the medial gastrocnemius muscle. Magnetic resonance imaging (MRI) results showed the lesion was homogeneously low signal on T1 weighted image and high signal on T2 image. No extra-osseous lesion arose from the femur. Because we were not confident in diagnosing the lesion as benign, and because the patient complained of long-term pain, we decided to perform a curettage. The pathological report showed a proliferation of fibrous and osteocartilaginous tissue, but there were no tumor cells or active inflammatory cells (Fig. 1).

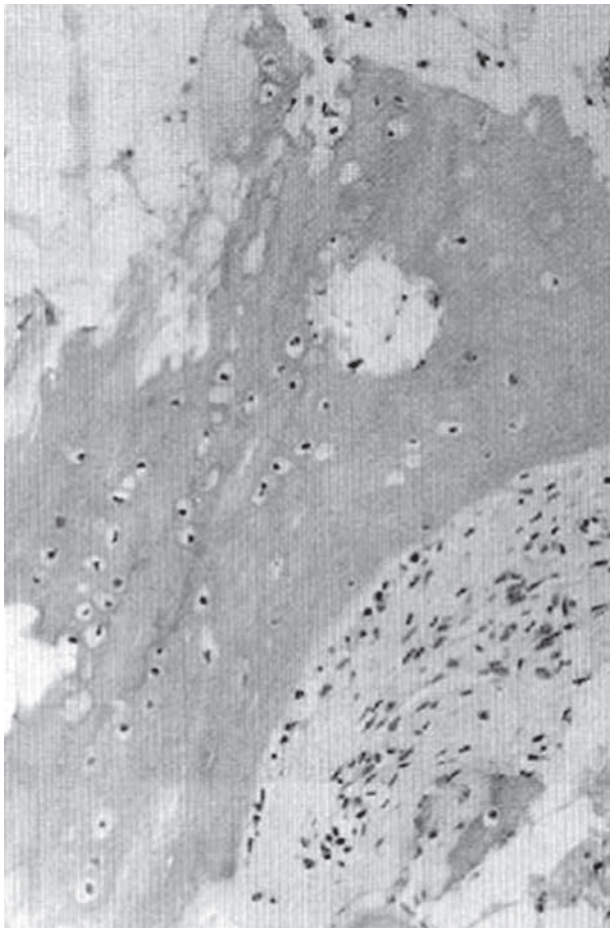

Fig. 1. — Pathological findings in an 11-year-old girl with MGL. The specimen showed proliferation of fibrous and osteocartilaginous tissue, but there were no tumor cells or active inflammatory cells.

Newly diagnosed cases with distal femoral cortical irregularity

Over the past 5 years four children, three boys and one girl, were referred to our hospital for

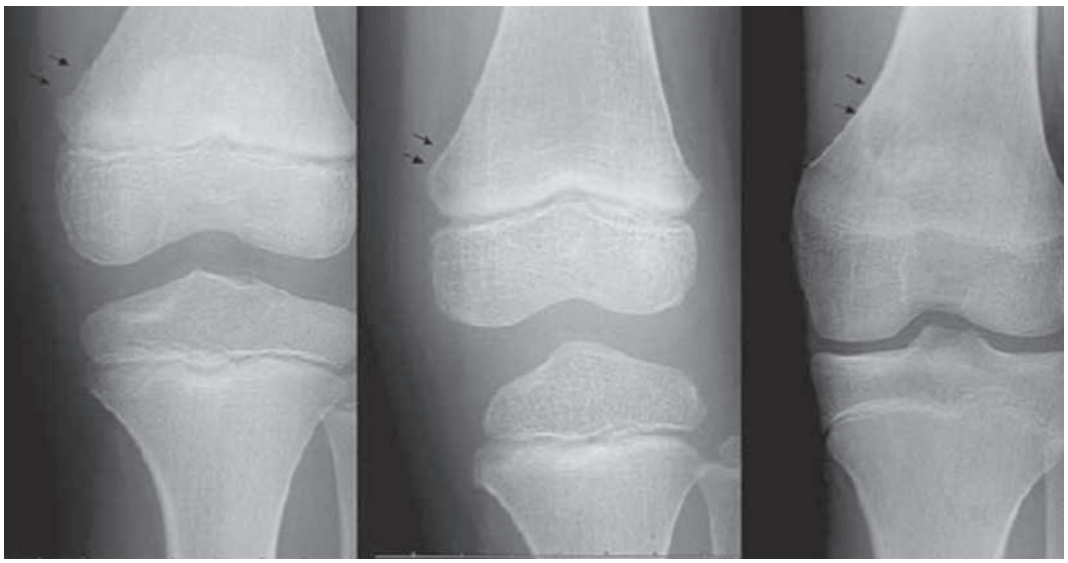

Fig. 2. — Modified classification of DFCI. Lesions were divided into two types according to location at the insertion of the adductor magnus (AML) or at the origin of the medial gastrocnemius muscle (MGL). AML lesions were more often irregular (right) and cystic (center). MGL was always cystic (left).

evaluation of a bony tumor in the distal femur and for possible diagnosis of DFCI (Table I).

Three children were diagnosed as unknown or with a suspected malignant tumor. Two cases presented with anterior knee pain and two with medial knee pain. Point tenderness corresponding to the radiographic lesion was not recognized in any of the cases, leading to diagnosis of an asymptomatic lesion. In three cases the lesion was located at the origin of the medial gastrocnemius muscle (Fig. 3A-C). An 11-year-old boy was the first case to show a radiolucent, cortical irregularity at the origin of the lateral gastrocnemius muscle (Fig. 4A,B). All cases were finally diagnosed as asymptomatic DFCI and pain relief was obtained without any treatment.

DISCUSSION

Classification of DFCI

In a previous review, DFCI was reported to occur in 11.5% of male children and 3.6% of female children aged between 3 and 17 years. These lesions were bilateral in up to 35% of cases (*15*). In 1982, Resnick and Greenway studied a collection of over 1,000 osseous specimens at the San Diego Museum of Man and classified this entity into *cortical excavations* and *proliferative cortical irregularities* (*11*). They proposed that cortical excavations arise due to stress from attachment of the medial gastrocnemius

Table I. — Details of four newly diagnosed patients with a distal femoral cortical irregularity

Cases	Age/ Gender	Symptoms	Duration	X-ray findings	Suspected disease	Other modalities	Diagnosis	Treatment
1	5/F	Anterior knee pain	1 y	MGL	Unknown tumor	CT	DFCI	None
2	8/M	Anterior knee pain	6 m	MGL	? Malignancy	MRI	DFCI	None
3	11/M	Medial knee pain	2 m	MGL	Non-ossifying fibroma	CT, MRI	DFCI	None
4	11/M	Medial knee pain	2 wk	LGL	? Malignancy	CT	DFCI	None

MGL, medial gastrocnemius lesion ; LGL, lateral gastrocnemius lesion ; DFCI, distal femoral cortical irregularity.

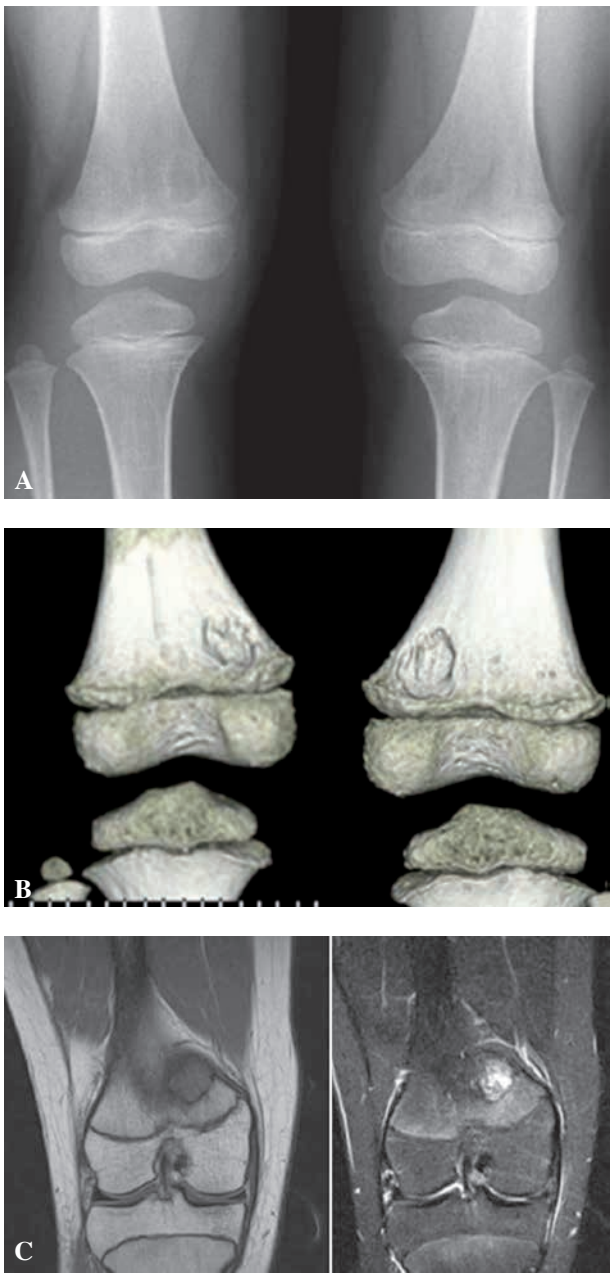

Fig. 3. — A 5-year-old girl with bilateral asymptomatic MGL of the distal femur. (A) plain radiograph, (B) three-dimensional CT showing a cortical concave lesion bilaterally, (C) MRI showing the lesion with low and high signal on T1 and T2 weighted image, respectively. No extra-osseous lesion arose from the femur.

muscle, resulting in reactive soft tissue formation at the osteo-tendinous junction.

Proliferative irregularities are located at the medial ridge of the linea aspera and are likely to be

Fig. 4. — An 11-year-old boy was the first case to show a radiolucent, cortical irregularity at the origin of the lateral gastrocnemius muscle. (A) plain radiograph, (B) CT showing concave cortical lesion.

related to the adductor magnus aponeurosis attachment. Suh et al. classified three distinct types of lesion according to their shape (*14*). These authors studied radiographs and MRIs of 100 knees in 93 patients with an average age of 34 years. Forty-four cortical irregularities were found by radiography, with 4 classified as concave, 36 as convex and 4 as divergent.

We modified the classification proposed by Resnick and Greenway (*11*) and by Suh *et al* (*14*) and separated lesions into AML and MGL. AML was further separated into irregular or cystic, whereas MGL was cystic only (Fig. 2). We recently experienced a case with a lateral gastrocnemius lesion

Table II. — Incidence of distal femoral cortical irregularities diagnosed by modified classification

Age	Boys	Girls	Knee	Adductor Magnus Lesion			Medial Gastrocnemius Lesion			Total (%)
				Irregularity	Cystic	Subtotal (%)	Boys	Girls	Subtotal (%)	
5-9	21	12	55	2	7	9 (16)	5	0	5 (9)	14 (25)
10,11	31	14	66	9	4	13 (20)	3	0	3 (5)	16 (24)
12,13	31	21	76	3	5	8 (10)	1	1	2 (5)	10 (13)
Total (%)	83	47	197	14	16	30 (15)	9	1	10 (5)	40 (20)

(LGL), which should therefore also be added to the classification.

To date, benign cortical defects of the proximal humerus at the insertion of pectoralis major in a 29-year-old male have been described by Brower (*1*). It is still unclear why DFCI occurs at this location.

Anatomical characteristics at the posterior aspect of the distal femur

One reason could be the mechanical weakness of this area. The posterior aspect of the distal femur has a special characteristic in that the shape is anatomically concave on the posterior condyle. This area forms a border between cortical and cancellous bone and the cortical surface is very thin. Numerous vessels enter through the surface of the bone and vascular passages are concentrated in this area (*9*).

Resnick and Greenway (*11*) proposed the following etiology for these lesions : 1) the presence of small, osseous irregularities at the base of the lesion could result from traction on muscle fibers ; 2) the cyst-like appearance evident on radiography could represent focal osteoporosis due to hyperemia provoked by the traumatic insult. If so, it is unclear why a stress-related phenomenon occurs at the distal insertion of the adductor magnus. Insertion of the gastrocnemius muscle is proximal to the epiphyseal plate. During the period of growth spurt in childhood, this insertion would be stretched as the epiphyseal plate rapidly grows longitudinally. The aponeurosis of the adductor magnus is inserted into the adductor tubercle medial to the head of the gastrocnemius muscle. This area of insertion may be quite narrow compared to the volume of the entire muscle (*9*).

It is also unclear why cortical excavations seldom occur at the insertion point of the lateral head of the gastrocnemius muscle, although we did experience one such case. Resnick and Greenway (*11*) also reported that the reason for this was unclear. The insertion of the medial gastrocnemius muscle is broader and thicker and the shape is more transverse than that of the lateral head.

Symptomatic or asymptomatic ?

Whether or not AML and MGL are symptomatic remains controversial. Kontogeorgakos et al. presented 4 cases of which three had no obvious symptoms related to the lesion and one in which the source of pain was unclear (*8*). In the present study, 20% of cases had positive X-ray findings of AML or MGL but there were no symptomatic children.

Craigen *et al* reported on 7 cases of symptomatic cortical irregularities (*4*). However, 6 cases were unlikely to have symptoms caused directly by MGL. Moreover, these authors performed a biopsy in five patients and obtained similar pathological results for each. The lesions consisted of fibroblastic tissue containing trabeculae of woven bone, with some formed by rows of osteoblasts and others by metaplasia from the fibroblastic stroma. There was also resorption of cortical and cancellous bone by osteoclasts. The overall appearance was that of repetitive proliferation of fibrous tissue with new bone formation. Histologically, DFCI has been considered as a variant of periostitis ossificans due to the mixture of scar-like fibrous tissue. These pathological findings suggest the lesion may cause knee pain but this would be mild and would soon resolve.

Accurate diagnosis of DFCI by image modalities

Accurate diagnosis of DFCI cannot be made simply by plain antero-posterior viewing of plain radiographs because MGL is frequently hidden by the patella shadow. The borderline between fatty tissue and muscle lies on the medial aspect of the distal femur, thus confounding the diagnosis of AML. Lateral viewing of radiographs is helpful for the diagnosis of MGL.

Recently, some authors have recommended CT (*10*), MRI (*6,14,17*), bone scintigraphy (*2*) and even positron emission tomography (*3*) for the diagnosis of DFCI. In relation to location and age, the differential diagnosis of this lesion includes osteomyelitis, periosteal osteosarcoma, periosteal osteoblastoma, osteoid osteoma and non-ossifying fibroma (*7*). CT or MRI is recommended in order to distinguish DFCI from tumor or osteomyelitis. However, accurate diagnosis can be made from plain antero-posterior and lateral radiographs provided orthopedic surgeons are familiar with the typical features of this lesion. Invasive diagnostic modalities should be used sparingly for diagnosis. If the radiological findings mimic periosteal reaction, further examinations are required to rule out malignancy, although this event would be very rare.

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