Epiphyseal Photopenia Associated with Metaphyseal Osteomyelitis and Subperiosteal Abscess

Patrice K. Rehm and John Delahay

Division of Nuclear Medicine, Departments of Radiology and Orthopedic Surgery, Georgetown University Hospital, Washington, DC

We present a case of metaphyseal osteomyelitis in a child where bone scintigraphy demonstrated photopenia of the distal femoral epiphysis in the absence of infection of the epiphysis or the joint space. A subsequent bone scan demonstrated evolution of the vascular compromise of the epiphysis due to the metaphyseal osteomyelitis complicated by subperiosteal abscess. We discuss the mechanisms and implications of photopenia in the setting of acute bone and joint infection.

Key Words: epiphyseal photopenia; metaphyseal osteomyelitis; subperiosteal abscess; bone scintigraphy

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Photopenia on bone scintigraphy in the clinical setting of acute bone and joint infection is well recognized. It may occur by a variety of mechanisms, all related to alterations in blood flow and delivery of the radiotracer secondary to infection. We report a case of a previously healthy child whose metaphyseal osteomyelitis of the distal femur resulted in epiphyseal photopenia on bone scintigraphy in the absence of infection of the epiphysis or knee joint.

While findings on the three-phase bone scan were indicative of osteomyelitis of the distal femoral metaphysis, there was the unusual associated finding of decreased uptake in the distal femoral epiphysis. The complicated clinical course, including surgical interventions, subsequent development of septic arthritis and follow-up bone scan are described. The mechanisms and implications of photopenia on bone scintigraphy in the setting of acute bone and joint infection are discussed.

CASE REPORT

A previously healthy 4-yr-old boy was admitted for a 6-day history of vague right distal femoral pain and low-grade fever, and a 2-day history of refusal to bear weight. The patient had a leukocytosis with left shift, elevated erythrocyte sedimentation rate and swelling and erythema of the right leg from the knee to the ankle. Radiograph of the knee was unrevealing (Fig. 1A). The right knee was aspirated of serosanguinous nonpurulent fluid. Gram stain and cultures were negative for an infectious agent. After blood cultures were obtained, intravenous nafcillin was started for presumed osteomyelitis. Within 24 hr of admission, a three-phase ^{99m}Tc-diphosphonate bone scan was performed.

The bone scan demonstrated findings indicative of osteomyelitis of the distal metaphysis. In addition, the soft-tissue phase and delayed images demonstrated photopenia of the distal epiphysis (Fig. 1B–D). Blood cultures subsequently grew Group A streptococci.

On the third hospital day, the patient continued to have spiking fevers and knee pain necessitating surgical exploration. An abscess was present, with a small amount of purulence within the bone, as well as copious purulent material beneath the metaphyseal periosteum medially, neither being under pressure. No effusion or purulence was found within the joint or the epiphysis. Copious irrigation was performed and drains were left in place. Antibiotic therapy was changed to intravenous penicillin. Gram stain and cultures of the purulent sites subsequently were positive for Group A strep and the epiphysis and joint sites were negative.

Because of spiking fevers and continued knee pain, the patient underwent a second surgical exploration and debridement on the fifth hospital day. Purulent material was found within the knee joint and within the metaphysis, neither being under pressure.

The child defervesced and completed a 6-wk course of intravenous ceftriaxone. A three-phase bone scan 1 mo after onset revealed increased activity of the distal femoral epiphysis in addition to the metaphysis (Fig. 2). The patient subsequently did well and had no joint or growth disturbance.

DISCUSSION

The normal circulation to a growing tubular bone such as the knee includes distinct epiphyseal and metaphyseal arteries. The growth plate lacks vascular connections between 1 yr of age and puberty (Fig. 3). In children, vascular anatomy predisposes the metaphysis to infection. While up to 30% of cases of acute osteomyelitis in children occur at sites other than the metaphysis, these metaphyseal-equivalent regions occur adjacent to cartilage and demonstrate similar vascular anatomy. Metaphyseal-equivalent sites include those adjacent to apophyseal growth plates, articular cartilage or fibrocartilage (*1*). As in this patient, the epiphysis typically is not involved by primary infection or by extension from the metaphysis (*2*). The effectiveness of the physis as a barrier to the spread of infection is confirmed by the rarity of contiguous extension to the epiphysis, destruction of the growth plate or growth disturbances. The infection spreads from its metaphyseal origin by way of the Haversian system to the metaphyseal subperiosteal space. The periosteum may be elevated, and it may rupture. When the metaphysis is intra-articular, as in the shoulder, hip, knee and ankle, suppurative arthritis results.

While most frequently demonstrated as increased radiotracer uptake, acute bone and joint infection may appear normal or photopenic on bone scintigraphy. The spectrum of bone scan findings in osteomyelitis reflects the pathophysiologic processes. Early in osteomyelitis, edema and increased local pressure may decrease the blood flow and tracer uptake. Subsequent local hyperemia causes increased radiotracer uptake, with an intervening normal scan appearance.

The less common, but well-recognized, pattern of photopenia in infection may occur by a variety of mechanisms, all related to alterations in blood flow and radiotracer delivery. Edema, subperiosteal pus and intraosseus pus can elevate intraosseous

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For correspondence or reprints contact: Patrice K. Rehm, MD, Nuclear Medicine, Gorman 2005, Georgetown University Hospital, 3800 Reservoir Road, NW, Washington, DC 20007-2113.

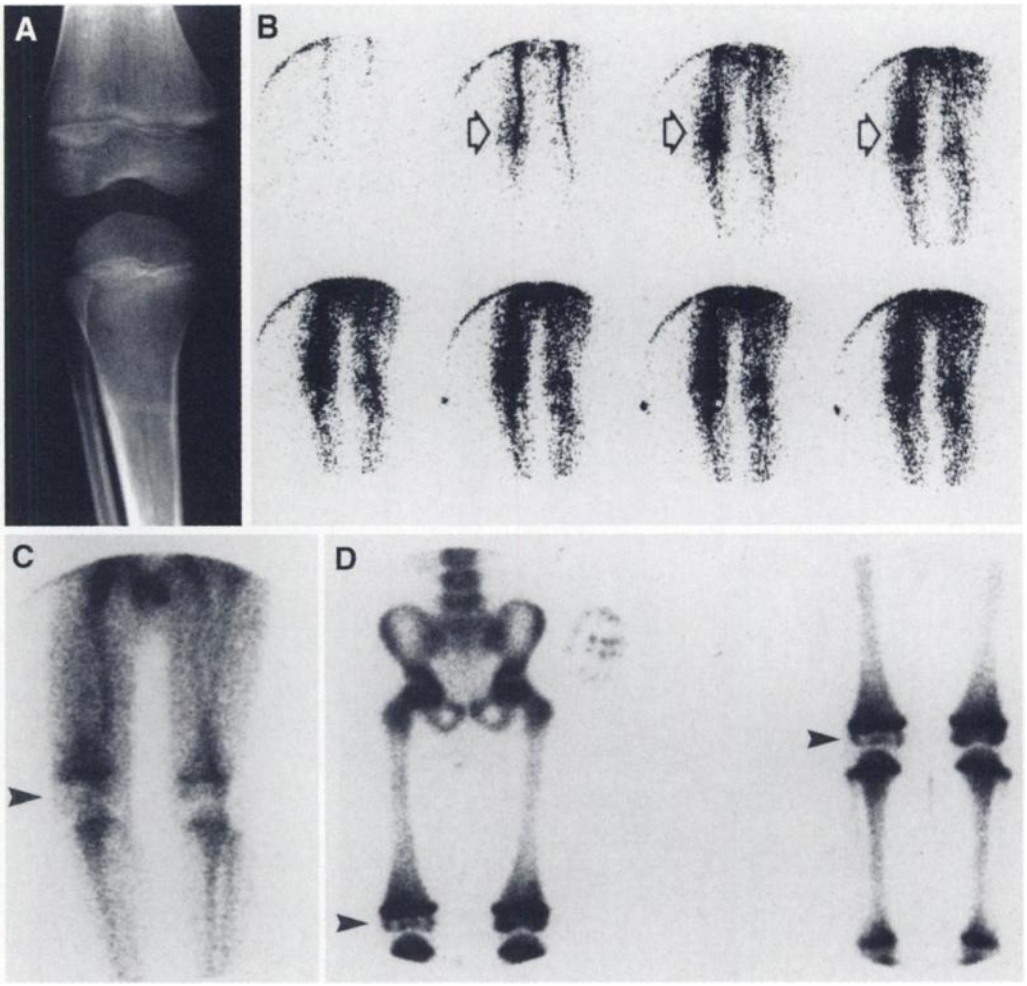

FIGURE 1. (A) Normal anterior radiograph of right knee. (B) Angiographic phase demonstrates hyperemia of right thigh, more pronounced in distal metaphyseal region (arrows). (C) Blood-pool image demonstrates increased activity in right distal metaphysis and physis. There is relative photopenia of right distal epiphysis compared to the left, most evident laterally (arrowhead). (D) Delayed image demonstrates photopenia of distal epiphysis (arrowhead) more pronounced in central portion. There is normal uptake in distal metaphysis.

pressure. Infection spreading throughout the cortex may compromise or thrombose the nutrient artery as well as lead to subperiosteal abscess formation. At a later stage, prolonged ischemia may produce photopenia representing infarction.

True photopenia must be distinguished from apparent photopenia that may result from juxtaposition of bones of differing osteoblastic activity such as an epiphysis compared to the adjacent physis. Comparison to the contraleral side as well as to the proximal tibial epiphyses confirms the presence of true photopenia of the distal epiphysis in this patient.

Case reports and series reporting photopenic osteomyelitis in children describe involvement of long bones, the head of the femur or humerus, as well as small and flat bones (*3*). Previous authors have noted an association between photopenia and subperiosteal or intraosseous abscess (*4*), which can necessitate prompt drainage to decrease morbidity (*5*). In patients with photopenic osteomyelitis, CT and MRI have been suggested for identifying coexisting abscess requiring drainage (*6*). Some authors have suggested an association between photopenic osteomyelitis and a poor outcome. The impairment of blood flow and decreased antibiotic delivery may increase the morbidity and risk for sequestrum formation. Photopenia may signal the need for aggressive surgical management (*7*).

Photopenia of the intracapsular bone, such as in the shoulder and hip, can occur in acute infection and has been attributed to several mechanisms other than epiphyseal osteomyelitis. Sterile or purulent joint fluid can result in reduced blood flow and tracer uptake of the proximal femoral and humeral epiphyses (*6*). Reductions in intracapsular pressure through aspiration or drainage can restore blood flow and tracer uptake (*7*). Blood flow to the epiphysis may be compromised by metaphyseal infection without joint effusion by edema of the overlying synovium compressing vessels that supply the head. A subperiosteal abscess bulging into the joint can stretch and compress the epiphyseal arteries and veins within the synovium. Because of potential compromise of the epiphyseal blood flow by any of these mechanisms, surgical drainage of the proximal metaphysis of the humerus or femur as well as the joint has been recommended (*8*). Diagnostic maneuvers such as saline washings or arthrography during arthrocentesis can produce transient photopenia by increasing pressure in the joint if radiotracer injection follows the joint procedure within 1.5 hr (*9*). However, a similar pattern of vascular compromise and associated photopenia has not been reported for the distal femur.

Abnormalities on the early phases of the bone scan can indicate osteomyelitis when the delayed images are normal (*10*) as demonstrated in the metaphysis of this patient. The osteomyelitis originated in the distal femoral metaphysis, as indicated by the findings on the three-phase bone scan and confirmed by subsequent surgery. Epiphyseal osteomyelitis extending from the metaphysis could be postulated as an explanation for the photopenia on the initial scan, although this occurs rarely. However, cultures obtained at surgery before antibiotic administration indicated that infection had not spread to the epiphysis or the joint. The bystander photopenia of the epiphysis indicated vascular compromise by subperiosteal and intraosseous abscess of the adjacent metaphysis. The evolution from bone ischemia and infarction to healing is depicted by the findings in the epiphysis on sequential bone scans.

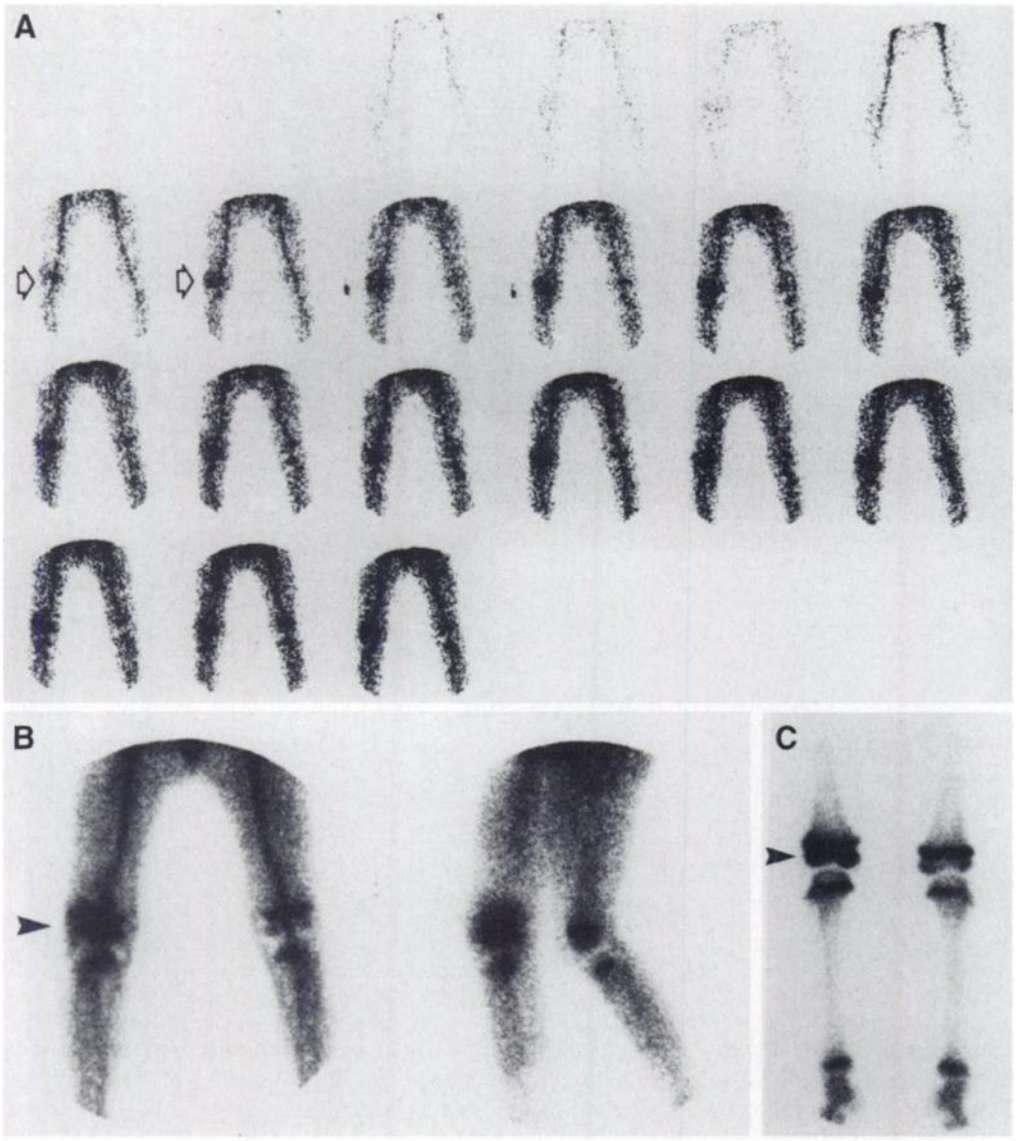

FIGURE 2. (A) Angiographic phase demonstrates hyperemia of right distal metaphysis and epiphysis (arrows). (B) Blood-pool image demonstrates increased activity in distal metaphysis and epiphysis (arrowhead). (C) Delayed image demonstrates increased activity in distal epiphysis (arrowhead).

CONCLUSION

It is important to recognize photopenia as a manifestation of osteomyelitis and to alert clinicians to vascular compromise and to the frequent coexistence of intraosseous or subperiosteal abscess. Appreciation of bystander photopenia as a presentation of vascular compromise of the distal femoral epiphysis due to metaphyseal subperiosteal abscess may lead to appropriate surgical management and decreased morbidity (*7,11*).

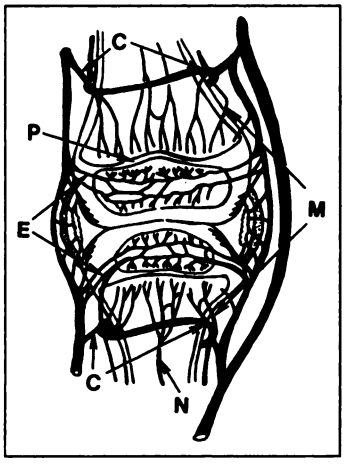

FIGURE 3. Diagram of arterial supply to knee of child. C = circulus articuli vasculosus (Hunter vascular circle); E = epiphyseal arteries; P = physis; M = metaphyseal artery; N = branches of nutrient artery. Reprinted with permission from Rosenbaum DM, Blumhagen JD. Acute epiphyseal osteomyelitis in children. *Radiology* 1985;15:89–92.

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