INVESTIGATIVE NUCLEAR MEDICINE

The Effect of Iatrogenic Trauma on the Bone Scintigram: An Animal Study: Concise Communication

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An animal study was performed to assess the effect on the Tc-99m phosphate bone scintigram of injury by needle aspiration or drill hole to metaphyseal and diaphyseal areas in immature and mature bones. Results showed that in 12 immature rabbits such trauma to metaphyseal regions had no effect on the bone image. Similar metaphyseal trauma in two mature dogs showed definite abnormalities on the bone image, but in one mature rabbit, no abnormality could be identified by scintigram. Diaphyseal trauma always gave a definitely abnormal bone image. Extrapolation of these results to humans should be cautious, but it suggests that needling or drilling in metaphyseal regions in neonates or young children probably does not affect later bone images.

J Nucl Med 25: 978–981, 1984

The importance of making an early diagnosis of acute osteomyelitis has been documented by the direct correlation of prognosis with early institution of appropriate antibiotic therapy (*1*). Radionuclide bone imaging has been shown to be a useful and more sensitive diagnostic tool than conventional radiography in the detection of acute osteomyelitis (*2–4*). However, particularly in young children and neonates, false-negative bone scintigrams are common and troublesome. In contrast, positive bone images, in the appropriate clinical setting, are generally thought to provide reliable indication of osteomyelitis, except when there has been previous trauma to the region in question (*5,6*).

In young children, hematogenously seeded osteomyelitis may localize in the metaphyses near the epiphyseal growth plate and the joint. Bone aspiration of purulent, culture-positive material at the site of maximal tenderness makes a definitive diagnosis. Occasionally, however, a definitive diagnosis is not evident, and an abnormal bone scintigram, made after the needle aspiration, is then interpreted as consistent with aspiration trauma, and therefore nondiagnostic for osteomyelitis.

The purpose of this study is to define the effect of iatrogenic trauma, including needle aspirations and subperiosteal drillings into bone, on the radionuclide bone image in immature animals.

MATERIALS AND METHODS

Fourteen immature New Zealand white rabbits, weighing 2–3 kg, were the subject population. In addition, one immature dog, two mature dogs, and one mature rabbit were studied. Immaturity was confirmed by radiographic demonstration of open epiphyseal plates. Six of the 14 immature rabbits underwent percutaneous subperiosteal needle puncture with an 18-gauge needle into the proximal tibial and contralateral distal femoral metaphyses. Six additional immature rabbits underwent $\frac{1}{8}$-in. drill holes into proximal tibial and distal femoral metaphyseal sites. Two other immature rabbits had similar $\frac{1}{8}$-in. drill holes placed in the mid-shaft diaphyseal area of the tibia. In an immature dog, a drill hole

Received May 18, 1983; revision accepted May 25, 1984.

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TABLE 1. RESULTS

Subject	Epiphyses	Trauma site	Bone scintigram
Rabbits	Open	Metaphysis	12/12 negative
Puppy	Open	Metaphysis	1/1 negative
Rabbit	Closed	Metaphysis	1/1 negative
Dogs	Closed	Metaphysis	2/2 positive
Rabbits	Open	Diaphysis	2/2 positive

was made in the distal femur on the left side, with 18-gauge needle aspirations of both proximal tibiae and the distal femur on the right. In the mature animals, 21-gauge needle percutaneous aspirations of a distal femur and a proximal tibia were performed.

Bone scintigrams were obtained at 2 to 3 hr after i.v. administration of 150 μCi of Tc-99m MDP per pound body weight. Imaging was performed with a 37-photomultiplier mobile scintillation camera, with a low-energy converging or pinhole collimator. All animals had normal preintervention bone images and radiographs of both knees in frontal and lateral projections. Postintervention bone scintigrams were performed 1, 2, 7, and 14 days after the injuries. Images usually contained 100,000 counts each, but several 50,000-count images were obtained when counting rates were particularly low (usually when pinhole collimation was used). Radiographs were also obtained.

RESULTS

The results are summarized in Table 1. None of the 12 immature rabbits with iatrogenic trauma in the metaphyseal-epiphyseal regions had abnormalities on postsurgical bone images up to 14 days after needle aspiration or drilling (Fig. 1). In a few cases, early images gave a very subtle appearance of slightly increased width of the proximal tibial metaphyseal-epiphyseal uptake, but later scintigrams were clearly within normal limits. The bone scintigram of the puppy with metaphyseal trauma showed no detectable abnormalities. Although the mature rabbit also showed no scintigraphic abnormality corresponding to the metaphyseal trauma (Fig. 2), both mature dogs gave abnormal bone images after similar injury (Fig. 3). Both of the two immature rabbits with diaphyseal trauma had abnormal bone images in the injured region (Fig. 4).

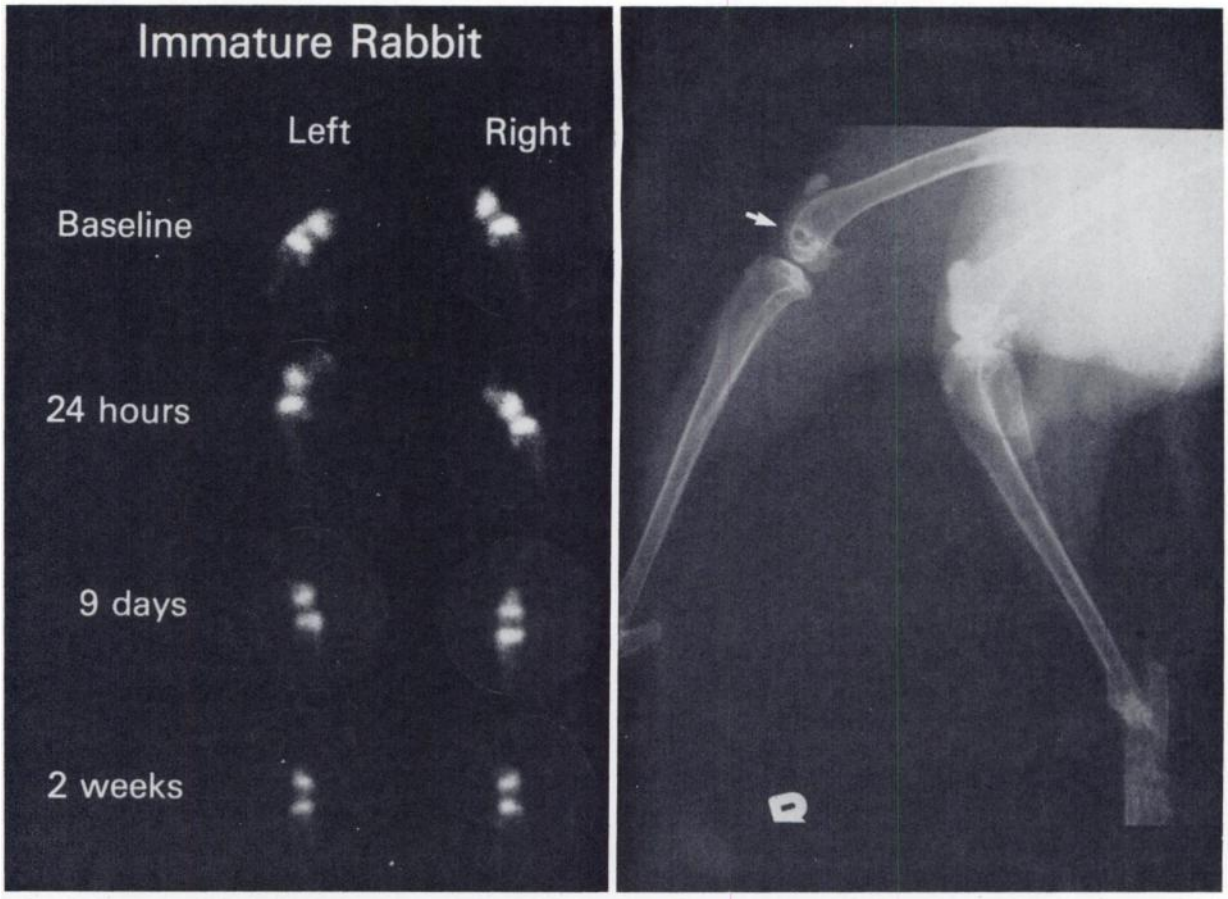

FIG. 1. Series of Tc-99m MDP bone images of knees (all lateral views except right knee at 9 days) from young rabbit after placement of drill hole at distal end of femur (cf. radiograph at right). None differs appreciably from normal preoperative image.

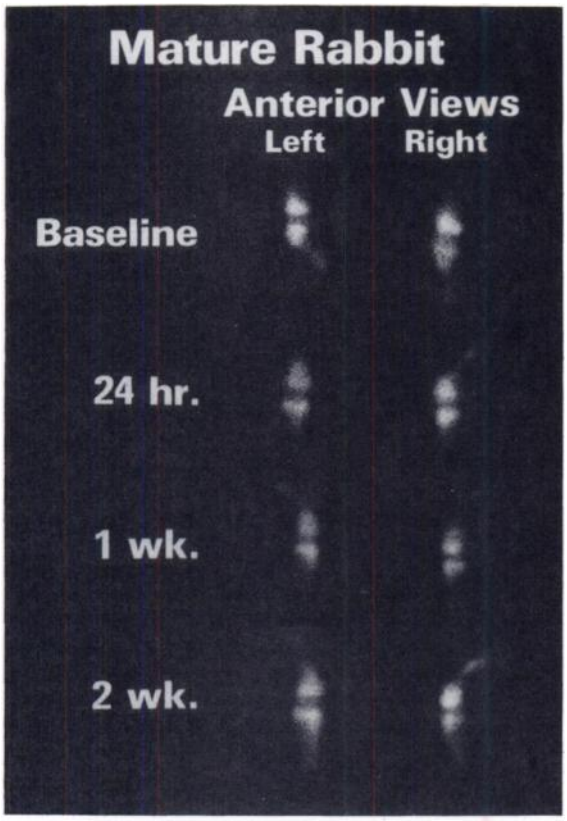

FIG. 2. Serial Tc-99m MDP images of knees of adult rabbit. Anterior views, with some variation. Preoperative control at top, after which right distal femur and left proximal tibia were aspirated with 21-gauge needle. Metaphyseal uptake of tracer remains essentially unchanged.

DISCUSSION

Multiple bone scintigrams of 12 immature rabbits and one immature dog were normal following metaphyseal trauma, in spite of the radiographic abnormalities that were sometimes seen. Although the numbers are small, in the mature animals focal abnormalities in bone scintigrams were usually seen after metaphyseal trauma in the appropriate locations.

We suggest that the normal high level of uptake in the metaphyseal-epiphyseal regions of immature animals masks the uptake presumed to result from the experimental injury, so that an abnormality cannot be identified on the bone image. In the mature animals, the normal metaphyseal uptake does not seem adequate to obscure superimposed trauma-induced uptake. Even in the mature animals, however, an abnormality related to trauma, although usually evident, was not always seen. Although a small needle aspiration in the distal femur of a mature dog (Fig. 3) was easily identified on the bone image, large drill holes in the distal femora of immature rabbits could not be detected. Likewise, in the mature rabbit, an abnormality could not be identified. Possibly the much smaller size of the rabbit knee contributed to the failure of detection, whereas in the larger mature dogs, the traumatic abnormalities were evident. Species differences between rabbits and dogs in the normal metaphyseal bone uptake may also contribute.

The Tc-99m phosphate bone scintigram is reported to be relatively insensitive in detecting osteomyelitis in young children and neonates. In a report by Ash and

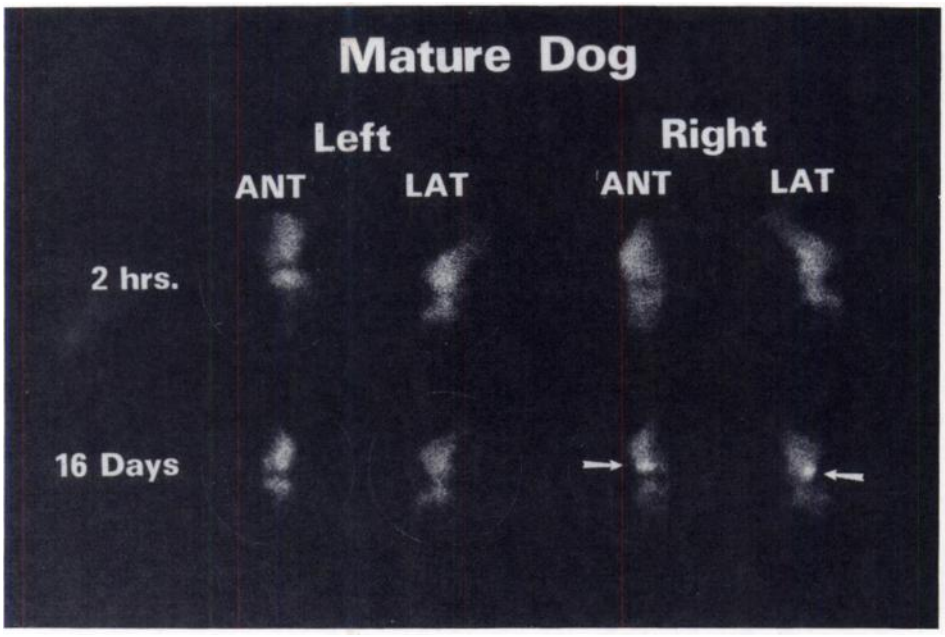

FIG. 3. Bone images from mature dog. Abnormal uptake in right distal femur (arrows) at site of needle aspiration.

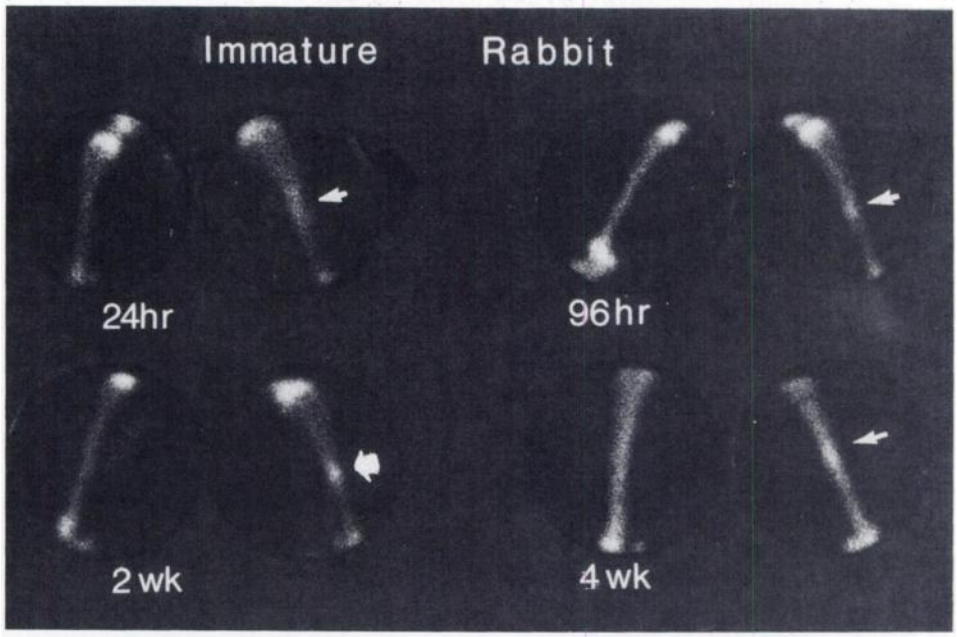

FIG. 4. Series Tc-99m MDP images of young rabbit showing abnormal uptake at site of needle aspiration in midshaft **tibial diaphysis (arrows). Uptake focalizes and increases in intensity to 4 wk after trauma.**

Gilday (*7*), 21 neonates suspected of having acute osteomyelitis were studied with Tc-99m phosphate tracers. Of the ten infants subsequently proven to have osteomyelitis, including 20 sites, 31% of the sites were abnormal on bone imaging, 58% of the sites were normal, and the remainder were equivocal. Perhaps the same masking mechanism as that suggested by our experiments with young animals was operating in these infants.

Tyler and Power (*8*) reported that in 24 cases of bone-marrow biopsies from the posterior superior iliac crest, bone scintigrams performed hours to weeks later showed no abnormality at the biopsy site. This supports the low likelihood that iatrogenic injury will cause an abnormal bone scintigram.

Extrapolating the significance of our experimental results to humans, we suggest that needling or drilling metaphyseal regions in youngsters probably will not affect the results of subsequent bone imaging. Nevertheless, this extrapolation requires caution. Immature rabbits' and puppies' bones are considerably smaller than those of young children, so our camera's image resolution may not have been adequate. Nonetheless, this study strongly suggests that any abnormality produced by the needling or drilling of metaphyseal bone in young humans is likely to be subtle. Regarding our adult animals, we can say only that the results of experimental injury were sometimes seen on the bone scintigrams.

ACKNOWLEDGMENT

This research was supported by the Veteran's Administration Research Service.

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