NEW PERSPECTIVES IN BONE DENSITOMETRY

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The ability to make accurate measurements of bone mineral content has developed only within the last decade, and that the pattern of bone density through life has been established. Measurement is important, to study the factors which influence peak bone mass, and thereafter, as bone loses mineral. In women, who lose more bone mineral that men, 35% of cortical bone and 50% of trabecular bone can be lost over a lifetime. Osteoporosis studies are dependent on the relationship of bone mass to normal data.

MEASUREMENT TECHNIQUES

1. RADIOLOGICAL PHOTOGRAMMETRY

Radiological examination of bone has been well established as a clinical procedure. Advanced osteoporosis is obviously visible, but early stages more difficult to observe subjectively. Recent developments in image digitisation now enable clinical investiga¬tors to transfer radiographs to a computer, and measure some of the morphological features relating to bone structure.

2. SINGLE PHOTON ABSORPTIOMETRY

A procedure for measuring bone density at the forearm is one

of the oldest methods available. The subject may be required to place the forearm in a water tank, and gamma rays from an isotope are passed through the distal ulnar and radius.

3. DUAL PHOTON ABSORPTIOMETRY

Using a dual energy isotope source, gadolinium 153, better discrimination can be obtained between hard and soft tissues. Therefore, it has been possible to scan the lumbar spine and femoral neck at the hip joint which are surrounded by soft tissues. These systems have almost entirely been replaced by DXA, where improved resolu¬tion and shorter scan times have greatly enhanced their clinical use.

4. DUAL ENERGY X-RAY ABSORPTIOMETRY (DXA)

The stable X-ray beam is scanned across the patient and Is detected by one of three different methods to generate a quantitative image. Early systems are designed as a linear X-Y scanner, using a pencil beam generated below the patient and a detector system on the tracking arm over the patient. Later technology has replaced the pencil beam of X- rays with a fan beam, which can sweep the patient in a fraction of the time.

Resolution has also Improved. A useful feature of the later machines is the introduc¬tion of a C – arm for the generator and detectors. This enables the system to be rota¬ted around the patient, and is particularly useful for making a lateral examination of the lumbar spine. A DXA report usually contains a table of values which in addition will quote the T scores and Z scores for the specific regions measured. These are expressions in relation to a reference population in standard deviation units. The T score relates to a young healthy population and the Z score is expressed in relation to an age and sex matched population.

5. COMPUTED TOMOGRAPHY

By calibration with phantoms of known mineral content, Computed Tomography can be adapted to measure bone mineral content in – vivo(QCT). Most applications to date have been restricted to the spine, where separate measures of cortical and trabecular density are obtained. Contour tracking algorithms allow for automatic determination of the regions of

interest within the vertebral body and the posterior elements. A much smaller and less expensive dedicated system for peripheral bone densitometry is available (pQCT). This system is easy to use, has a radiation exposure which is extremely low (equivalent to DXA), and measures forearm cortical and trabecular bone in 2 minutes. Short term reproducibility is given as C.V. < 1%.

6. ULTRASONOGRAPHY

The possibilities of a truly non invasive technique have attracted much research into the attenuation and velocity of ultrasound through bone as a measure of strength. Most of the commercial systems available provide for measurement at the os calcis. Positional problems have been recognized as a source of lower reproducibility. Two other devices for bone measurement are available using ultrasound. A system which requires the operator to hold a sound head on the mid tibia through a layer of gel, uses the reflected sound signal as an index of bone quality Another system uses a small hand jig to send a signal across individual fingers, the metacarpal joints of the hand, and the distal radius. The units of measurement vary, but most report the speed of sound SOS or the broadband attenuation BUA units. Evidence on what these techniques actually measure is still being studied.

While much of the activity in bone densitometry is understandably focused on the middle – aged and elderly, there is a lack of substance in data on the young. Control values for children and younger populations under 25 years are very slowly accumu¬lating. This reduces the level of confidence that can be applied to densitometry data in these groups. More work in this area is needed to Improve the value of individual measurements, especially in the years leading to 'peak bone mass', which if low, is considered to be a risk factor to fractures in later life.