Regeneration of the proximal tibial epiphysis after infantile osteomyelitis
REPORT OF THREE CASES WITH AN EIGHT- TO 22-YEAR FOLLOW-UP

K. S. Song,
H. K. W. Kim

From Keimyung University, Taegu, South Korea and Shriners Hospital for Children, Tampa, Florida, USA

We reviewed three infants with destructive osteomyelitis involving the proximal tibial epiphysis at a follow-up of eight to 22 years. All cases showed early radiographic destructive changes in the medial or lateral aspects of the epiphysis and metaphysis. Despite the ominous early appearance of the epiphysis, all cases showed spontaneous re-ossification of the epiphysis with restoration of the tibial condyle and preservation of joint congruity. The patients, however, developed a valgus or varus deformity which was treated satisfactorily with one to three proximal tibial osteotomies. The potential for regeneration of the epiphysis following infantile osteomyelitis of the proximal tibia suggests these cases should be treated expectantly with regard to joint congruity.

In infants, the epiphysis can be destroyed by bacterial infection spreading from a metaphyseal focus. At this young age, transphyseal vessels provide a pathway for infection to spread.\(^1\,^2\) If the metaphysis lies within the joint, pus from the metaphysis can also rupture through its thin cortex and periosteum early in the process and cause septic arthritis. A concomitant septic arthritis can also result from drainage of an epiphyseal abscess into the joint through the articular surface.

Since the first report by Bank, Krigsten and Compere,\(^3\) several authors have reported on the management and outcome of infants with osteomyelitis of the distal femoral epiphysis.\(^1\,^3\,^8\) However, only three cases of infantile osteomyelitis of the proximal tibial epiphysis have been reported,\(^6\,^8\) leaving uncertainty about optimal management and long-term outcome. We report three further cases of infantile osteomyelitis involving the proximal tibial epiphysis with eight to 22 years of follow-up.

Case reports

Case 1. An infant aged four weeks presented with a history of acute osteomyelitis of the right proximal tibia. At that time, he was noted to have a swollen right knee whose aspirate grew *Staphylococcus aureus*. Radiographs showed no evidence of osseous involvement. He was treated by incision and drainage, intravenous broad-spectrum antibiotics and immobilisation of the lower limb with a splint for three weeks.

At the age of four, he was referred to our institution for the management of a 40° valgus deformity of the knee. There was complete osteolysis of the lateral aspect of the tibial epiphysis and resorptive changes in the metaphysis (Fig. 1a). A proximal tibial osteotomy with staple fixation was performed when he was four years and 11 months old. The post-operative course was unremarkable and the osteotomy healed without complications. The lateral aspect of the tibial epiphysis, however, showed no radiographic evidence of re-ossification. Two years and five months after the osteotomy, the first radiographic sign of re-ossification was observed as small centres in the subchondral region. These became clearer six months later (Fig. 1b). By eight years after the osteotomy, the epiphysis had completely re-ossified (Fig. 1c). Two more osteotomies were performed when the patient was 12 and 16 years of age to correct a recurrent valgus deformity. The patient was asymptomatic and working as an outdoor manual labourer 22 years after infection. Examination revealed a stable right knee with a full range of movement. There was 7 cm of shortening in the right lower limb which was treated by tibial lengthening. At the age of 26, there was no limitation of movement or pain in the knee. However, a femorotibial angle of valgus of 14° and 2.2 cm of shortening were observed (Fig. 1d). The patient was treated with a shoe raise.

Case 2. A two-week-old febrile infant boy with swelling of the right knee and proximal tibia was seen at our institution. Radiographs of the left proximal tibia were normal except for soft-
tissue swelling on the medial aspect of the tibia and knee. The knee and the most fluctuant area over the proximal medial tibia were aspirated separately. Pus was aspirated from the proximal tibia and clear fluid from the knee. Incision and drainage of the medial aspect of the proximal tibia were performed. 

*Staph. aureus* was identified from the bacterial cultures of the samples from the proximal tibia. Microscopic examination and cultures of the aspirate from the knee were negative. Post-operatively, he was treated with intravenous antibiotics and immobilisation of the limb in a splint. After two weeks, the swelling of the knee and proximal tibia had subsided. He was afebrile and feeding and behaving normally. Radiographs four weeks later showed osteolysis in the medial aspect of the proximal tibial metaphysis (Fig. 2a). The epiphysis had not begun to ossify. At the age of two years and nine months, a 15° varus deformity was present with absence of ossification in the medial aspect of the epiphysis and metaphysis (Fig. 2b). An arthrogram showed the medial condyle of the tibia to be intact and the knee joint congruent (Fig. 2c). The knee was clinically stable. At the age of three years and four months, a corrective valgus opening-wedge osteotomy of the proximal tibia was performed (Fig. 2d). He had an unremarkable post-operative course. The first radiographic sign of re-ossification of the defective epiphysis was not seen until 11 months post-operatively. Over time, the medial aspect of the epiphysis became completely ossified (Fig. 2e). At nine years of follow-up, there was no recurrence of the deformity and shortening of only 0.6 cm, suggesting no significant growth disturbance.

**Case 3.** A two-week-old infant boy presented with acute multifocal osteomyelitis involving the right proximal tibia, the left distal femur and the right distal radius. He had no fever but there was swelling of both knees and the right wrist. Blood culture grew *Staph. aureus*. Intravenous antibiotic therapy and immobilisation of the extremities were undertaken. Radiographs of both lower limbs three weeks later showed blurring and widening of the right proximal tibial metaphysis and a periosteal reaction on the lateral aspect of the left femur (Fig. 3a). By three weeks, the swelling had subsided and the infant was well.

However, by the age of one year and eight months, he had developed a 25° varus deformity of the knee, and the medial aspect of the epiphysis and metaphysis showed osteolytic changes (Fig. 3b). A corrective valgus opening wedge osteotomy of the proximal tibia was performed at the time. The first radiographic evidence of re-ossification of the defective epiphysis was first seen nine months after the osteotomy (Fig. 3c). At eight-year follow-up, the radiographs showed no evidence of recurrence of the deformity and he had complete re-ossification of the medial condyle with intact joint congruity (Fig. 3d). There was satisfactory alignment of the limb although the right tibia was 1 cm shorter than the left; however, the total length of the right lower limb was 1 cm longer than the left because of growth retardation of the left distal femoral physis (Fig. 3e).

**Discussion**

Since osteomyelitis in infants can easily spread from the metaphysis to the epiphysis by way of the transphyseal vessels, a major orthopaedic concern is destruction of the epiphysis and disturbance of joint development leading to premature joint degeneration. The destructive process can also affect the physis, disturbing longitudinal growth.

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**Fig. 1a** Radiographs showing a) a boy aged four years and three months with a severe valgus deformity of 40° and osteolysis on the lateral aspect of the proximal tibial epiphysis; b) at the age of seven years and 11 months, ossification centres were clearly visible in the lateral aspect of the proximal tibial epiphysis; c) at the age of nine years and 11 months, the epiphysis was completely re-osified; d) at the age of 26 years, 2.2 cm of shortening and 14° of valgus deformity of the knee were noted after a limb-lengthening procedure. The radiolucent areas in the tibial diaphysis represent the areas of lengthening.
growth and producing angular deformity.\textsuperscript{1,4,6-9} Our three cases show that the proximal tibial epiphysis has a remarkable potential for recovery and regeneration. In all cases, a congruent knee joint was present at the latest follow-up. It is important to note that the initiation of re-ossification can begin several years after the infection. In the meantime, it is prudent to treat the bony epiphyseal defect expectantly.

Initiation of re-ossification of the defective epiphysis universally occurred after osteotomy to correct angulation. In cases 2 and 3 who had the osteotomy performed relatively earlier than case 1, initiation of re-ossification was earlier. Also, recurrence of an angular deformity was not seen in the two cases who underwent their osteotomy performed before the age of four years. This suggests that it may be beneficial to perform the proximal tibial osteotomy sooner rather than later, as observed in the treatment of infantile Blount’s disease.\textsuperscript{10-14}

Our cases show that osteomyelitis of the proximal tibial epiphysis tends to affect either the medial or lateral aspect
but not both. The three cases reported in the literature are in agreement with this finding.\textsuperscript{6,8} It is remarkable that once the deformity is corrected, recurrence was not seen in two of our cases at eight- to nine-year follow-up, suggesting that the affected growth plate can recover its potential to contribute to symmetrical growth once normal alignment is restored. These cases also demonstrate that longitudinal growth may not always be significantly affected following infantile osteomyelitis at this site.

The pathology of infantile osteomyelitis has been described by Ogden.\textsuperscript{2} In neonatal osteomyelitis, the amount of growth disturbance that is observed is believed to be directly related to the area of physeal destruction, the site of physeal damage, the amount of concomitant destruction of hyaline cartilage and the degree of damage to the cartilage canals/vascular system of the chondroepiphysis.\textsuperscript{1,4-8} Our cases suggest that, although the infective process may involve the ossification centre of the epiphysis, it
can spare the cartilaginous portion which contains resting stem cells with the potential to regenerate the damaged portion of the epiphysis. Even if radiographs reveal a substantial destruction of the bony epiphysis and metaphysis, the appearance may be deceptive as the remaining chondroepiphysis can restore the epiphysis and lead to normal joint development.1,4-8

No benefits in any form have been received or will be received from a commercial party related directly or indirectly to the subject of this article.

References