As throughout the developed world, the median age of the population of the US is increasing: whereas in 1970 it was approximately 27 years of age, it is expected to be nearer 40 years of age by 2025. As a result, we are likely to see an increase in the amount of surgery being performed in the elderly, who have increased comorbidity; significant alterations in thinking and procedural matters in dealing with surgery will be required.

Osteoporosis is assumed to be primarily a disease of females, although it does occur in males. At age 75, 40% of the population will have osteoporosis, of which 50% will sustain a fracture, the spine being the most common location. A peak bone mass generally occurs at approximately age 30 and then decreases significantly in the female population as menopause occurs. As bone mass decreases, the risk of fracture increases.

It is estimated that 30–35 million people in the US are at risk for osteoporotic fractures, and approximately 700,000 vertebral fractures occur per year, of which more than 200,000 are refractory to narcotics and 150,000 require admission to hospital.

The problem is not benign. In 1995, the costs were estimated to be greater than US$13.8 billion annually. It is anticipated that by 2050 this cost will be greater than US$60 billion.

There are many myths and legends with reference to osteoporotic fractures. The myths are that these fractures do not disable people, do not hurt much, will heal with rest, and result in few long-term problems.

However, if one looks at the reality, first that fractures do not hurt, why are there more than 150,000 hospital admissions and more than 200,000 people requiring narcotics? There is no doubt that 60% of people feel better within six months. However, bed rest is far from recommended, as 10% of bone mass can be lost within two weeks. With one thoracic fracture, thoracic kyphosis may be increased by an average of 12°. Respiratory functional capacity may be decreased by 9%. The risk of further fracture is increased by 500%. In a study of osteoporotic fractures in 9,000 women of greater than 65 years of age—of whom 1,915 had fractures at baseline—who were followed for more than eight years, adjusting for age and comorbidities of smoking, any fractures resulted in an approximately 23% increase in mortality, and severe fractures resulted in a 37% increase. There is an increased risk for pulmonary death in this population of 300%.

Fracture Types
The majority of compression fractures are a result of axial compression. Other fracture types are wedge fractures involving the anterior column, biconcave fractures, and crush or burst fractures with failure of the anterior middle columns. These crush factors may be true burst fractures and have implications for stability and altered neurological function.

The use of magnetic resonance imaging (MRI) has greatly enhanced the ability to assess these fractures from the points of view of both soft tissue problems and possible neurological compression, as well as being able to differentiate between old and new fractures.

Treatment of Compression Fractures
A patient must be assessed carefully, including a careful neurological examination, and assessment for a deformity, posture, osteoporotic risk, and bone mineral density. Current treatment options include prevention, which may include specifically exercise, drug therapy, calcium supplementation, and vitamin D. The diphosphonates are often used. Bracing has proved generally to be of little value in the presence of kyphosis. Surgical repair in the past has been restricted for neurological problems and more recently for chronic pain and deformity.

Standard treatment, such as analgesics, have problems and the deformity remains with potentially continued pain and a mechanical environment that may lead to further fracture. Prevention does not reverse severe cases and symptomatic control with analgesics and braces does not correct deformity and pain. Surgical repair can be fraught with failures of fixation, is invasive, and has a high potential of morbidity. Delayed collapse of osteoporotic fractures may occur and be progressive. This is often secondary to avascular necrosis of the bone. As a result, females with compression fractures should be followed for a minimum of one year.
Although neurological compromise is uncommon, it is not as uncommon as initially thought. There are no good population data. Four hundred and ninety-seven fractures submitted with variable compression factors; 10 had significant involvement requiring surgery.2

Newer Treatment Ideas
It is not the purpose of this article to go into detail with reference to the use of vertebroplasty or kyphoplasty. There have been no studies to date comparing one procedure with the other. Evidence would certainly indicate that both are of extreme value.

Vertebroplasty conducted by the transpedicular route may be time-consuming and there is risk of pedicle breach and cement leak, which could result in a nerve root compromise. The transpedicular route requires a smaller needle and high pressure injection. As a result, many have advocated a posterolateral route. The only risk to this is direct nerve root irritation. The cement is more easily controlled using this route and there is less risk of leaking into the epidural canal. The pressure used to eject the cement is significantly less than via the pedicle.

Kyphoplasty has been shown to increase vertebral body height, but its main use is early on, following fracture. The indications for this remain somewhat unclear as many fractures (60%) do well without chronic pain.

Vertebroplasty and kyphoplasty do not work if there is major significant collapse or late problems. These are only amenable to surgical intervention.

Neurological Deficit from Fractures
Neurological deficit may result from minor trauma or spontaneous fracture. It may result due to a collapse of the vertebral body. Generally, radicular pain precedes motor deficit. As a result, it is recommended that all osteoporotic fractures be followed for a minimum of one year. Patients with minor deficits may be treated non-operatively, but must be followed closely. It is clear that, if there is a major neurological deficit, surgical intervention is warranted.

Surgical Indications
Indications for surgery in the presence of an osteoporotic spine include progressive scoliotic or kyphotic deformity with intractable pain or an acute fracture with neurological deficit. The diagnosis is not always one of osteoporosis or osteopenia. Given today’s urban society and some aspects of reclusion, osteomalacia must be ruled out. It is important to assess the nutritional status of the patient before any surgical intervention, including assessing such things as calorie count, serum albumin, and serum ferritin. As well as assessing nutrition pre-operatively, nutrition may need to be assessed and supplemented post-surgery as well.

Critical Surgical Concepts
Osteoporotic bone demonstrates greatly decreased mechanical strength. The pedicle is the strongest point of fixation. The sacral promontory is much more efficacious in holding screws then is the ala of the sacrum. In the osteoporotic spine, the greatly reduced fixation strength may result in screw pullout, hook failure, and wire pullout.2–4 In the long term the posterior fusions mass in the osteoporotic spine, although initially healed, may go on to stress fracture, particularly following the removal of so-called painful posterior segmental instrumentation.

It should be recalled, however, that osteoporotic bone does heal in contrast to osteomalacic bone. There are also concerns of failure of spinal instrumentation. There is a risk of adjacent vertebral body fracture of about 20%. As a result of the large pedicles that occur in osteoporosis, there may be a weak screw purchase and poor three-column control. This may necessitate enhancement of fixation within the pedicle and vertebral body when using screw purchase.

As well as enhancing the vertebral body, the use of multiple points of fixation and the addition of anterior surgery, either directly anterior or from a posterior approach, may be of value. Surgery should be individualized to the patient.

Posterior Approaches
The advantage of posterior approaches to the osteoporotic spine is that of a single approach when multiple fixation points can be used. The disadvantage of the approach is that it may be limited and, as a result of a decompression, there is a diminution of surface area for any potential fusion and there may be failures of the posterior tension band. In addition, posterior approaches require longer constructs, as shorter constructs may fail in osteoporotic bone.

Combined Approaches
Combined anterior–posterior approaches may be undertaken using an all-posterior approach that includes the use of such things as egg shell techniques, kyphectomy, posterior subtraction osteotomy, and vertebrectomy. Combined anterior–posterior approaches, performed posteriorly, have decreased morbidity in comparison with separate anterior–posterior approaches. The advantages of these combined approaches are the decompression and stabilization via one route and three-column reconstruction. There are disadvantages, however, related to patient morbidity and comorbidity.

Combined approaches may be appropriate for neurological compromise and are potentially valuable where deformity correction and/or increased stability are required. It does not decrease the instrumentation failure and it increases the rate of fusion. However, in modern surgery, less direct anterior approaches are made due to the advent of the shortening of posterior column (pedicle subtraction osteotomy) and translumbar interbody and post-lumbar interbody fusions.

Anterior Approaches
The advantages of anterior approaches—for the osteoporotic spine only—are that one can decompress the spinal canal directly in the presence of burst fractures; it has been shown that reconstruction is better for wedge-
Osteoporosis

Type fractures. The disadvantages of anterior approaches are poor fixation and the fact that reinforcement of screws in the vertebral body by cement may be necessary. Bone graft mismatch may be a problem as well, and anterior approaches may be associated with significant morbidity in the elderly, particularly at the thoracolumbar junction.

Mochida et al. have recommended non-operative care for concave fractures with no neurological compromise and for flat biconcave fractures with uniform compression. They have recommended operative treatment for neurological problems by a posterior approach, plus or minus an egg shell procedure with pedicle screws for the biconcave fracture or flat uniform fractures compromised by neurological difficulties. They have recommended the anterior approach for wedge-type fractures.

In anterior surgery, auto-graft has the best modulus of elasticity. The rib may be used. For a long strut, vascularized rib may be used. However, ribs are often fragile in the osteoporotic spine. Femoral shaft rings and other shaft rings may be valuable in providing stability. The ideal strut is not well known. It is not recommended that metal cages or plastic vertebral body replacements be used in the osteoporotic spine. The anterior approach may be best used for late deformity and neurological compromise, as it allows for direct decompression.

The Use of Polymethylmethacrylate in Spinal Surgery

Vertebral spacers using cement have been used for some time, particularly in tumor disease. Disc-space fusions have been performed in the cervical spine. Screw augmentation with cement has been recommended in surgery of the osteoporotic spine.

One of the major problems in the osteoporotic spine is often referred to as the ‘topping-off phenomenon,’ or the development of fractures above or below spinal instrumentation. Although this may occur primarily at the apex of the thoracic spine or at the thoracolumbar junction, it is a significant problem that may occur in up to 22% of cases. (This may be prevented by augmentation or vertebral body by bone cement.)

Augmentation of pedicle screws can be accomplished easily with a small amount of polymethylmethacrylate into the vertebral body. It is known that up to 20% of perforation may occur during preparation for the pedicle screw insertion. As a result, it is ideal to insert the cement within the body and not within the pedicle, although the screw itself may be coated with a small layer of polymethylmethacrylate. The addition of 1cm³ of cement at the tip of the screw may enhance pullout strength by 100%, and 3cm³ by up to 1,000%.

Osteoporosis/Deformity

It has been well demonstrated that there is increased kyphosis with decreased bone mineral density. It is the author’s recommendation that younger females—pre-menopausal—with a thoracic kyphosis greater than 75° warrant correction of their deformity. The surgical indications in patients with spinal deformity with osteoporosis are those of progressive deformity associated with pain and/or spinal stenosis.

The goals of deformity correction are primarily to correct sagittal plan imbalance.

Complications

In a retrospective review of 407 operative procedures for adult deformity—age range 20–87, divided between ages 20–40, 41–60, and 61+—of whom two-thirds were revision, it was revealed that:

- there were no differences between revision versus primary cases;
- there were no differences in the 50+ age group;
- patients 40+ had an approximately 30% higher incidence of major life-threatening complications than those under 40 years of age;
- total complication rate, minor and major, was 57%;
- major complications were associated with American Society of Anesthesiology (ASA) status >2, blood loss, and staged procedures (twice as many sicker patients with anterior/posterior procedures staged 5–7 days apart than with single-stage procedures);
- minor complications occurred 1.7 times more in patients over age 60;
- anterior procedures were more risky than posterior procedures (32% versus 24%); and
- patients with greater than 10-level fusions were two times more likely to have a major complication than those with a five-level fusion.

References: