Osteopenia 1: osteoporosis

Osteopenia, or loss of bone density – is a radiological appearance that has three main causes:

1. Osteoporosis
2. Rickets and osteomalacia
3. Hyperparathyroidism.

Osteopenia can be diagnosed on a radiograph as a visual loss of bone density, but is nowadays best assessed by DEXA scanning or computed tomography (CT) scanning, both of which use computers to measure attenuation of the X-ray beam by bone.

Dual energy X-ray absorption densitometry (DEXA scan)

X-ray sources of different energies are passed through bone and soft tissue in the area of interest – usually the hip, wrist and spine. The attenuation of the beam is assessed by computer. The results are expressed in terms of the number of standard deviations above or below the mean for an age-related control population (the 'Z' score) or with a young healthy adult population (the 'T' score) (Fig. 1).

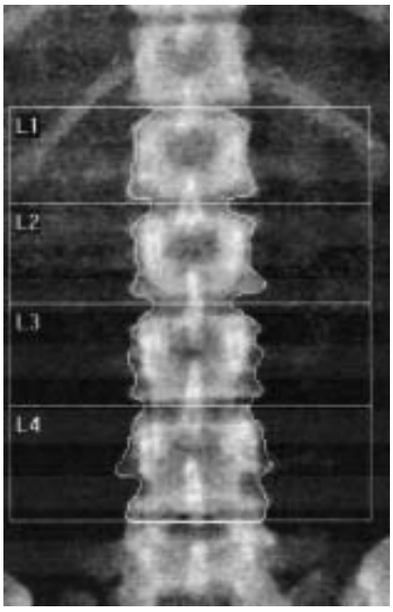
Bone-density measurements at a site give a predilection for *local* fractures, while those obtained at the distal radius and calcaneus give a good prediction for fractures at any site.

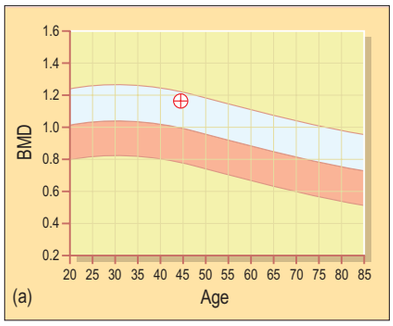
Osteoporosis

Osteoporosis (Fig. 2) is responsible for much skeletal disease in patients over the age of 50 years because of the increased incidence of fractures. These occur mainly in the spine, proximal femur and distal radius (and ulna), as well as in the pelvis and upper humerus. The risk of these osteoporotic fractures is much higher in women. Thus, the risk of a femoral fracture is 40% in women over the age of 50, but only 13% in men.

Colles' fracture of the distal radius and ulna, usually caused by a fall onto an outstretched hand, increases in incidence in women between the ages of 40 and 65 years, after which the incidence remains constant; in males of all ages the (lower) incidence remains constant. There is a coincidental increase in the incidence of falls in females between those ages. In the over-80s, perhaps because of an inability to break a fall with the wrist, a fracture of the hip is more likely (Fig. 3).

The incidence of femoral neck fractures is rising, not only because of an increase in the number of elderly (presumably osteoporotic) females, but also because of a change in lifestyles, with the elderly being increasingly more active. Fracture rates have been increasing, especially in women over 75 years, at a faster rate than the

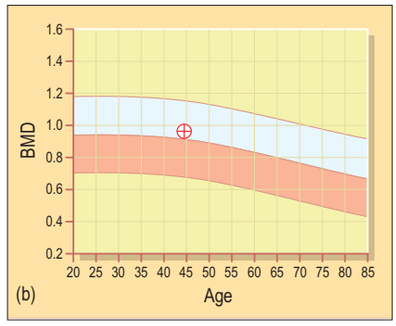




DXA Results Summary

Region	Area (cm^2)	BMC (g)	BMD (g/cm^2)	T-Score	PR (%)	Z-Score	AM (%)
L1	10.88	10.46	0.961	0.3	104	0.7	109
L2	11.66	13.12	1.126	0.9	110	1.3	115
L3	12.86	16.31	1.268	1.7	117	2.1	122
L4	16.38	20.28	1.238	1.1	111	1.6	116
Total	**51.78**	**60.17**	**1.162**	**1.0**	**111**	**1.5**	**116**

(A)



DXA Results Summary

Region	Area (cm^2)	BMC (g)	BMD (g/cm^2)	T-Score	PR (%)	Z-Score	AM (%)
Neck	4.61	3.85	0.835	–0.1	98	0.3	104
Troch	8.47	5.89	0.696	–0.1	99	0.1	102
Inter	12.58	14.60	1.161	0.4	106	0.5	108
Total	**25.66**	**24.35**	**0.949**	**0.1**	**101**	**0.3**	**104**
Ward's	1.04	0.80	0.774	0.3	105	1.2	122

(B)

Fig. 1 **DEXA scans for the lumbar spine and hip.** The patient scores above average, both in the spine (A) and in the femur (B). Ward's triangle lies in the neck of the femur between the major trabecular groups. It is the area within the small square. Lack of trabeculation in this region is often an early indication of osteoporosis on a plain film.

Fig. 2 **Osteoporosis** – 3D electron microscopic reconstruction to show structure. (Reproduced with permission from Gaw *et al. Clinical biochemistry: an illustrated colour text, 2nd edn*, Churchill Livingstone, Edinburgh, 2004.)

Fig. 3 **Transcervical fracture of the femur in osteoporotic bone.** Bone density is diminished.

increase in the mean age of the population.

Women at risk for hip fractures include those whose mothers had fractures and those with any previously occurring fracture after 50 years of age. Most femoral neck fractures occur in winter and at home, so that icy surfaces are not necessarily involved. Their incidence is increasing; some 60 000 occur every year in England and Wales. In Finland in 1988 the incidence of hip fractures per 100 000 population was 174 in women and 78 in men. In that year, the costs of primary hospitalizations for hip fractures were US$66 m. In Belgium the mean annual incidence of hip fractures increased from 108 to 141 per 100 000 population between 1984 and 1996. Demographic changes accounted for only 10% of this rise. Up to 40% of these patients die within a year of fracture, often because of coincidental disease of the elderly.

Around 30% of patients at the age of 80 have fractures of vertebral bodies; these too are more common in women and are also increasing in incidence. Acute vertebral collapse causes back-pain localized to the area of the fracture. Subsequent fractures (these are unlikely to be solitary) are associated with even more frequent episodes of pain and, eventually, permanent discomfort. Vertebral deformity is associated with a scoliosis or kyphoscoliosis. A 'dowager's hump' may be present and clothes may no longer fit properly (Fig. 4).

The vertebral body fractures at its anterior surface and the upper end-plate becomes depressed or deformed. The disease is not necessarily seen in contiguous vertebrae – many may be uninvolved. Pain and vertebral collapse in the elderly may also occur with metastatic malignant disease, for example, from carcinoma of the breast. Metastatic disease often destroys the pedicle of the vertebral body, but osteoporosis does not.

Fig. 4 **Dowager's hump** associated with multiple wedge compression fractures of the thoracic vertebrae. The bones are very osteoporotic. The vertebral cortices are thinned, but remain sharp and well-defined.

Osteoporosis and resulting fractures are a complication of an excess of corticosteroids, either in Cushing's syndrome, or following excessive steroid administration (7 mg prednisolone daily seems to be the threshold dose).

Perhaps as expected, the changes are worse in post-menopausal females; however, they are also seen in children treated for juvenile idiopathic arthritis, which may be worsened by immobilization (see p. 25).

Radiological features of osteoporotic bone

Bone has a dense cortex and a relatively lucent medulla. After the menopause, cortical bone loss is of greater magnitude in women than is trabecular loss in the medulla. Excess endosteal resorption of cortical bone results in cortical thinning but, because the remaining cortical trabeculae are normally mineralized, the image of the cortex remains well-defined and sharp, though thinned. It stands out clearly in distinction to the medulla, which suffers trabecular loss and appears 'grey', while the cortex looks thin, pencilled and 'white' (Fig. 4).

Osteoporosis

Radiological appearances
- Cortical thinning
- Medullary trabecular resorption
- Fractures – wrist, hip, spine.

Features of osteoporosis
- Pathologically, the bone trabeculae are diminished in ***quantity***, but are of normal ***quality***
- Radiologically, the cortices are thinned but sharp, and medullary trabeculation is diminished.

Causes of osteoporosis
- Old age, especially in females
- Disuse
- Drugs – steroids, heparin
- Endocrine disorders – Cushing's syndrome, thyrotoxicosis
- Marrow infiltration – metastasis, myeloma.

Complications of osteoporosis

Fracture of:
- femoral neck
- wrist
- vertebral bodies.

These can result in deformity, e.g. of the spine (dowager's hump in the elderly female).