Current Clinical Assessment and Surgical Treatment of Osteoporosis

In osteoporosis there is a reduction of bone mass. Bone mass is determined by a balance between bone forming cells and bone resorbing cells. In osteoporosis, the bone forming cells may be less effective, and bone resorbing cells are more active which results in a net loss of bone. This causes the bones to have less mass and to become more brittle and makes them more susceptible to breaking. Normally it requires a significant injury to fracture a bone, but in osteoporosis, a broken bone or fracture can occur from a minor incident.

Osteoporosis causes fragility fractures which occur from only minor trauma (eg a bump or minor fall from standing height). It has been estimated that 50% of females over the age of 50 and 33% of males over the age of 70 will suffer a fragility fracture. Also 50% of patients suffering a fragility fracture have a second fracture.

With the world's population over the age of 65 expected to double between 1990 and 2020 this creates a very significant burden of disease. This burden is even more daunting as two thirds of patients with a hip fracture do not return to their pre-fracture level of functioning.

Osteoporosis is generally a disease of the elderly although soft and brittle bones are seen in young people with certain inherited conditions, some drug usage (e.g. cortisone) and in some bone cancers (multiple myeloma and secondary cancer deposits). It is also seen uncommonly in some hormone disorders and in bone that has been previously treated with radiation. Other causes of soft bone e.g. osteomalacia, childhood rickets and Paget's disease cause similar mechanical problems to bones as those affected by osteoporosis.

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Treatment of fragility fractures

Fracture prevention

Treatment of fragility fractures poses a difficult challenge for the surgeon. Clearly the best treatment is to prevent fractures.

Measures to reduce the incidence of hip fractures may include:

- adequate daily vitamin D and calcium intake (requires correction if deficient)
- use of treatments to improve bone density (e.g. sex hormones, bisphosphonates)
- prevention of falls and the use of hip pads
- exercise to improve balance (e.g. Tai Chi)

Non Surgical treatment of fractures

Since many fractures occur with minimal trauma and result only in minor displacement of the affected bone(particularly in the pelvis and spine), non-surgical treatment is often effective. Non surgical treatment, for example, may involve a sling, splint or bed rest and is usually effective in treating upper limb fractures.

However, in fractures of the lower limbs treatment involving prolonged bed rest is not appropriate because there is a high risk of complications and fractures not healing. Prolonged bed rest leads to complications in the elderly such as pneumonia, deep venous thrombosis (DVT), clots in the lungs (pulmonary embolism), urinary tract infections, pressure sores, joint stiffening due to disuse and mental conditions (eg depression). Osteoporosis is also aggravated by a person being immobile.

These complications can be avoided by ensuring patients are up and out of bed as early as possible. The young can use crutches and the elderly can be mobilised early with the use of a walking frame.

Surgical treatment of fractures - implants

Implants used to stabilise fractures consist of a bridge which crosses the fracture site of the bone and devices to fix this bridge to the bone.

The bridge may be:

- a rod passed down the marrow cavity of the bone *(Figure 1A)*
- a plate applied to the surface of the bone *(Figure 1B)*
- an externally fixated system - applied to the bone but which is external to the skin *(Figure 1C)*

The bridge has to be fixed to the bone by either screws, wires or bolts *(Figure 1)*.

Shaft fractures

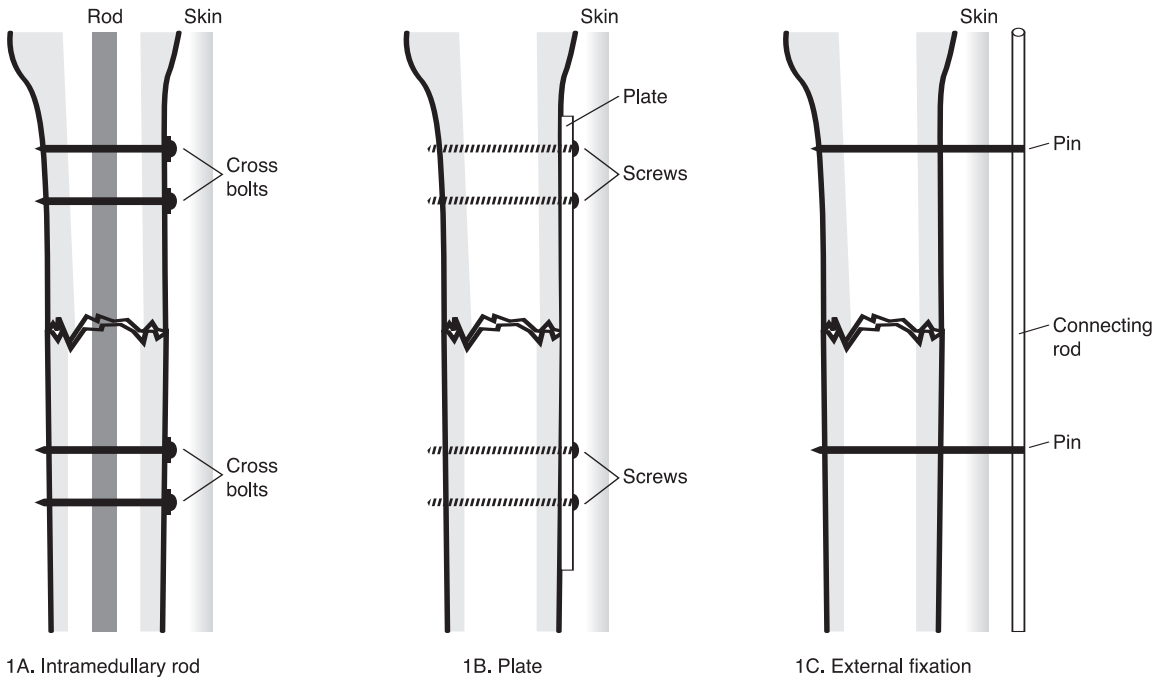
Long bones *(Figure 2)* have a shaft and expanded ends. The shaft of the bone consists of a hollow cylinder with thick walls. The expanded ends are filled with spongy bone and have a relatively thin outer shell.

Surgically treated shaft fractures are relatively easy to stabilise because:

- the bone is strong and a firm grip can be achieved by the implant
- fractured bones can be easily re-aligned into the correct position
- perfect re-alignment is not critical because no joint is involved
- the surfaces are flat

The preferred treatment for shaft fractures is a nail through the middle of the bone which is cross bolted. In osteoporosis the central canal of the bone shaft is wide due to a thinner outer shell and the quality of bone is poor which decreases the grip of the cross bolts. This can lead to loss of position of the fracture. To

Figure 1

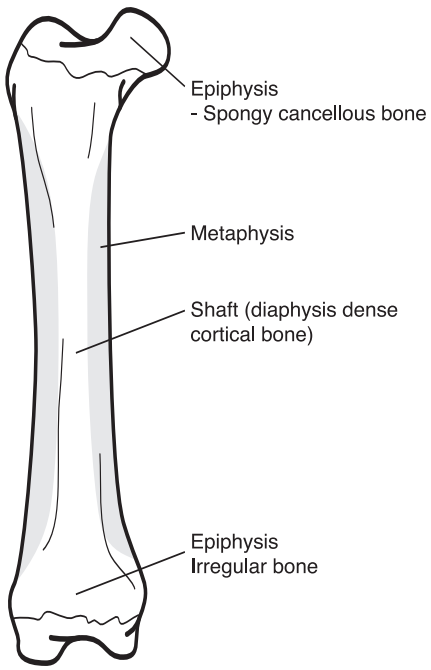


1A. Intramedullary rod

1B. Plate

1C. External fixation

Figure 2



overcome this surgeons can use an external splint or modified nails. When stability can not be achieved with a nail, through the middle of the bone, plating can be used. Long plates are usually required.

Wide ends of long bones (epiphyses)

Fractures in the epiphyses are generally more difficult to treat because:

- the bone is spongy and loses its shape when fractured
- screwing or fixation is less effective in soft bone
- the irregular shape of the bones makes re-aligning the fracture difficult
- the surfaces are flat

If the joint surface is fractured this must be accurately repositioned to prevent the development of arthritis.

When fixing implants to these fractures certain modifications are needed. For example, rods are not as effective, plates need to be specifically designed, screws need to have longer threads and grafting of bone from another site is often required (to fill defects due to crushed bone).

Where applicable, the use of tension band wires in osteoporotic bone is minimally invasive and gives good results. Specially contoured plates may be required in more unstable fractures (titanium is more flexible and therefore is preferred to stainless steel).

With osteoporosis, the spongy bone in epiphyses is often soft and easily damaged so greater bulk in the bone is required. One way to achieve this is with a bone graft. However, in osteoporotic individuals bone for the graft is difficult to obtain because the bones are of poor quality. A donor bone graft may be required or use of an alternate substance, for example, coral may be used.

This bulking up *(augmentation)* of deficient areas of bone can be achieved by the use of cement injected into the fracture site. Recently the introduction of new calcium based cement which is biodegradable shows promise for the future - although extensive trials have not yet been carried out.

Osteoporosis and fracture treatment

The most critical factor in surgically treating fractures is the successful fixing of the implant to the bone. The implant can lose position if this is unsuccessful. This is much more likely to occur in people with osteoporosis because of the poor quality of the bone. The 'architecture' of bone is weaker due to osteoporosis.

Fracture treatment therefore needs to be modified to create a 'load sharing' rather than a 'load bearing' fixation system.

This can be achieved by:

- wider implant plates
- longer splints
- bone substitution (graft or cement) – *see page 11*
- external splints. This may cause joint stiffness but this is not as critical as it is in the young

External fixation systems (applied to the bone but external to the skin) have a limited place in the treatment of osteoporotic fractures because pins may become loose causing a loss of position and infection. If needed, an external fixation system will only be used in particular instances and in a modified way to general external fixation.

Fractures in the upper limbs can be treated non surgically, because weight bearing is not such a significant issue as it is with lower limbs. However, in some instances, surgery for fractures in upper limbs is required, such as:

- multiple fractures in the top of the upper arm
- unstable wrist fractures, and,
- fractures with associated nerve or blood vessel damage.

Pelvic Fractures

In osteoporosis, these often occur as minor stress fractures from minor trauma. They can be difficult to diagnose and a bone scan or an MRI may be required to establish the diagnosis. Such fractures are best treated non surgically.

Major fractures can be very severe because of the splintering due to the soft bone. In these cases surgical treatment is required based on certain surgical approaches. >>

Hip Fractures

Fractures of the femur (thigh bone) in the elderly usually occur in the 'head' or 'neck' of the bone.

Femoral 'Head' fractures (top end of thigh bone)

Because of the soft bone the femoral head is frequently damaged in addition to the socket of the hip - this may require a total hip replacement. Total hip replacement may be performed early in conjunction with stabilisation of the fracture using a plate. Alternatively the fracture can be treated non surgically and a total hip replacement performed at a later stage.

Femoral 'Neck' fractures (neck of the thigh bone)

There is virtually no place for the non surgical treatment of femoral neck fractures in the elderly because of the high incidence of complications and the high rate of non healing.

There are two types of femoral (thigh bone) neck fractures.

1. **Fractures through the base of the femoral neck**

   These fractures are inherently unstable in osteoporosis and treatment consists of the application of a screw/plate system. Interlocking plates may be useful in difficult cases. Creating bulk in the bone using bone cement or calcium based cement may be required.

2. **Fractures at the point where the head and the neck of the thigh bone meet**

   These fractures have the added risk of loss of blood supply to the femoral head. Treatment depends on the patient's age and the degree of displacement.

   ### Age less than 65 years

   The gold standard is to re-align the fractured bones and to internally fix it using screws. Early mobilisation and weight bearing should be allowed. If the bone is very osteoporotic, augmentation may be necessary.

   ### Age greater than 75 years

   Most appropriate treatment is a total hip replacement provided the patient is active and able to cope with the rehabilitation program.

   ### 65 to 75 years

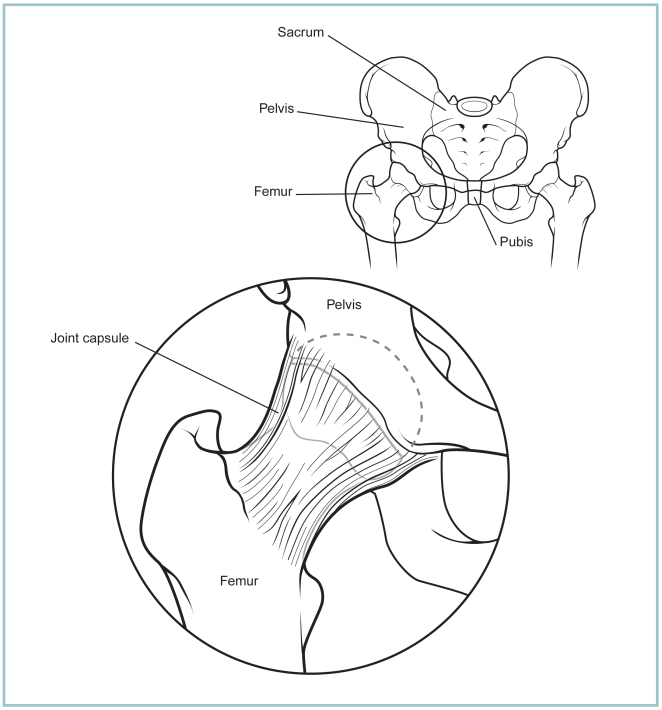
   Different options should be considered eg internal fixation using screws, partial hip replacement or total hip replacement which needs to be discussed with the treating surgeon.

Vertebral fractures (spinal fractures)

Vertebral fractures are common in osteoporosis and can be difficult to treat.

For minor fractures non-surgical treatment is appropriate and consists of anti-inflammatory drugs, epidural injections, spinal braces/supports and physiotherapy (in particular hydrotherapy).

Where pain persists several techniques have proven effective.



Vertebroplasty

In 1987 the concept of injecting 'cement' through the skin into the vertebrae was introduced. 80 to 90% of these patients achieved immediate pain relief. A significant number did develop later problems because the cement strengthened the effected vertebrae but could not restore the actual vertebral height to its pre-fracture level. This resulted in secondary disc problems at a later stage.

Kyphoplasty

This technique was developed in 1995. In this procedure, an expandable balloon is put into a vertebrae. The balloon is inflated and the bone is expanded creating a cavity which is then filled with cement. This technique has to be performed very carefully to avoid the cement going into surrounding tissue. The use of newly developed 'calcium based' cement is likely to give better results in the future.

Open surgery

Open surgery for osteoporotic fractures of the spine is very difficult but is occasionally required.

Summary

Osteoporosis does provide a difficult challenge and one that is becoming more common as the ageing population increases. A large number of innovative techniques have been developed to meet this challenge, but this does remain a very difficult treatment group. Prevention is a key issue and all of those involved in the management of osteoporosis have to make a more determined effort to help prevent fractures.

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