Bone Mineral Density of the Radius: Where Do We Stand?

Bone mineral density measurements are useful for predicting the risk of fracture in an individual, for assessing the effect of a disease or drug on bone mass, and for monitoring the effect of therapy of osteoporosis. For the hip and spine, measurements made at the affected site discriminate better between fragility fractures and nonfracture cases than do measurements made on other parts of the skeleton (*1,2*).

Nonetheless, there is renewed interest in measuring bone mineral density at other sites—e.g., the radius. Single-photon absorptiometry equipment is less expensive than dual-photon absorptiometry apparatus, and iodine-125 sources are less expensive than gadolinium-153 or americium-241 sources. The area of bone measured is smaller and more uniform, and positioning is usually simpler. The spine is commonly subject to deformities, such as hypertrophic spurs, that do not contribute to bone strength, kyphoscoliosis, and vertebral fractures. Calcium deposits in the aorta may also falsely elevate the estimated lumbar spine density.

The regions of the radius studied previously have been composed mainly of cortical bone. Figure 1 shows the location of the so-called "10%," "1/3," and "50%" sites. These proportions refer to the length along the ulna, not the radius. Figure 2 is taken from Schlenker and von Seggen (*3,4*) and shows the distribution of bone mineral content and percentage of trabecular bone along the radius. Since the "10%" site is actually about 12–15% of radius length, the percentage trabecular bone at this site is less than 25% and the percentage of trabecular bone at the "1/3" and "50%" sites is less than 10%. These sites are therefore mainly cortical bone whereas the vertebrae are made up of predominantly trabecular bone (*5*). Measurements made on the radius are often in the "normal range" for age in patients with vertebral fractures (*6*). Also, the effect of aging differs at the two sites. Bone density of the lumbar spine appears to decline after the age of 35 yr in women (*6–8*) whereas in the midradius and distal radius the decline does not begin until after the menopause (*9*).

In the past year, three groups have reported their experiences using single-photon absorptiometry to study the radius at the site where the percentage of trabecular bone is similar to that found in the lumbar spine, a site referred to as the "ultradistal" radius (*10–12*). One such study is reported by Nilas et al. (*10*) in the present issue of the *Journal of Nuclear Medicine*. The major difficulty in studying the ultradistal radius is the large change in bone mineral content over a short distance, as shown in Figure 2. Methods that depend upon palpation of bony landmarks such as the ulnar styloid process do not permit accurate relocation of the scanning site. Nilas et al. scanned the radius and ulna and then used a computer-based edge detection program to determine the site at which the radius-ulna gap was 8 mm. From this point, four scans were made at 2-mm increments distally. This region is shown in Fig. 1.

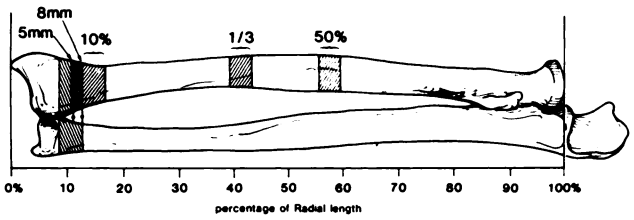

FIGURE 1
Tracing of radiograph of forearm bone excised postmortem from 94-yr-old man. Sites marked "1/2," "1/3," and "10%" are those measured by Riggs et al. (*6*) and distances are related to *ulnar* length. Distal site of Nilas et al. (*10*) begins where radius-ulna gap is 8 mm and extends for distance of 8 mm. Distal site of Awbrey et al. (*11*) is one measurement made where radius-ulna gap is 5 mm.

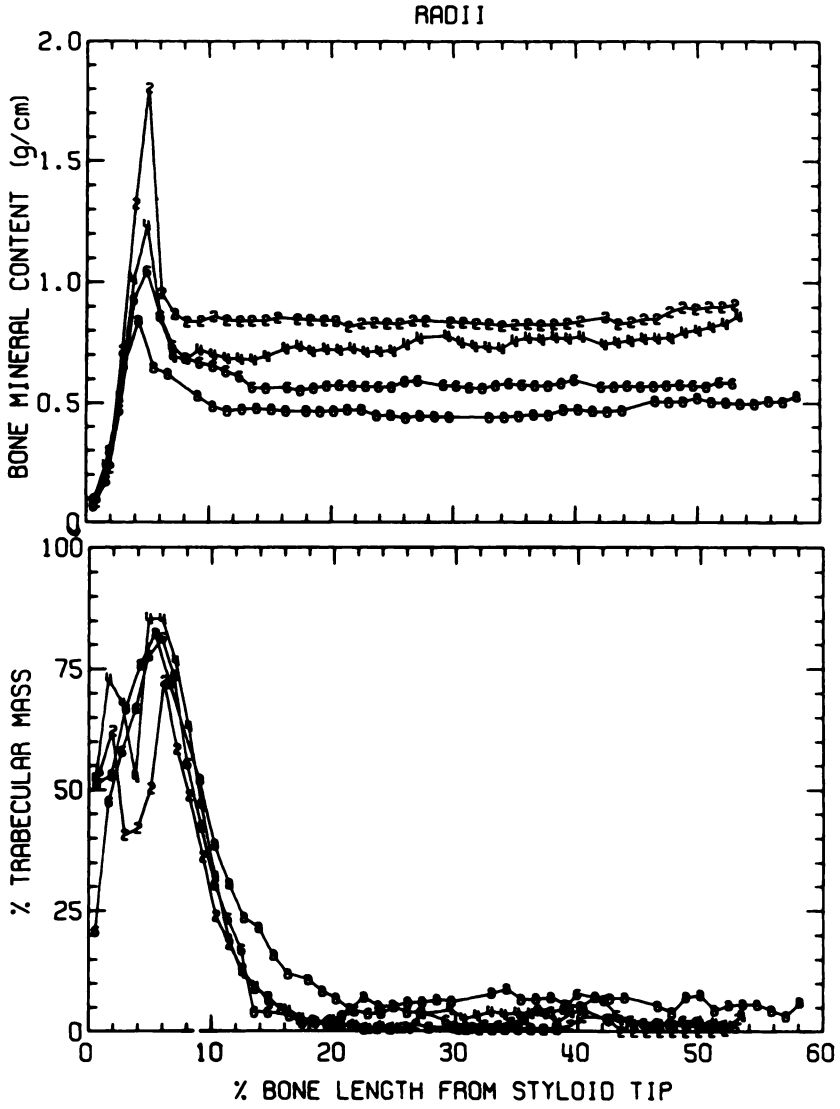

FIGURE 2
Bone mineral content and percentage of trabecular bone in radius as functions of percentage of bone length from *radial* styloid tip. After Schlenker (*3*)

Awbrey et al. (*11*) also used the radius-ulna gap to permit accurate repositioning but they made only one scan, where the radius-ulna gap was 5 mm. This is also shown in Fig. 1. The third group who measured ultradistal radius density by single-photon absorptiometry used computed tomography and obtained a cross-sectional image. From this image they measured the attenuation coefficient of the inner 50% of bone—i.e., of trabecular bone (*12*). The site of interest was identified by using digital radiographs to locate a point 3% of the length of the radius starting at the distal edge of the distal radio-ulnar joint. They reported a reproducibility of 0.1%.

How do measurements made on the ultradistal radius compare with lumbar spine density? Nilas et al. reported a correlation coefficient of 0.56 between bone density of the ultradistal radius and that of the lumbar spine. From measurements made at the "5 mm" site in normal women, Grubb et al. (*13*) found a correlation coefficient of 0.52. These correlation coefficients are statistically significant but, in terms of predicting lumbar spine density from ultradistal radius density in an individual, the appropriate parameter is the 95% confidence interval which is derived from the standard error of the estimate of the regression. Nilas et al. reported a standard error of the estimate of 11.2%, and so the 95% confidence intervals of

lumbar spine density as predicted from ultradistal radius measurement would be ± 22%. Similar 95% confidence intervals are obtained when predicting lumbar spine density from age alone (*6*).

In cross-sectional studies of bone density at the ultradistal radius site, no decline was found until after the menopause (*11,12*). This differs from lumbar spine density which declines from age 35 yr on (*6–8*). However, in the study by Awbrey et al. (*11*) the ratio of lumbar spine density to ultradistal radius density did not change with age. It is therefore uncertain whether the rates of loss of bone mineral at these two sites are similar.

Several questions remain to be answered before the ultradistal radius density can be considered a clinically useful measurement.

1. How well do ultradistal radius measurements discriminate between women with and without insufficiency fractures of the wrist, spine and hip?
2. Is the rate of bone loss with aging similar at the ultradistal radius and lumbar spine?
3. Is the effect of treatment of osteoporosis the same on ultradistal radius density as on lumbar spine density?
4. Does a disease known to affect bone mass, such as hyperparathyroidism or thyrotoxicosis, or drug therapy, such as corticosteroids, affect ultradistal radius to the same degree as lumbar spine?

Measurements made at the ultradistal radius site should be interpreted with caution until these questions have been answered.

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