Osteoporosis

[Net decrease in the bony mass]

Osteoporotic bones are qualitatively normal but quantitatively deficient. Since these bones appear rarefied and radiolucent on radiograms, the term 'osteopenia' is often used to refer to 'poverty' of bone (Hall and Lenchik 1999; Griscom and Jaramillo 2000). Radiolucent bones, however, are not seen exclusively in osteoporosis, but also in osteomalacia, hyperparathyroidism, neoplasms, and several other conditions of varying pathogenesis (Resnick and Niwayama 1995). Thus, the term 'osteopenia' is not specific for, and cannot be used synonymously with, osteoporosis. Additional radiographic features may help in identification of the specific cause of osteopenia: for example, subperiosteal resorption characteristically occurs in hyperparathyroidism, while multiple focal radiolucent bone areas may suggest plasma cell myeloma. In osteomalacia the bone matrix is normal but its mineralization is defective, resulting in the 'osteopenic' appearance on radiograms. Again, supplementary radiographic signs, including Looser's lines, pseudofractures, and such deformities as acetabular protrusion or a bell-shaped thorax, are necessary to identify osteomalacia. In the absence of these signs, the differential diagnosis against osteoporosis can be difficult, which is why a 'hedge' word like osteopenia is used. Unfortunately, specific radiographic features are often lacking in isolated osteoporosis, which cannot be reliably diagnosed except in the presence of typical clinical and histological features (Resnick and Niwayama 1995).

Osteoporosis occurs when bone resorption exceeds bone formation, a situation that can be produced by a net decrease in bone formation, a net increase in bone resorption, or a combination of the two. Scurvy and osteogenesis imperfecta are remarkable examples of osteoporosis caused by impaired bone formation and mineralization, while hyperparathyroidism is an example of osteoporosis caused by increased bone resorption. In normal individuals, loss of the bone mass is an age-related event that is more prominent in women than in men. Osteoporosis is established when bone loss is greater than expected for a person of a given age, sex, and race (preclinical state) or when it results in structural bone deficiency manifested by fractures. Several classification systems for postnatal osteoporosis have been developed. Osteoporosis has been classified as low-turnover and high-turnover types, depending on whether bone remodeling activity is decreased (steroid therapy, hepatic disease, hypothyroidism, systemic disease, malnutrition, parenteral nutrition, certain forms of postmenopausal and senile osteoporosis) or increased (anticonvulsant therapy, calcium deficiency states, gastrointestinal disease, hemochromatosis, hyperparathyroidism, hyperthyroidism, juvenile osteoporosis, mastocytosis, and certain other forms of postmenopausal and senile osteoporosis). Another classification system, which is taken as a reference in the following discussion, distinguishes between a generalized (most of the skeleton involved), a regional (one segment of the skeleton involved), and a localized (focal areas of osteoporosis within a skeletal segment) form of osteoporosis (Resnick and Niwayama 1995).

In generalized osteoporosis, involvement is most prominent in the axial skeleton (spine, pelvis, ribs and sternum) and proximal portions of the long bones of the appendicular skeleton. Involvement of the cranial vault is generally mild, with the exception of hyperthyroidism and Cushing disease where it can be extensive. Senile and postmenopausal osteoporosis (OMIM 166710) are the most common causes of generalized osteoporosis. Radiographic signs of axial osteoporosis, including osteopenia and vertebral collapse, have been detected in about 30% of women and 20% of men between the ages of 45 and 95 years (Targovnik 1977). Fractures at other sites, especially in the proximal femur and distal radius, are common. The male-to-female distribution of osteoporosis is about 1:4 before the age of 80 years and tends to approach 1:1 after this age (Dunn 1967). In women after the menopause, the magnitude of cancellous bone...
Osteoporosis is prominent in the axial skeleton, especially the spine, and in the tubular bones of the extremities. The adult form, manifesting in individuals after the menopause, whether physiological or surgical (Jowsey 1966; Aloia et al. 1983), is likely to be deficient in senile osteoporosis, possibly as a result of impaired osteoblast function or recruitment (Jackson and Kleerekoper 1990; Rosenberg 1991). Increased bone resorption resulting from estrogen deficiency has been implicated in osteoporosis after the menopause, whether physiological or surgical (Carbonare et al. 2001; Lafferty and Fiske 1994), is likely to be deficient in senile osteoporosis, possibly as a result of impaired osteoblast function or recruitment. The skeletal alterations are most prominent at the end of tubular bones and at costochondral junctions; they include a transverse band of diminished density on the metaphyseal side of provisional calcification (the ‘scurvy’ line) and thickening and sclerosis of its epiphyseal side. Despite heavy calcification, the provisional zone of calcification is brittle and often presents subepiphyseal clefts and fractures. Small beaklike marginal outgrowths of the metaphyses and periosteal elevation with new bone formation due to subperiosteal hemorrhage are also typical (Fig. 9.1 a, b). Similar changes in the epiphyses produce a radiodense shell around the ossification center (thickening of provisional zone), with central rarefaction owing to atrophy of spongiosa. In the diaphyses, generalized atrophy of the cortex and spongiosa produces a radiolucent or ground glass appearance. Subperiosteal hemorrhage and periosteal elevation can be striking and are usually most frequent in the large tubular bones, such as the femur, tibia, and humerus. The adult form of scurvy can be observed in severely malnourished persons, especially the elderly, and is marked by the hemorrhagic manifestations, with hemorrhosis, bleeding at synchondroses, and skin petechiae and ecchymoses (Bevaleta et al. 1976; Haslock 2002).

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Several bone dysplasias and syndromes exhibit osteoporosis on a generalized basis. A reduced bony