The management of thoracolumbar trauma remains controversial despite years of debate. Two centuries ago Sir Astley Cooper (1839) was an advocate for surgical intervention, yet Sir Charles Bell (1824) indicated his disdain at the thought by expressing “laying a patient upon his belly and by incision laying bare the bone of his spine, breaking up these bones and exposing the marrow itself, exceeds all belief”. Since then not much has changed with arguments being made for and against conservative and surgical options. The surgery itself is widely varied and ranges from relatively conservative posterior fixation to extensive 360° insults. Most data remains anecdotal and much is based on opinion.

Gaines published some pearls in the 1980s which still hold true today. He stated that “an assessment of plain roentgenograms, tomograms, and CAT scan and an understanding of the anatomy of the fracture site provide essential, but insufficient data for clinical decisions...about surgical stabilisation”. This is important to remember, as all algorithms are simply guidelines. A broad view of a patient should be taken before deciding on a management plan, rather than simply plugging into a protocol. Gaines went on to state that “the only absolute indication of surgical fixation is where the spinal column healing may not be anticipated with fair reliability. [This is] generally associated with complete neurological injury with poor or absent opposition of the fracture fragments.” This principle is of course true but is very subjective and open to vast interpretative differences. He made the point that all other indications were dependent on “other variables of the patient’s general condition”.

The goals of spinal fracture management
The goals of spinal fracture management are threefold:
• anatomical reduction
• neural decompression
• stability
Anatomical reduction
This is a basic principle of general orthopaedics where the normal anatomical relationships and alignment are restored. This is done in the belief that our natural state is the most efficient state in terms of kinematics. In the spinal context, the philosophy is to restore the normal sagittal alignment, by vertebral body height restitution, as this is the plane usually affected during spinal trauma. It would seem that economy of gait is best with the normal profile and that kyphosis resulting in a forward list will increased the work of gait, as the compensatory mechanisms of hip and knee flexion come into play. Thoracic kyphosis will also create secondary lumbar hyperlordosis possibly resulting in pain and accelerated degeneration and stenosis. This is not proven and may be extremely difficult to ever tease out of all the other factors involved. There are other concerns of late onset myelopathy, as seen in severe kyphosis following severe spinal tuberculosis, and the development of a post-traumatic syrinx. The question of what sagittal malalignment is acceptable is difficult and thirty degrees has been bandied about. Much of this argument is philosophical and should not be used as an overriding argument for intervention.

Anatomical reduction will improve stability if facet reduction is achieved (Figure 1a-c). However, the spine may be changed to a more unstable state if correction of significant anterior column compression is performed, without restoration of the anterior column. Should there be a considerable compression component, there may be an associated vertebral body collapse or impaction. Once the sagittal profile is restored, there may be a residual leaving a defect and no anterior support. This is a relatively unstable state resulting in large cantilever forces on the posterior construct inviting failure (Figure 2). This needs to be borne in mind when deciding on the type of surgical intervention. Successful anatomical reduction may assist with neurological decompression.

Neurological decompression
The need for decompression is controversial. The spinal cord damage occurs at time of injury and it can be argued that the horse has bolted in terms of decompression after the fact. It is also well accepted that most incomplete neurologically injured patients will improve one Frankel grade irrespective of treatment.

There is basic science to support decompression. With the mechanical injury there is direct tissue disruption with possible persistent compression of the cord. This leads to cord oedema with altered perfusion and haemorrhage and subsequent necrosis. There is a biochemical response and decreased metabolic activity, which result in neuromembrane breakdown within 6-8 hours. This is where anti-inflammatory agents such as high dose steroids may have a role to play. At this point, reversibility of cord damage may still be possible.
The effects of compression and decompression have been studied in the animal model. Following cervical corpectomies, an incomplete spinal cord injury can be induced by the placement of weights on the cord, typically in a central cord type syndrome. Recovery was shown to be possible without removal of the weight, i.e. no decompression. However recovery was more rapid and reached higher levels of function with decompression. Thus incomplete injuries have the ability to recover and that if incompletely damaged, varying amounts of functional cord remain. Bohlman suggested that mechanical compression of the remaining cord may prevent optimal recovery. Compression may physiologically block cord function and recovery for extended periods without destroying neural tissue. This is frequently seen in tuberculous compression, although this has a much lower energy component. When clinical recovery plateaus, the spinal cord may still recover with decompression.

Bodner experiments in the cauda equine model and shows that with 75% constriction there was significant paralysis with Wallerian degeneration of the motor roots. Should decompression be performed, there are a number of methods. The least invasive is that of indirect decompression or so-called “ligamentotaxis”. This technique requires an intact posterior longitudinal ligament (PLL). It involves a distraction force, tensioning the PLL and displacing the retropulsed fragments anteriorly. This is most effective in the first 24-48 hrs, and yields poor results after 10 days as the fragments fail to reduce. This technique does not completely clear the canal. Gertzbein reported a 31% area of residual compression. However, in the thoracolumbar area it may be adequate for conus/cauda equine recovery.

A disrupted PLL is recognised by the “reverse cortical sign” on the axial CT scan, where the sclerotic cortical rim of the fragment lies anteriorly. This is due to the inversion of the retropulsed fragment which can only occur if the PLL is torn (Figure 3). In this setting, ligamentotaxis is not an option and direct decompression is required.

The philosophy is to restore the normal sagittal alignment, by vertebral body height restitution, as this is the plane usually affected during spinal trauma.
Direct decompression may be done from the posterior or anterolateral approach. The posterior approach utilises the pedicle as an entry. It is curetted out and the bony fragments removed or punched anteriorly, away from the cord. This is frequently made difficult by poor visibility due to local epidural and bony bleeding. There is risk of secondary, iatrogenic neurological injury due to thecal manipulation required to expose the fragments. The ventral reconstruction options are also limited from the posterior approach. The anterolateral approach allows direct decompression and visualisation of the spinal cord. Ventral reconstruction is easily possible with either a cage or allograft humeral/femoral shaft.

Figure 4: Gross instability in a neurologically normal patient. This patient is at risk of secondary neurologically injury and needs to be fixed.

Figure 5: 22-year-old woman MVA managed with one month bed rest and mobilised. Posterior ligamentous injury missed resulting in progressive deformity and axial and radicular pain.

Figure 6: The case has three-column ligamentous injury and is unlikely to ever be stable. There was a gap palpable pre-operatively and demonstrated intra-operatively. This is a clear surgical candidate.

Figure 7: This case has a bony Chance fracture which will heal with time. Surgery and conservative care are both options here.

Many outlying centres do not have access to MRI facilities and bony injury is all that is considered.
Stability
The third aspect can be divided into gross mechanical stability and subacute where slow progressive kyphosis is possible. Gross stability would allow abnormal motion to normal physiological forces and pose an immediate risk to the cord (Figure 4). Subacute refers to potential progressive deformity over time due to settling. This may be in the context of an impacted vertebral body with some comminution or disrupted posterior ligamentous complex. This is often where mistakes are made, especially in the context of posterior ligamentous injuries which often go undiagnosed. Many outlying centres do not have access to MRI facilities and bony injury is all that is considered. Figure 5 shows a case which was managed with a month’s bed rest and mobilised. She developed a progressive kyphoscoliosis with axial and radicular pain. This required an extensive simultaneous anterior and posterior reconstruction. This could probably have been averted with an early posterior intervention.

The unstable cases need to be divided into those that are unlikely to ever become stable (Figure 6) and those that may become stable by the end of management (Figure 7). The former require immediate surgery and the latter have a management choice.

Surgical options
Should surgery be decided on, there are a variety of options. Harrington distraction rods, sublaminar wiring and hooks are historical and most surgeons would rely on pedicle screw constructs. Modern constructs are shorter. They show good initial correction with some loss by follow-up. There are high fusion rates and a 80-90% return to work reported. There are concerns about hardware breakage of up to 10% in earlier studies. This can be predicted with the McCormack and Gaines score which assesses vertebral body comminution, loss of height and kyphotic pain. Should this be extreme, anterior surgery is recommended.

There are protagonists of instrumentation and no fusion. This is based on the idea that the vertebral body will reconstitute and become stable. This requires removal of the instrumentation at 6-9 months, i.e. a second operation. In addition, there may be increasing deformity and pain due to disc degeneration. Disc apoptosis is induced by trauma. In addition, there are concerns about the facet degeneration with fixation. Sanderson reviewed 24 patients utilising this technique. The residual correction was only 7°, 60% good/excellent results and four screw breakages. He concluded that fusion was not necessary, but on these mediocre results, this could be argued.

“Rodding long and fusing short” is an option where multiple levels are fixed but only the fracture site fused. This technique also requires instrumentation removal. In addition, there are concerns about facet joint damage due to the transient immobilisation and impingement of pedicle screw heads.

Transpedicular bone grafting has been attempted in an effort to restore anterior body height and pack with bone to prevent repeat collapse. Although still used by some, it does not reliably prevent anterior collapse. Studies show that the final kyphosis approximates that of the pre-intervention status with a 10° loss of correction in the follow-up phase. Disc space grafting via the trans-pedicle approach has been done but Knop found that only a third of patients went on to an interbody fusion with the technique.

The addition of anterior decompression and reconstruction has become more popular with the problems of the posterior only techniques. Steib reported that anterior and posterior surgery achieved a lower postoperative Oswestry disability score than posterior alone. This is of course at the cost of an additional approach with its related morbidities. Sasso reported that there was better preservation of sagittal correction with the anterior reconstruction, losing only 1.8° with the anterior alone technique as opposed to the 8° of the posterior alone technique. Despite the radiological improvements, one must bear in mind that it is clinical status that is most important. Briem reported that despite the difference in sagittal profile, there was no difference in SF36 score. He found quality of life (QoL) to be independent of treatment option, and there was no relationship between the radiology and QoL. This has been echoed by others.

When comparing surgery to non-operative options, Post confirmed the expectation that surgery reduces spinal range of motion as opposed to conservative care, but that this did not correlate with functional impairment. Wood performed a RCT on stable fractures with normal neurological status. He found that residual fracture kyphosis and canal dimensions were the same whether surgery was performed or not. There was a trend of less disability in the conservatively managed group. Shen looked at minor bursts and found that the surgical group had less pain at the 3 month mark, but by 6 months clinical outcome was similar between surgical and conservatively managed groups. He commented that hospital costs were four times higher with surgery.

So where does this leave us in terms of the indications of surgery in thoracolumbar fractures? One can go back to Gaines’ statement that surgery is necessary when spinal column healing is not expected and that the individual patient’s context needs to be taken into account.

In the South African setting, resource allocation and availability of surgical skills vary tremendously from region to region. In an outlying hospital, where surgical facilities are limited or rudimentary, the bias will be to non-surgical management of fractures. Due to the load on tertiary hospitals, not all cases can be referred on and the stable injuries can be managed in the relatively low-cost environment of the secondary hospital environment with bed rest. Of course, great care must be taken to make the correct diagnosis or else the complications seen in Figure 5 will occur.
In many of the tertiary hospitals, the surgical skills are available and there is huge pressure on beds due to the constant cuts. In addition, the nursing shortage limits adequate conservative care in terms of regular turning and positioning. This has led the Acute Spinal Cord Injury (ASCI) Unit, Groote Schuur Hospital, to adopt a relatively aggressive approach to the management of these fractures. The bias is towards early surgical stabilisation with decompression if indicated, to facilitate early entry into the rehabilitation phase and transfer out of the tertiary environment. In addition, orthotic availability is limited and compliance remains a major problem with many patients defaulting on follow-up and returning with severe complications requiring complicated corrective procedures.

**Indications for surgical intervention**

As a guideline, we would recommend the following indications for surgical intervention in thoracolumbar trauma:

**Absolute indications**
- **Unstable injury**
  - Gross instability with soft tissue disruption (disc and posterior column)
- **Incomplete spinal cord injury**
  - Deteriorating neurological status and residual compression

**Relative indications**
- **Incomplete spinal cord injury**
  - Static, reduced neurological status with residual compression greater than 50% of the canal size
- **Unstable**
  - Subacute, bony where risk of progressive kyphosis anticipated
  - In patients where non-compliance is expected or no adequate orthosis service is available

**Indications in terms of surgical approach**
- **Posterior approach with pedicle screw fixation is the default**
- **Anterior and posterior surgery reserved for fractures with high McCormack and Gaines score and residual compression with an incomplete neurological injury**

No benefits in any form have been received or will be received from a commercial party related directly or indirectly to the subject of this article.

**References**