Technique for Improving Quality of Bone Scans

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A technique that has significantly enhanced the quality of bone scan images in our institution is described. The increased quality has been accomplished by the introduction of two modifications of present bone-scanning techniques: (A) adjusting the focal plane of the lower probe of the dual-probe scanner to coincide more closely with the midaxillary plane of the thoracic spine to minimize the background arising from the soft tissue of the trunk; and (B) reducing the spinal curvature to improve the resolution of the spine and ribs. The latter modification also helps eliminate high lumbar activity sometimes seen on the anterior scan.

Since the introduction of ^{99m}Tc-polyphosphate by Subramanian, et al *(1)* in March 1972, the number of bone scans performed by nuclear medicine departments has increased substantially. At our institution the number of bone scans performed in the first half of 1974 totaled 269, as compared to only 13 ^{85}Sr bone scans in the equivalent time span in 1972.

The use of technetium-labeled bone-scanning agents has not only simplified the bone-scanning procedure but has also improved the results significantly because of the increased information density (I.D.) that can be achieved. However, even though this increased I.D. has improved, there are still some gains to be made if good technique is adopted. This communication relates two improvements made in this department that may be of interest to others.

Bone scans taken with our initial techniques demonstrated high background activity in the region of the trunk, poorly defined ribs and spinal structures, and evidence of activity from the lumbar spine in the anterior scan (Fig. 1). Some factors contributing to the difficulty of obtaining satisfactory spinal images may be explained by the anatomy of the spine. The spine shows four curves that bend anteriorly and posteriorly from the midaxillary plane (Fig. 2). The cervical and lumbar

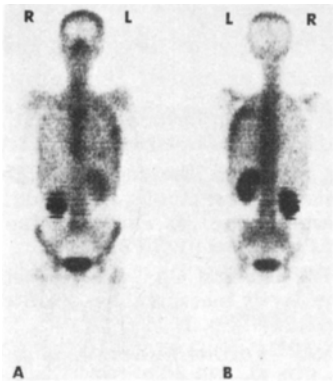

FIG. 1. Anterior (A) and posterior (B) bone scans before introduction of modifications demonstrate high body background and poorly visualized spine.

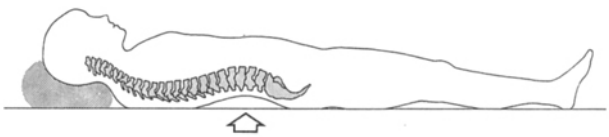

FIG. 2. Body outline demonstrates anterior and posterior curves of spine.

curves are convexed anteriorly and the thoracic and sacrum curves are concaved anteriorly. This is even more prominent in females in whom the lumbar and pelvic curves are greater, thus resulting in a more acute angle at the lumbo-sacral junction *(2)*. The average thicknesses of the sternum and spine are approximately 0.5 in. and 1.5 in., respectively. The femurs extend laterally and posteriorly from the hips to the knees.

Materials and Methods

The patient is injected with 10–20 mCi of ^{99m}Tc-Sn-polyphosphate and is scanned on the

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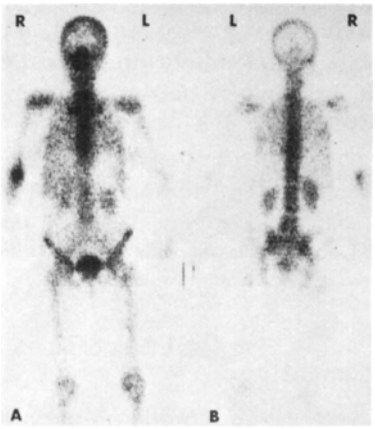

FIG. 3. Anterior (A) and posterior (B) bone scans after lower probe adjustment was made show decrease in background activity. Spinal activity (A) and poor visualization of spine (B) still exist.

Ohio-Nuclear model 84 dual-probe scanner 3 hr later. Model 35L low-energy, 5-in. focal length collimators are used. Instrument settings are: window, 34 keV; centerline, 143 keV; and background-erase, 15%. All patients are scanned in the 5:1 minification mode.

Lower probe adjustment. The patient is placed in the supine position. The lower probe is then adjusted so that its focal plane coincides with the average midaxillary plane of the thoracic spine. The thickness of the patient's body must be considered at this time. If the patient is thin, the lower probe must be lowered so that the midaxillary plane of the spine is within the focal plane of the lower probe. The upper probe is adjusted so that the focal point traverses the anterior cranium bone and is then lowered to maintain focal depth as the scan progresses down the body. The patient-detector distance of the lower probe is not changed during the scan.

Implementation of this modification has minimized the background activity compared to earlier techniques. The posterior scan demonstrates improved resolution of the trunk, but the spinal structure still remains poorly visualized. The activity from the lower spine remains high in the anterior scan (Fig. 3).

Reduced spinal curvature. The problem of spinal activity was eliminated by the introduction of this second modification that requires the patient's hips and knees to be flexed so that the lumbo-sacral region comes in contact with the table. The feet are placed firmly on a wooden wedge with the knees touching each other; the thighs are held vertical with respect to the table. This vertical position of the thighs is necessary to avoid obscuring the intervertebral space and to reduce the spinal curvature (Fig. 4).

Scanning is commenced at the head. When the detector approaches the substernal notch, the head is elevated by means of a firm pillow to reduce even further the lumbar curve and to insure patient comfort (Fig. 5). The shielding of the upper probe, when in the umbilicus region, begins to come in contact with the thighs, thus making it necessary to gradually slide the wedge away from the patient (with his feet remaining on the wedge). When the upper probe reaches the hip, the wedge is removed entirely so that the legs are flat on the table. Completion of the scan is accomplished by lowering the upper probe so that the focal point traverses the femoral and lower legs. The lower probe is adjusted to meet the midaxillary plane; the patient-detector distance remains unchanged during the posterior scan as described previously.

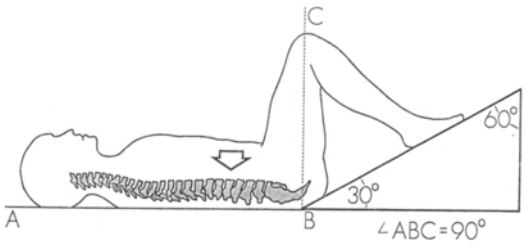

FIG. 4. Body outline demonstrates straightening of spine by flexing hips and knees.

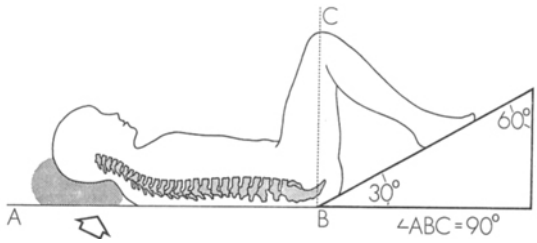

FIG. 5. Pillow is placed under patient's head to flatten spine even further.

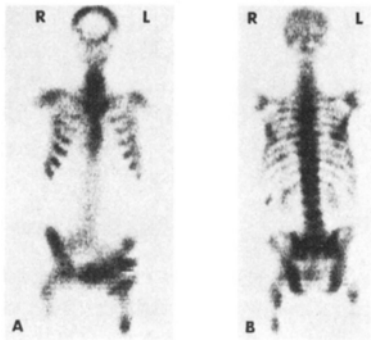

FIG. 6. Anterior (A) and posterior (B) bone scans after addition of two modifications demonstrate better resolution of ribs, spine, and sternum and reduced body background.

Results and Discussion

The clarity of the skeletal images is almost always improved with the introduction of the new techniques. Background activity is minimized and improved visualization of the spine and ribs is obtained. Finally, the lumbar activity sometimes seen on the anterior scan disappears because the lumbar curve is greatly reduced and falls outside the focal plane of the upper probe (Fig. 6).

There are, however, some situations in which it is difficult to obtain the desired effect. For example, when the patient is unusually thin the posterior scan may not be much improved because the movement of the lower probe is restricted such that the maximum detector-table surface distance is only 2.75 in. The average half-thickness of the spine is approximately 0.75 in., meaning that the total detector-spine distance is about 3.5 in. Consequently, the midaxillary plane of the spine is not far enough from the lower probe to be in a focal plane, even after taking into account reduction of the focal length by attenuation of radiation by the table, the sponge mattress (0.5 in.), and the patient himself. In these cases the resolution of the skeletal structure is often poor, even though the background is undoubtedly reduced. This problem is not evident in extremely obese patients because of the tissue thickness between the spine and the table.

There have been no complaints from patients of discomfort caused by flexing the hips and knees, unless the patient happens to have pain in these joints.

Acknowledgment

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