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EPIPHYSEAL GROWTH ARREST LINES MR FINDINGS

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We present two cases in which MR exams revealed unusual, low signal intensity lines in the marrow space of epiphyses. These epiphyseal lines were smooth and regular, creating a bone-in-bone appearance. These lines were much more conspicuous on MR than on radiographs, partly because of adjacent alterations in trabecular architecture. A history of prolonged immobilization during childhood in both cases suggests that these lines represent growth arrest lines persisting in the epiphyses. © Elsevier Science Inc., 1997

KEY WORDS:

Growth arrest lines; Normal variants; Epiphysis;
Magnetic resonance imaging

INTRODUCTION

On magnetic resonance (MR) imaging, we have noted unusual, low signal lines in the epiphyses of long bones. The smoothness and symmetry of these lines distinguish them from the findings in avascular necrosis, and suggest that they represent persistent "growth arrest lines" in the epiphysis. We present two cases in which correlative clinical history was available. While epiphyseal growth arrest lines have been described on radiographs (1, 2), their detection on MR may be unexpected and confusing.

CASE PRESENTATIONS

Case 1

A 46-year-old female, involved in competitive tennis, complained of knee pain. MR evaluation de-

tected a subacute stress fracture of the patella. MR also demonstrated low signal intensity lines paralleling the subchondral cortex of the distal femoral and proximal tibial epiphyses (Figure 1A). Areas of sparse trabecula bordering these lines exhibited higher signal intensity, especially on gradient-echo images (Figure 1B). Corresponding sclerotic lines were faintly seen on radiographs of the right (Figure 1C) but not the left knee. No typical growth arrest lines were present in the diaphyses or metaphyses of the femora or tibiae. The patient reported no major childhood illnesses. She had, however, fractured her left tibia at the age of 8, and was subsequently confined to a wheel chair for three months.

Case 2

MR was performed on a 22-year-old female to evaluate right groin pain of three weeks duration that was worse with hip flexion. MR showed no abnormalities except smooth semicircular low signal lines paralleling the subchondral cortex of the femoral heads bilaterally (Figure 2A). These lines terminated at the growth plate scar. There was no associated marrow edema. Similar, less well-defined lines were seen in the posterior ilia, highlighted by a preponderance of fatty marrow within their borders (Figure 2B). Radiographs were reportedly normal. The patient's childhood history was significant for developmental dysplasia of the right hip. At the age of 14 months, the patient underwent surgical reduction of the hip and was subsequently immobilized for six months: first in a cast, then in a brace.

DISCUSSION

The preceding cases illustrate the unusual MR finding of smooth, regular, low signal intensity lines par-

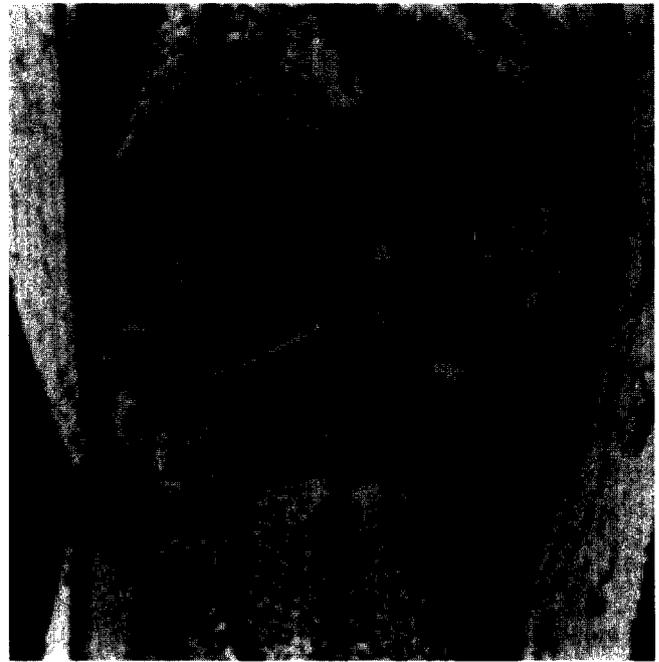
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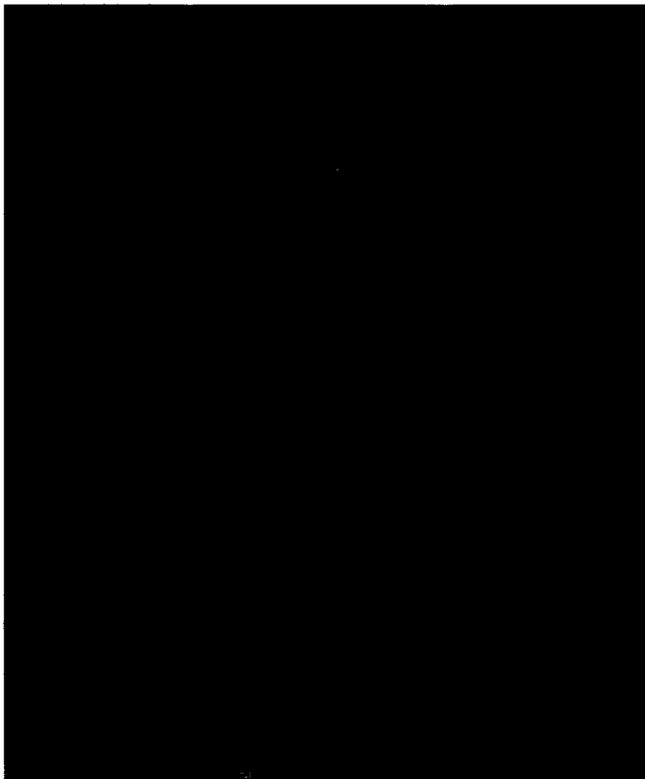
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A

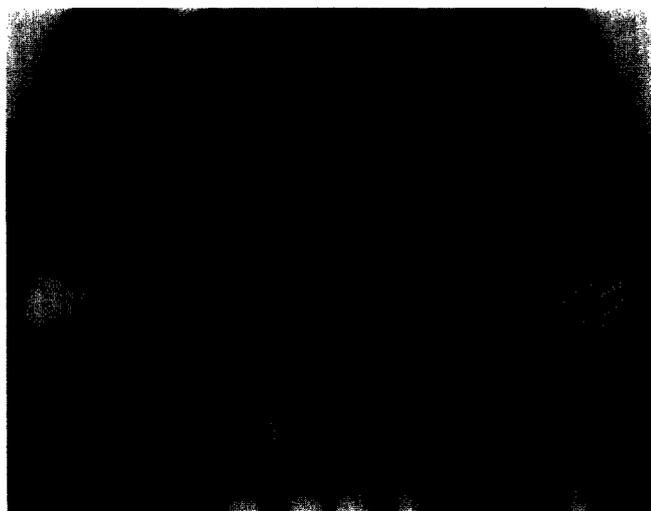


B



C

FIGURE 1. (A) Sagittal proton density MR image (TR1800, TE20) of the right knee shows a low signal line paralleling the subchondral cortex of the femoral trochlea (*curved arrow*). The line terminates proximally at the growth plate scar. Another line is faintly seen within the proximal tibial epiphysis (*small arrows*). (B) On coronal 3-dimensional Fourier transformed gradient recalled image (TR28, TE13, flip angle 33°), areas of sparse trabecula along the internal margins of the epiphyseal lines appear as focal regions of higher signal intensity (*arrows*). (C) Anteroposterior radiograph of the right knee depicts a faint sclerotic line paralleling the subchondral cortex of the medial femoral condyle (*small arrows*). Similar lines closely parallel the subchondral cortex of the proximal tibia (*large arrows*). Radiographs of the left knee were normal.



A



B

FIGURE 2. (A) Coronal T1-weighted MR image (TR600, TE10) demonstrates symmetric curvilinear low signal zones (*small arrows*) paralleling the subchondral cortex of the femoral heads. These lines terminate at the expected level of the (non-visualized) physal scar. (B) Axial proton density MR image (TR1800, TE15) reveals less well-defined lines in the posterior ilia that are accentuated by the regions of fatty marrow they demarcate (*arrows*).

alleling the subchondral cortex of epiphyses. These lines are characterized by an absence of surrounding marrow edema, though focal areas of sparse trabecula along their internal margins may exhibit relatively higher MR signal intensity. The configuration of these lines and the corresponding clinical histories suggest that they are epiphyseal growth arrest lines, analogous to the more familiar transverse growth arrest lines seen in the metaphyses and diaphyses of long bones on radiographs (3, 4).

Metaphyseal or diaphyseal growth arrest lines of Harris or Park, while commonly seen on radiographs

taken in childhood, only occasionally persist into adulthood (1). Diametaphyseal growth arrest lines were not seen in our cases. What might predispose to the formation and persistence of growth arrest lines in the epiphyses rather than the metaphyses is unclear. The greater rate of bony remodeling in the metaphysis could explain the disappearance of diametaphyseal growth arrest lines, and the persistence of epiphyseal growth arrest lines in cases such as ours.

Traditional growth arrest lines are associated with severe childhood infection, malnutrition, or immobilization (3, 4). They may also result from immunosuppressive or chemo-therapeutic drugs (5, 6). Paleontologists have used these lines to assess the health of ancient civilizations (7). The metaphyseal growth arrest line is probably caused by a slowdown in endochondral ossification, and a resultant decrease in the height of physal column cells. The hypertrophic and columnar zones of the growth plate become narrower, and ensuing, secondary endochondral ossification creates more transversely oriented bony trabecula. These condensations of trabecular bone are seen on radiographs as a "growth arrest" or "growth recovery" line (1, 8). Growth arrest lines predominate in skeletal regions of most rapid growth, such as the proximal tibia and distal femur.

The epiphyseal lines in our cases intersected rather than paralleled the physal scar. This orientation is consistent with the known hemispherical pattern of epiphyseal growth which parallels the surface of the articular cartilage (9); the physis contributes linear growth in the metaphyseal but not the epiphyseal direction. The outline created by the epiphyseal growth arrest lines represents a "ghost" of the epiphysis as it was at the time of arrest. Like a radiograph for bone age determination, the "epiphyseal ghost" in such cases may indicate the approximate time or age when the insult to growth occurred.

In summary, epiphyseal growth arrest lines may be depicted on MR exams and should not be confused with fractures or avascular necrosis. These lines are analogous to the Harris growth arrest lines that are commonly seen in the diaphysis or metaphysis on radiographs. These lines may be more conspicuous on MR imaging than radiography, being accentuated by local distortions in trabecular architecture. In the appropriate setting, these lines could be of potential forensic value.

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