The Futility of Bone Scanning in Neonatal Osteomyelitis: Concise Communication

Judith M. Ash and David L. Gilday

The Hospital for Sick Children, Toronto, Ontario, Canada

Twenty-one neonates suspected of having acute osteomyelitis were studied by technetium-99m phosphate radiopharmaceuticals. Of the ten infants subsequently proven to have osteomyelitis involving 20 sites in all, only six sites (31.5%) were abnormal by bone imaging. Fifty-eight percent were normal and 10.5% equivocal. These poor results are contrary to the high accuracy rate achieved in slightly older infants; they negate the ability of the bone scan to diagnose neonatal osteomyelitis.

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The value of the bone scan in diagnosing childhood osteomyelitis has been well documented. Although there is some controversy as to whether the technetium-99m phosphate agents or gallium-67 citrate is better to diagnose either very early or chronic osteomyelitis (*1–3* and H. Handmaker, unpublished data) many authors (*4–7*) have reported 100% accuracy using the bone scan to diagnose acute osteomyelitis in children. The largest single series is that of Gilday and coworkers (*8*), who reported positive scans in 70 out of 71 children with this disease. However, as neonatal osteomyelitis is an uncommon disease, a specific reference to the usefulness of the bone scan in its diagnosis has not yet been published. The purpose of this paper is to report our experience in ten infants with neonatal osteomyelitis.

METHODS

Each infant was given an i.v. injection of Tc-99m polyphosphate or methylene diphosphonate, based on a dose of 8.3 mCi/m^2 body surface area, with a minimum dose of 1 mCi. An immediate blood-pool scintigram and 2- to 3-hr delayed bone images were obtained with a gamma camera. Images were recorded with an information density of 1,000–1,500 c/cm^2. In several instances converging collimator or pinhole views were obtained, the latter with an information density of 200 cts/cm^2.

This is a retrospective study comprised of 21 infants studied consecutively over a 4-yr period (1974–1978) to rule out neonatal osteomyelitis. Of these, 11 had a final diagnosis of septic arthritis, synovitis, cellulitis, or other disease (Table 1). The ten infants with a final diagnosis of osteomyelitis ranged in age from 7 to 42 days at the time of the first scan, but all had had the onset of disease within 30 days post partum. The diagnosis of osteomyelitis was based on the clinical response to antibiotics in conjunction with one or more of the following criteria: positive blood cultures (six infants), growth from bone aspirates (five infants), positive CSF culture (one infant), and typical radiographic changes either initially or on follow-up examination (nine infants). In the majority of cases, the causative organism was *Staphylococcus aureus* (Table 2).

RESULTS

There were 20 sites of bone involvement in the ten infants with proven osteomyelitis (Table 2). Six sites were positive by bone scanning, 11 were normal, two were equivocal, and one other was positive but had a fracture at the site and the increase was probably due to only the fracture. If this latter patient is excluded, in the

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For reprints contact: Judith M. Ash, MD, Div. of Nuclear Medicine, The Hospital for Sick Children, 555 University Ave., Toronto, Ontario M5G 1X8 Canada.

TABLE 1.

Presenting diagnosis	Final diagnosis				
Osteomyelitis	Osteomyelitis	Cellulitis and abscess	Septic arthritis	Monarticular synovitis	Other
21	10	4	3	1	3

remaining 19 sites, 31.5% of the scans were positive, 10.5% were equivocal, and 58% were normal.

In some cases the bone scan was negative despite a lytic lesion and extensive periosteal new-bone formation seen in the radiograph (Fig. 1), whereas in others in whom the scan was positive, the radiographs were normal aside from soft-tissue swelling (Fig. 2). We were not able to relate increased uptake in the bone scan to the causative organism or to the stage of the disease, since some patients with positive scans were scanned within a day of the onset of the disease whereas others were scanned as late as 34 days after the onset. Similarly, no definite relationship could be established between the bone-scan results and duration or efficacy of antibiotic treatment. All patients had been on antibiotics anywhere from 6 hr to 30 days (usually 3–4 days) at the time of the initial scan. Of the five infants who had follow-up bone scans between 1 and 2 wk later, only one that was previously normal became abnormal, and this was probably due to the effects of surgery.

These findings are quite different from the results in a group of 43 infants (within the same 4-yr period) ranging in age from 40 days to 1 yr (average age = 6.9 mo), with their onset of disease after the neonatal period. Bone scans were positive in all 19 of the infants subsequently proven to have osteomyelitis, some of whom had been treated with antibiotics at the time. The lack of false-negative results is particularly striking, as some of these infants had their bone scans at almost the same age as those who presented with neonatal osteomyelitis (Fig. 3).

DISCUSSION

Acute neonatal osteomyelitis is a disease very different

TABLE 2. COMPARISON OF INITIAL SCAN AND CORRESPONDING RADIOGRAPHIC RESULTS IN NEONATAL OSTEOMYELITIS

Case	Site(s)	Age at onset (days)	Initial scan	Age at scan (days)	Corresponding radiograph	Age at radiograph (days)	Organism
S.B.	proximal R. femur*	14	N	23	destruction	23	*Salmonella paratyphi B*
J.B.	proximal R. tibia	7	N	32	destruction	31	*Str. pyogenes*
G.N.	sternum	15	N	29	destruction	25	*S. aureus*
	proximal R. humerus	26	N	29	destruction, PNBF	28	
	L. calcaneus	26	N	36	destruction	39	
	proximal R. femur	26–36	N	36	destruction, PNBF	42	
	proximal R. tibia	26–36	N	36	destruction, PNBF	42	
J.K.	L. scapula	20	N	24	N	21, 32	*S. aureus*
B.W.	proximal R. femur	6	+	7	edema only	7	*S. aureus*
	proximal R. tibia	6	+	7	edema only	7	
	distal R. tibia	6–7	N	7			
	proximal L. tibia	6–7	+/−	7			
J.E.	distal R. tibia	9	+	42	destruction?	43	*S. aureus*
	proximal L. humerus	29	+	42	destruction	43	
	proximal R. femur	29	N	42	destruction, PNBF	41	
	proximal L. femur	29	N	42	destruction, PNBF	41	
S.K.	R. clavicle	7	+	35	edema only	33	*S. aureus*
A.R.	proximal R. humerus	4	+/−	15	edema only	14	*S. aureus*
M.Y.	R. tibia	18	+ (decrease)	22	edema only	22	*Str. pyogenes*
C.M.	proximal R. femur	16	+	20	destruction, fracture	21	no organism isolated

* Abbreviations used: R. = right, L. = left, N = normal, + = positive, +/− = equivocal, PNBF = periosteal new-bone formation.

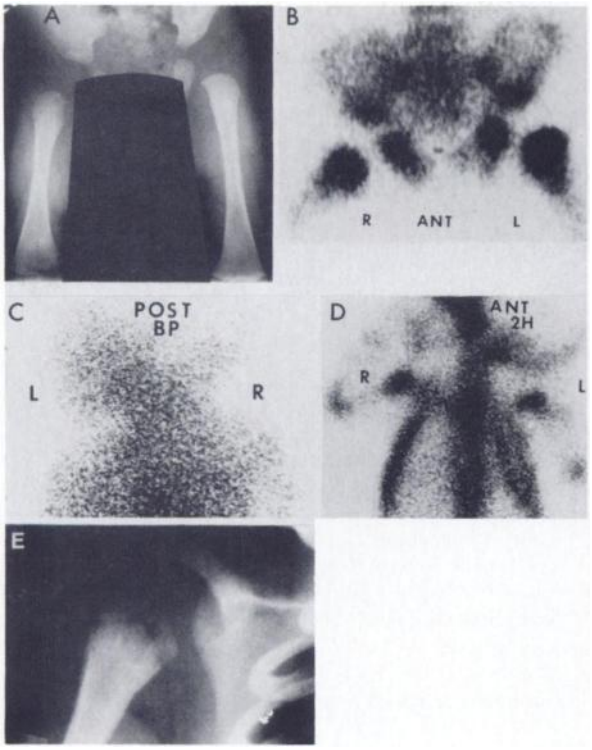

FIG. 1. Neonatal osteomyelitis of proximal right femur in 23-day-old in which (A) radiograph shows destruction in medial aspect of proximal right femur, whereas (B) pinhole view of hips is normal. Neonatal osteomyelitis of proximal right humerus in 29-day-old female. (C) blood pool and (D) delayed bone scan images show no hyperemia with no increased radioactive uptake in right humerus despite (E) radiograph of shoulder with humeral destruction and periosteal reaction.

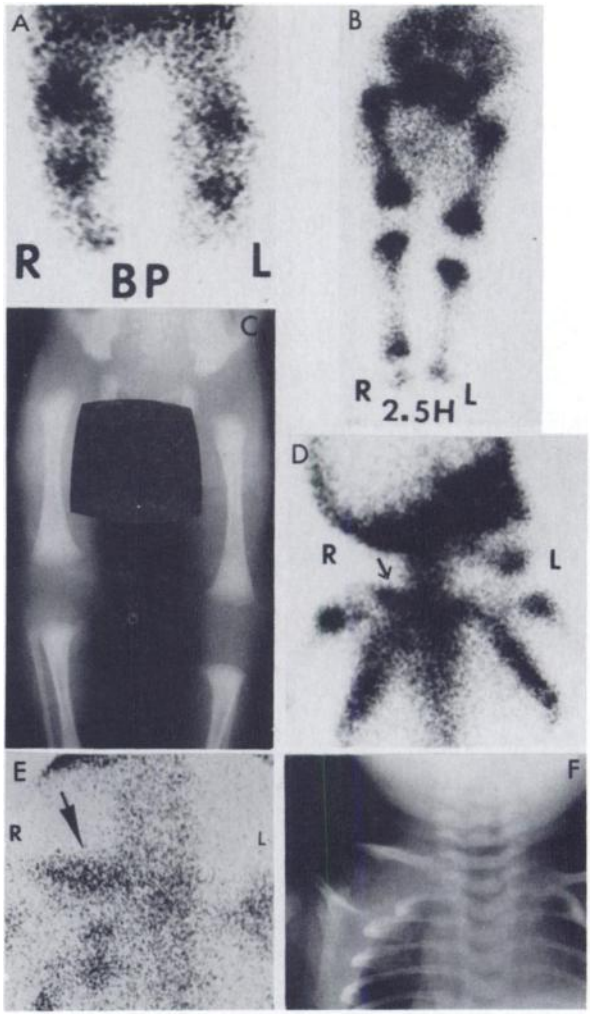

FIG. 2. Neonatal osteomyelitis of proximal right femur, proximal and distal right tibia, and proximal left tibia in 7-day-old male. (A) Blood-pool and (B) delayed bone images using converging collimator show slight hyperemia to right knee with mild increased bone uptake in right femur and right proximal and distal tibial metaphyses. Left knee was felt to be equivocal. (C) radiograph of legs shows soft tissue swelling only. Delayed bone scans in 35-day-old male with neonatal osteomyelitis of right clavicle, using (D) high-resolution collimator and (E) pinhole collimator show increased radioactivity in right clavicle (arrows) with diffuse soft tissue increase. (F) Radiograph shows no bony abnormality.

from osteomyelitis seen in older children (*9–11*). Since the infant often has little or no systemic disturbance, the disease may not become clinically apparent for some time after the onset. Multicentric involvement is more common than in older children. Since the epiphyseal plate does not act as a relatively avascular barrier, infection passes more easily into the adjacent joint. Thus diagnosis is extremely important so that adequate treatment may be given to prevent long-term morbidity.

The failure of the bone scan to demonstrate osteomyelitis in neonates is extremely disappointing when compared with its diagnostic accuracy in slightly older infants and children who were studied using the same technqiues, including doses related to body surface area. This discrepancy only serves to emphasize the fact that neonatal osteomyelitis must be considered as a disorder separate from that seen in older age groups. The hyperemia that is usually present in the blood-pool images in children with osteomyelitis was not seen even in the neonates with positive delayed bone scans in the acute stage. One would expect hyperemia to be present, since there was increased delayed bone uptake, thus excluding persisting ischemia. Although one would expect decreased activity if ischemia were present (see case M.Y., Table 2), it is possible that the activity would appear normal later on at the stage of early revascularization. There should be increased activity, however, as the bone heals further. One can also postulate that a normal scan, performed when a purely lytic lesion is visible on the radiograph, might reflect the inability of the radioactive bone tracer to accumulate in a region of rapid bone destruction. However, this does not explain the absence of hyperemia early in the course of disease, or the lack of increased uptake at a time when periosteal new-bone formation was present and healing was seen radiologi-

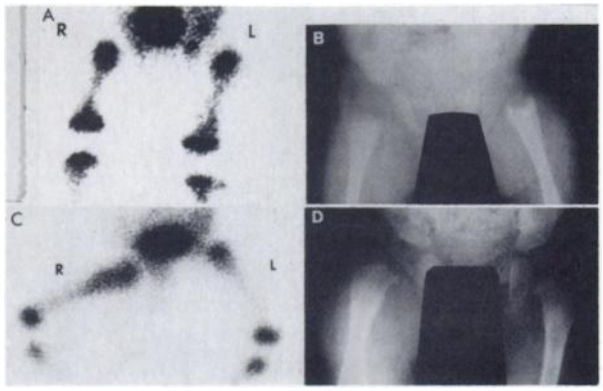

FIG. 3. Neonatal osteomyelitis of both proximal femurs in 42-day-old male (A) Delayed bone scan of the legs is normal in spite of (B) radiograph showing bone destruction with extensive periosteal new bone formation. Compare with (C) obvious radioactive increase in proximal right femur secondary to osteomyelitis in 60-day-old male with (D) radiograph also demonstrating bone destruction and periosteal new bone formation.

cally (Table 2). Although several infants had serial scans, no optimum imaging time emerged. Contrary to the experience of Sfakianakis and coworkers in children (*12*), the presence or absence of abnormal uptake in the bone scan in neonates did not correlate with the onset of disease, efficacy or length of antibiotic therapy, causative organism, or radiographic changes.

Immobilizing young infants can be difficult, and great attention must be paid to symmetrical positioning, since minor degrees of asymmetry will lead to apparent discrepancies in bone uptake. In some circumstances pinhole and converging collimator views were done to provide better anatomic detail, but even these did not show any abnormality. Although the recorded information density was lower for these views, this is the same information density that is used for all pinhole images and provides distinct bone detail.

There was a slight trend towards improved accuracy with improved camera resolution over the 4-yr period, but the accuracy rate after 1976 was still only 41%.

Since the bone scan was distinctly positive in infants with osteomyelitis who were the same age or slightly older than the ten with neonatal osteomyelitis, this supports our belief that the differences in accuracy are not due to difficulties in imaging infants, but rather to the nature of the disease itself. For this reason we do not recommend bone scans to diagnose osteomyelitis in the neonate. Although gallium-67 citrate has been used to locate infection in older children, we feel that the radiation dose from gallium is excessive in the neonate, particularly since other diagnostic techniques, such as needle aspiration, are available.

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