

Measurement techniques in Osteoporosis

Dual Energy X-ray Absorptiometry, Quantitative Ultrasound.

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Dual energy X-ray absorptiometry (DXA) has become the gold standard for measuring BMD. The regions most commonly scanned are the lumbar spine and the proximal femur. There are numerous studies demonstrating that BMD measured using DXA is predictive of future fracture risk. Proximal femur BMD appears to be the best overall predictor of fracture risk particularly at the most clinically relevant site of the hip. Each standard deviation reduction in femoral neck BMD increases the age-adjusted risk of hip fracture by a factor of 2.6 (range 2.0 to 3.5) and the risk of any atraumatic fracture by a factor of 2.0 (range 1.7 to 2.4). Each standard deviation reduction in lumbar BMD was found to increase the risk of vertebral fracture by a factor of 2.3 (range 1.9 to 2.8).

While DXA is generally reliable, osteoarthritis of the lumbar spine can lead to adjacent bony sclerosis, which may result in spurious elevations of BMD. Vascular or soft tissue calcification, previous fracture, clothing and extremes of body weight are less common causes of errors in BMD estimation. The reported in-vivo reproducibility of DXA is often approximately 1%. These precision data are however obtained in idealised conditions, and in clinical practice such high values are rarely achieved. At a realistic clinical precision of 2% a change of at least 5.6% between measurements is necessary to be 90% sure the change is real. In postmenopausal women the rate of bone loss is generally 1-2% per-annum and hence in most patients an interval of 2 years between scans is satisfactory, unless there is an accelerated rate of bone loss; eg. corticosteroid medication, where yearly (or even 6 monthly measurements) may be warranted.

In summary, DXA is currently the most widely used method for the quantitation of axial bone mass due to its utility in fracture risk stratification, and its high precision, which is essential for monitoring.

Quantitative ultrasound (QUS) utilises ultrasound to measure the physical properties of bone. The speed of sound transmission (SOS) and the attenuation of the ultrasound beam (broadband ultrasound attenuation - BUA), through peripheral bone sites (commonly the calcaneus) are used to assess bone mass. Some QUS machines combine these values to obtain a further index of fracture risk; eg., Stiffness or Quantitative Ultrasound Index. These ultrasound parameters reflect the bone mass, and in addition, may provide a marker of the integrity of the internal micro-architecture of bone, independently of bone mass.

There are a number of studies demonstrating that QUS of the calcaneus is predictive of the risk of osteoporotic hip fracture in elderly women. The gradients of risk reported for QUS are slightly lower than those reported for DXA. The application of QUS to monitoring is more problematical than its use in determining fracture risk, due to its poorer reproducibility compared to DXA and the significant differences in the response of bone at different skeletal sites to therapeutic interventions.

In summary QUS is a useful predictor of fracture risk and provides information independent of bone density. This technology is likely to be used to a greater extent in the future, possibly in conjunction with DXA. The commercial QUS devices available at present however, are more technically diverse than DXA instruments and standardisation of these instruments is still to be achieved.