Fractured hips are the cause of around a fifth of admissions to UK orthopaedic wards. Osteoporosis, literally porous bones, contributes to many of these traumas, from which some patients never recover.

Osteoporosis
features of disease and diagnosis

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Osteon (Greek) = bones. Poros (Greek) = passage or pore. Osteoporosis = porous bones. Osteoporosis accounts for 200,000 fractures every year, costing the NHS over £1.73bn annually.1

The National Osteoporosis Guideline Group reports that hip fractures account for 20% of orthopaedic bed occupancies in the UK, and that fractures in elderly patients over 60 years of age account for more than two million hospital bed days in England each year (exceeding the bed occupancy attributable to diabetes, ischaemic heart disease, heart failure or chronic obstructive pulmonary disease).1

Bone structure and function

The human skeleton is made up of 206 bones that support the body by giving it its shape, providing anchorage for the muscles that move it and protecting vital organs. Bone is also a storage area for calcium and phosphorus salts, and has an important role in blood cell formation. Despite bones being rigid, the joints linking them allow the flexibility needed for movement.

Before birth the skeleton is mostly made up of cartilage, which is less rigid than mature bone; this is gradually replaced by bone via a process called ossification, although some cartilage remains in the joints and also in the nose and ears.

Bones of the human skeleton can be subdivided into two main types: long bones and flat bones. Long bones are characteristically tubular and are the weight-bearing bones. They are made up of a dense outer layer of compact (cortical) bone and a central region (medulla) made up of narrow plates (trabeculae) separated by a maze of tiny spaces filled with bone marrow. This configuration provides high strength for relatively little weight.

At birth all bone marrow is red marrow and has a blood cell formation role. This is replaced in the long bones by...
yellow marrow during adolescence. Yellow marrow consists mostly of fat cells and acts mainly as storage tissue.

Flat bones are the bones which either provide protection (eg, the skull) or the broad surfaces for muscle attachment (eg, scapula, pelvis). They are composed of a cancellous (lattice structure) core surrounded by a layer of cortical bone, partly covered with articular cartilage. They contain red bone marrow throughout life and are important sites for blood cell formation.

Bones are active organs containing living cells, surrounded by protein fibres and mineral crystals. The living cells in bone are present over the surface of the bone, and within cavities (lacunae) inside the bone. These cells are osteoblasts, osteoclasts and, in fewer numbers, osteocytes.

The osteoblasts control bone formation, the osteoclasts control bone resorption and the osteocytes are involved in calcium regulation. Bone cells are arranged in concentric circles around Haversian canals through which blood vessels and nerves run, allowing nutrients and fluid to flow throughout the bone.

Remodelling The skeletal system is subject to stress and damage caused by daily use. It is able to repair itself by cutting into older mineralised bone (resorption) via the action of the osteoclasts and developing new mineralised bone tissue (formation) under the control of the osteoblasts — a process known as remodelling.

During the ongoing cycles of bone remodelling, the skeleton plays an important role in calcium homeostasis. Calcium is the most abundant mineral in the body. There is approximately 1.2kg of calcium in the adult human skeleton (99.9% of the body’s total calcium content). Calcium homeostasis and bone metabolism are controlled by calcitonin, vitamin D and parathyroid hormone, which is the most important regulator (see Box 1). Other hormones that have an effect on bone and on determining bone mass are:

- Growth hormone — enhances collagen and non-collagen protein synthesis
- Glucocorticoids — at normal physiological levels these increase collagen synthesis thus aiding bone growth. However, if steroids are administered to provide levels above the physiological norm bone growth is reduced leading to steroid-induced osteoporosis
- Insulin — deficiency increases risk of bone damage
- Thyroxine — hyperthyroidism is associated with a higher rate of bone turnover, thereby inducing bone loss
- Sex hormones — oestrogen promotes bone growth in children and maintenance of bone mass in adults; androgens are thought to have an important role in the male growth spurt seen in adolescence
- Somatomedins — protein hormones produced in the liver in response to growth hormone. These stimulate protein synthesis and promote growth, and have a direct effect on osteoblasts, thus stimulating bone formation and repair

Features of osteoporosis
The internationally agreed description of osteoporosis is that it is a progressive systemic skeletal disease characterised by low bone mass and microarchitectural deterioration of bone tissue, with a consequent increase in bone fragility and susceptibility to fracture.2,3

Bone mass reaches its peak between 30 and 40 years of age. Beyond this age bone remodelling continues but does not keep pace with the everyday damage caused to bone structure during regular activities. An individual’s peak bone mass is determined by genetics, but it is also influenced by other factors (including diet, exercise, onset of menses, disorders of endocrine function, exposure to risk factors, eg, high steroid intake). Ensuring people achieve a high peak bone mass is important in reducing their future risk of fracture.

Osteoporosis can be described as primary (idiopathic), ie, postmenopausal or age-related; or secondary, with an identifiable cause (eg, hyperparathyroidism, alcoholism, renal disease and hyperthyroidism).

Primary osteoporosis After the onset of menopause bone breakdown increases. This is thought to be because of an inhibitory effect of oestrogen on osteoclasts, slowing breakdown of bone. When oestrogen levels decline bone breakdown increases.

Areas of large trabecular bone are the most affected because trabecular bone is more metabolically active. This trabecular bone damage results in fractures of the wrist and vertebrae.

Age-related osteoporosis occurs in both men and women over the age of 75 and is caused by decreased calcium levels, decreased vitamin D levels (caused by reduced exposure to sunlight and/or poor diet), reduced osteoblast lifespan and function, and decreased sex hormone production. Both cortical and trabecular bone are affected leading to an increase in all types of fracture, particularly hip fracture.
Secondary osteoporosis Many medical conditions have been associated with an increased risk of osteoporosis. Calcium and vitamin D absorption can be affected by a variety of endocrine disorders, such as hyperthyroidism, diabetes mellitus, Cushing’s syndrome, hyperparathyroidism and hypogonadism. Bone damage can be caused by plasmacytomas (tumours resulting from haematological cancers, eg, myeloma, lymphoma and leukaemia). Dietary deficiency or malabsorption of calcium and vitamin D will also increase people’s risk of secondary osteoporosis. Certain medicines have also been linked to secondary osteoporosis: these include corticosteroids (as described above) and some anticonvulsants, eg, phenytoin and carbamazepine (due to interference with vitamin D metabolism).

Fractures
Osteoporotic fractures usually result from (but are not limited to) low-impact trauma from simple falls from standing height or less. The risk of fracture for people with osteoporosis increases with age — raising further the already elevated risk of fracture for elderly people. Assessing and reducing falls risk are important in reducing fractures among this population.

Box 2 lists the various risk factors that may place an individual at higher risk of osteoporosis and fracture.

Hip fractures
Hip fractures are often regarded as the most serious consequence of osteoporosis. Up to 20% of patients die in the first year following hip fracture and only a third of survivors regain their original level of function. Such fractures are associated with significant pain and almost always result in hospital admission (with an average hospital stay of 30 days).

The number of hospital bed-days for hip fractures among women is similar to that for cardiovascular disease, breast cancer and chronic obstructive pulmonary disease. Hip fractures are typically the consequence of a fall, but they can also occur spontaneously.

Vertebral fractures
Vertebral fractures may be asymptomatic, hence identifying their incidence is difficult. Although hospital admission for vertebral fracture is rare, in some cases such fractures can have a significant impact on quality of life and sufferers may need assistance in carrying out activities of daily living.

Other fractures
Forearm fractures are common and are usually caused by a fall on an outstretched hand. They are typically painful and usually require surgical manipulation to reposition the bones and up to six weeks’ immobilisation in plaster. This can lead to the patient’s dependence on others for assistance with activities of daily living. Algodystrophy (bone pain, tenderness, swelling and stiffness) is common, and up to 50% of patients can have only fair or poor functional outcomes six months after the trauma.

All bones in the body can be weakened by osteoporosis and sustain fractures. In addition to the most common fractures (hip, vertebrae and wrist), fractures of the elbow and shoulder are not infrequent. Stress and crush fractures of the leg and foot bones are sometimes seen in osteoporosis sufferers who also have rheumatoid arthritis. These are possibly due to postural changes caused by rheumatoid arthritis.

Diagnosis
Osteoporosis is usually diagnosed by measuring bone mineral density (BMD) by dual-energy X-ray absorptiometry (DXA). The World Health Organization has developed a scale for women, which provides a T-score (the difference between a patient’s BMD and that of a healthy young woman, expressed as the number of standard deviations below the mean) and considers history of previous fracture (Box 3, p215).

In most cases the hip is the preferred site for determining BMD, although for early postmenopausal or drug-induced osteoporosis the spine is the preferred site for scanning because bone loss occurs in this area first.
BMD assessment alone has high specificity but low sensitivity for fracture risk. For this reason it is not appropriate to carry out general screening of all patients at a particular age; instead referral for a DXA scan should be made for patients with risk factors for osteoporosis:

- Untreated premature menopause (menopause occurring in women under the age of 45 years)
- Prolonged secondary amenorrhoea (for more than one year)
- Primary hypogonadism
- Chronic disorders associated with osteoporosis (eg, rheumatoid arthritis, hyperthyroidism, coeliac disease, chronic inflammatory bowel disease, chronic liver disease, hyperparathyroidism)
- A family history of maternal hip fracture under the age of 75 years
- A body mass index of less than 19
- Conditions associated with prolonged immobility

In addition, the following groups of patients should be referred for a DXA scan to confirm or exclude a diagnosis of osteoporosis:

- People aged under 75 years with a fragility fracture
- People with thoracic kyphosis and loss of height secondary to vertebral deformity (after radiological confirmation)
- People with X-ray evidence of osteopenia or vertebral deformity
- Postmenopausal women with two vertebral fractures
- People for whom quantitative ultrasound of the calcaneum or peripheral dual-energy X-ray absorptiometry (DXA) of the wrist or heel suggests osteoporosis. (These tests are not recommended for the diagnosis of osteoporosis but could have been carried out as a screening test)
- People under the age of 65 years who have been taking oral corticosteroids for three months or more, since prophylactic bone-protective drugs may be indicated

In women with a fragility fracture who are aged 75 years or older or younger women with a fragility fracture, osteoporosis should be assumed without the need for DXA scanning and treatment started immediately. Similarly, it is not necessary to perform DXA scanning for men or women over the age of 65 years who have been taking oral corticosteroids for three months or more — they should be treated without the need for screening.

National guidelines have been developed to assist with managing osteoporosis. The National Institute for Health and Clinical Excellence has produced guidance for primary and secondary prevention of osteoporosis and the National Osteoporosis Guideline Group has produced a guideline for diagnosis and management of osteoporosis in postmenopausal women and men aged 50 years or older.

The importance of screening and the management of patients with osteoporosis is described in an accompanying article (p216).

References

What sort of input can pharmacists have into the care of patients who experience frequent falls

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