Treatment Options for Thoracolumbar Spine Fractures

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Abstract

A decision for operative versus nonoperative management of thoracolumbar fractures should NEVER be based solely on one factor. Only after a thorough physical, neurological, and spinal examination, and an assessment of a patient's prior activity, social and educational background and patient's expectations, one should review the patient's radiographs and CT scans to determine risks and benefits of operative versus nonoperative care. Both treatment options are discussed in this paper. As a surgical option our preference is short-segment instrumentation and fusion. Careful and appropriate patient selection and an excellent operative technique insure the minimum complications.

KEY WORDS: thoracolumbar spine fractures, load-sharing classification, short segment fusion

There are three fundamental questions that every spine surgeon must answer when treating a patient with a spine fracture. First, should the fracture be treated operatively or nonoperatively. Second, if an operative treatment is recommended, how many spinal segments should be instrumented and/or fused (short vs. long segment fusion). Lastly, which surgical approach should be undertaken: anterior, posterior or combined.

Fracture anatomy should never be used as a single criterion to determine fracture treatment because if there is no neurological deficit, any fracture can be treated either operatively or nonoperatively. The majority of the spine fractures, especially in the thoracic spine can be successfully treated nonsurgically with bracing or adequate length of the bed rest. Patient selection is fundamental for nonoperative management. Besides anatomical characteristics of a fracture other factors critical for fracture management include patient's age, general health, expectations, and compliance.16 An overactive, debilitated, demented or noncompliant patient who is unwilling or unable to follow treatment instructions is particularly at risk.

NON-OPERATIVE TREATMENT

The treatment for the majority of the thoracolumbar fractures is non-operative. Non-operative treatment options are no bracing, bracing with early ambulation, bracing with delayed ambulation or defined period of bed rest with bracing.[18]

BED REST

Treatment with bed rest is not a preferable choice any more. Prolonged bed rest even for a few days increases a risk of deep venous thrombosis (DVT), pulmonary complications and pressure decubiti formation. If for any reason patients with spine fractures should be on a prolonged bed rest a chemical and/or mechanical DVT prophylaxis with aggressive pulmonary toilet should be initiated. Patients with spinal cord injuries treated with or without surgical stabilization are especially prone to these complications. Careful daily skin inspection especially around bony prominences and skin care with washing, massage, powdering and application of lotions are essential. Because of the above mentioned complications related to prolonged recumbency, bed rest is no longer considered as an accepted initial treatment method. If a fracture can not be maintained stable enough in a brace and patient mobilized as soon as a brace is applied, an indication for surgical stabilization should be strongly considered.

BRACING

It is accepted that compression fractures with up to 30 degree of kyphosis can be successfully treated with bracing. Some fracture types as a flexion-distraction fractures with bony involvement ("bony seat belt fractures, bony Chance fracture") can be successfully treated with bracing. Flexion-distraction injuries of the thoracolumbar spine with complete disruption of the ligamentous structures and, no or minimal bony involvement ("soft seat belt injuries, soft tissue Chance fractures") are not suitable for bracing and should be stabilized surgically. A minority of authors has made the attempts to popularize bracing for certain types of burst fractures but that has not been widely accepted. For the majority of the thoracolumbar fractures use of a high profile thoracolumbar orthosis (TLSO) is recommended. High profile TLSO's extend from the sternum to the pubis. These orthoses are made of fiberglass of different thicknesses that successfully restrict most of the motion in the thoracolumbar spine. TLSO's are made as a "clam shell" with anterior and posterior parts interconnecting together and secured with Velcro fastening straps. This orthosis design feature allows easy removal for hygiene and skin care. Low profile TLSO's extend from the xyphoid to pubis and are mostly used for postoperative bracing of the lower lumbar spine, and very rarely for non-operative treatment of lower lumbar fractures. If a fracture is localized in the upper thoracic spine or cervicothoracic junction a TLSO brace with cervical extension (CTLSO) is recommended. The CTLSO brace prevents most of the flexion, extension and lateral bending. Jewett braces can be used in the treatment of the thoracolumbar fractures but their weight due to metal bars, often exceeds the weight of TLSO and for this reason have fallen out of favor for fracture management.

CASTING

Body casting with either plaster of Paris or fiberglass is not used any more due to a patient's inability to effectively perform skin care and hygiene. Casts are heavier and their fit and effectiveness depends on the skill of the person applying them. Soft lumbosacral corsets are used in treatment of osteoporotic fractures in elderly patients whose diminished physical strength reduces their ability to carry a somewhat heavy TLSO. They are usually used in conjunction with a walker in order to decrease axial load of the upper body on the broken vertebra.

Surgical Treatment of Thoracolumbar Fractures

PATIENT SELECTION

Once the decision for surgical treatment is made a surgeon has to answer two questions: 1) how many spinal segments should one instrument and perform either short or long segment fusion, and 2) which surgical approach should one use either anterior, posterior or combined. Details regarding the patient's age, general health, compliance, future endeavors, and the surgeon's expertise in a particular system are essential component to treatment decision-making. For example, a young active patient with no medical problems whose life expectancy is long should be considered differently that a patient in elderly with multiple medical problems and sedentary lifestyle. Anterior approach through thoracotomy or laparotomy might not be suitable if not being dangerous for a patient with pulmonary or other medical complications, and a surgical treatment should be tailored to the patient condition. If a surgical treatment is chosen, in order to optimize a satisfactory surgical outcome a surgeon should understand the mechanical properties of any given implant and determine a patient's willingness and ability to comply with treatment recommendations. At the same time, the patient should understand basic principles of the spinal fixation system used and concomitantly take the responsibility for his/her recovery. The patient should be aware that noncompliance with postoperative instruction could lead to failure of the device and possible need for surgical revision. Fracture location influences a choice of the length of fusion and instrumentation. Because the thoracic spine is a less mobile area, posterior long segment instrumentation is generally the treatment of choice for surgical instrumentation, as the addition of a few segments generally does not limit functional motion. Posterior short segment or anterior instrumentation, or both, is therefore rarely done in the thoracic spine.

RADIOGRAPHIC FRACTURE ASSESSMENT

Load Sharing Classification - Analysis of load-sharing through the fracture site[14]

All currently used classifications accept the fact that imaging techniques provide only a static view of spinal displacement. Based on our data analysis, we recognized that by preoperatively quantifying the comminution of the most injured vertebral body (regardless of the mechanism of injury, and without being column-specific regarding the comminution), one can predict with great accuracy, the occurrence of a postoperative pedicle screw fracture for spine fractures treated with short segment instrumentation and fusion. The Load-Sharing Classification of spinal fractures is generated by the review of preoperative plain radiographs, and sagittal and axial CT scans, which provide data regarding three separate characteristics of the fracture site. These are: comminution, apposition of fragments and deformity correction (Figure 1). All three factors used in our system quantify the comminution of the vertebral body that occurred during the injury. Each of these factors is subdivided into three degrees of severity and graded by awarding 1 point for mild, 2 points for moderate, and 3 points for most severe. Every fracture regardless of the mechanism can be graded from a minimum total of three points to a maximum total of nine points. The Load-Sharing Classification by itself does not recommend a decision for operative or nonoperative treatment of a specific spine fracture. However, it does help the surgeon to understand the quality of load-sharing transferred across the fracture site and the spinal implant after surgical fixation.

Translational displacement

Translational displacement represents lateral or anterior-posterior disruption of the sagittal, coronal or axial spinal column alignment. It indicates serious multiple spinal ligament disruption, which we use to define a fracture-dislocation. It ranges from subtle to severe. Careful clinical evaluation of local swelling, identifying a palpable defect in supraspinal and interspinal ligaments, and evaluation of radiographs is necessary11 (Figure 2).

Surgical Treatment Options

SURGICAL GOALS

Main goals of surgical treatment are stabilization of unstable fractures and early patient mobilization in order to prevent complications associated with prolonged bed rest and posttraumatic deformities. Proper operative fracture reconstruction must restore spinal balance in all three planes over as few segments as possible.

SURGICAL DECOMPRESSION

Patients without neurological deficit. It is rarely necessary to do surgical decompression of the spinal canal in patients without neurological deficit. Long-term follow-up reviews have shown spontaneous resorption of bone fragments and spinal canal remodeling even without instrumentation as long as healing of the fracture

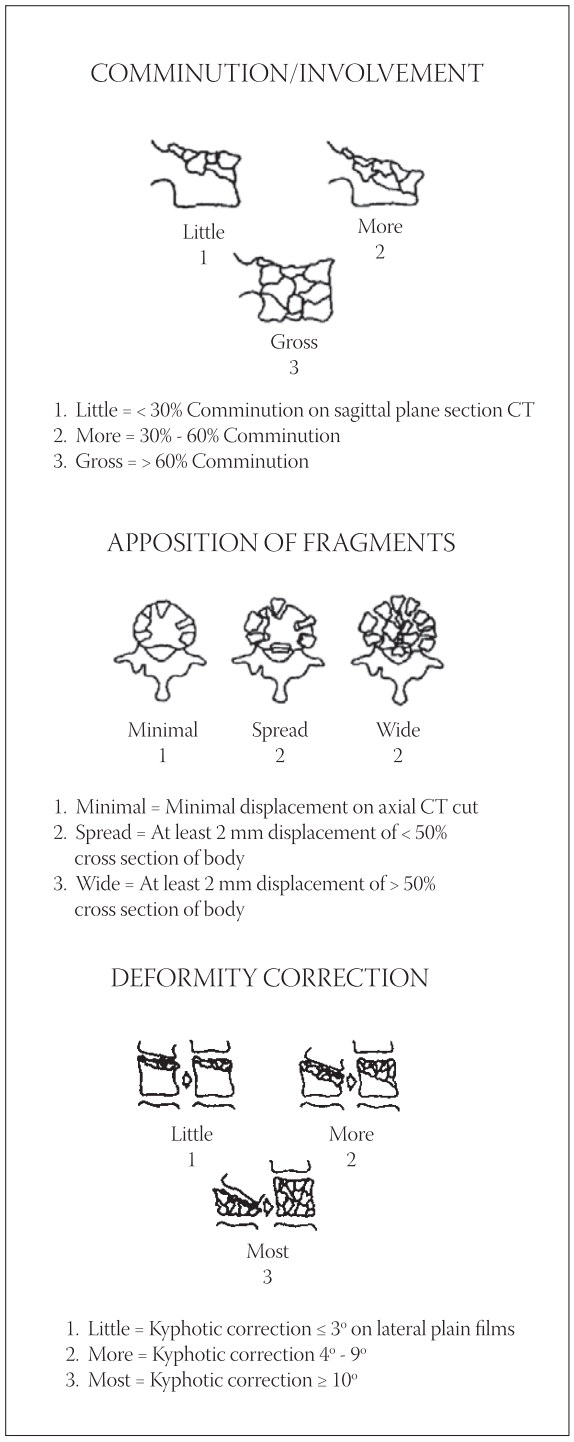

FIGURE 1. The Load-Sharing Classification of Thoracolumbar Fractures (1. *The amount of involvement/comminution* – as best seen on sagittal CT reconstructions of the fracture site. This factor describes the amount and extent of comminution of the most injured vertebra. Comminution controls collapse if nonoperative treatment is selected, and influences load-sharing if operative treatment is selected. 2. *The apposition/displacement of fragments* – as best seen on axial CT. This component of the classification assesses the ability of fracture fragments to carry axial load through the fracture site. The wider the displacement of fracture fragments, more poorly they transmit load; if displacement is wide enough, as seen in some particular grotesque injuries, the fracture may never heal. 3. *The correction of the kyphotic deformity* (an amount of correction of the angular deformity necessary to restore physiologic sagittal plane alignment at the involved motion segment). It is best measured on lateral radiographs. This component quantities the gap in the vertebral body that occurs when traumatic kyphosis associated with a severe fracture is corrected. When severe traumatic kyphosis due to a vertebral body crushing is well corrected by a posterior rod or plate technique, this "fracture gap" is unavoidable. The creation of such a gap totally eliminates anterior column load-sharing and exposes pedicle-screw-based spinal implants to the highest possible cantilever bending loads that might lead to the construct failure (a screw fracture or pull-out). The amount of necessary correction of posttraumatic kyphosis differs at different spinal levels due to the physiologic spinal curvatures. (McCormack T., Karaikovic E.E., Gaines R.W.Jr. The Load-Sharing Classification of spine fractures. Spine 1994; 19(15):1741-1744.). Published with permission.[14]

had occurred and posttraumatic deformity did not exist. On the other hand, neurological deterioration commonly develops in neurologically intact patients with progressive deformity after an unstable spinal fracture that was not stabilized surgically early after the injury.4 Neural recovery has been observed in many of these patients after direct decompression even after many years. Patients with neurological deficit. In patients with cord injury, decompression is usually performed concomitantly with spinal instrumentation, generally via the same approach used for fracture repair. However, anterior fragments compressing the spinal cord can be also successfully removed from a posterior approach, through a posterolateral or posterior transpedicular approach, if posterior instrumentation is selected for fracture repair.2,5 Isolated decompressive laminectomy without fracture stabilization has no beneficial effect with up to 35% occlusion of the spinal canal. Laminectomy without stabilization further destabilizes the spine fracture and is contraindicated in most cases of thoracolumbar fractures secondary to high development of iatrogenic kyphosis and need for instrumentation. Inadequate decompres-

sion of the spinal canal can cause long-standing radicular symptoms and/or spinal cord myelopathy much later from the time of injury. Possible consequences of chronic neurological compromise include arachnoiditis, syringomyelia, and late-onset vascular compromise.

LENGTH OF FUSION: SHORT VERSUS LONG SEGMENT FUSION

In preoperative planning of a surgical treatment of a spine fracture, the surgeon must determine the length of fusion and the surgical approach that will achieve stable fixation but preserve maximal spinal motion postoperatively. The fracture location (thoracic, thoracolumbar, or lumbar spine) influences the choice of length of fixation. Longer fixation in the upper or middle thoracic spine does not reduce the patient's mobility much, because this part of the spine is already naturally limited in motion from its connection with the ribs.

SHORT SEGMENT FUSION

Short-segment fixation (instrumentation one level above and one level below the damaged vertebra) and fusion limits the levels of fusion. The introduction of the pedicle-screw-based implants, anterior spinal implants, and better understanding of fracture biomechanics have led to the ability to perform short-segment instrumentation and fusion from either anterior or posterior approach to preserve motion segments.

LONG SEGMENT FUSION

Long-segment fixation and fusion involves instrumentation two or more levels above and below the fracture. In our practice, only patients with grotesque, severely displaced, and comminuted fracture dislocations are treated with long-segment instrumentation and/or combined anterior and posterior procedures, and for patients who apt to be noncompliant in brace-wear, based on their premorbid personality, their injuries, or both.

PEDICLE SCREW FIXATION

Pedicle screw fixation has improved the stability of the spinal fusion constructs, produced better correction of the fracture, allowed an application of short segment instrumentation and fusion, produced better retention of intraoperative correction of spinal deformity, and has nearly eliminated nonunion as a complication.3,9,17 Use of pedicle screws in fixation of the thoracic and lumbar spine is widespread and there use is popularized even in the cervical spine.7 Although complications associated with placement of pedicle screws are multiple (nerve root, spinal cord, and vessel injuries, etc.), their incidence is very rare with the use of a proper technique.20,21 We recommend using a technique of direct visualization of the pedicle during placement, the so called "funnel technique". The accurate placement of the pedicle screws is confirmed using intraoperative fluoroscopy. The "funnel technique" was proved to be very accurate based on anatomical and clinical data. Placement of pedicle screw based solely on a tactile feedback, landmarks, or fluoroscopy is dangerous and can produce grave consequences to a patient.

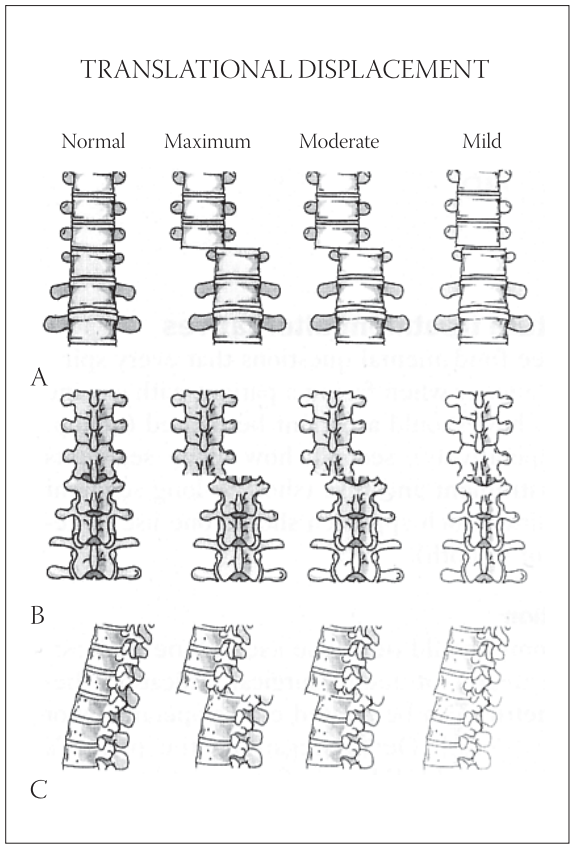

FIGURE 2. Anteroposterior (A), posteroanterior (B), and lateral views (C) of translational displacement in a thoracolumbar spine. The drawings on the left represent an intact spine, followed by the drawings of different degrees of translation from gross to subtle. Published with permission.[11]

SURGICAL APPROACH: POSTERIOR VS. ANTERIOR

The fundamental principle of load-sharing between the implant system and injured spinal column provides good bony apposition at any internally fixed fracture site to permit healing and prevent implant failure.10,15 A preoperative analysis of bone fracture anatomy, as well as individual characteristics of the patient, guide the selection of successful candidates for either anterior and/or posterior instrumentation and fusion, and for long- or short-segment instrumentation.8

POSTERIOR APPROACH

Posterior approach, especially short-segment fusion can be successfully used only if the support through the anterior and middle columns is adequate to transfer residual load that extends the capacity of the posterior instrumentation.17 Only when pedicle screws are applied posterior can short segment instrumentation be utilized.14 Strict analysis of the fracture character using the principles of Load-Sharing Classification will allow one to apply posterior short-segment instrumentation and fusion.12 Utilization of hook and wire constructs require long- or longer-segment fusion due to their inherent instability in short-segment constructs.

ANTERIOR APPROACH

In highly comminuted vertebral body injury at the thoracolumbar junction (a total point of 6 or higher on the Load-Sharing Classification scheme), anterior strut grafting and instrumentation is superior to fixation with a posterior instrumentation with pedicle screws. Anterior spinal fusion surgery is a safe procedure which can be used with confidence when the patient's disorder dictates its use. The total complication rate for all complications that were directly attributed to the anterior approach is 11.55%. Serious complications, such as death (0.3%), paraplegia (0.2%), and deep wound infection (0.6%) are rare.1 Any anterior device (screw-rods and a plate) must be applied laterally on the vertebral bodies, with bicortical purchase assuring no instrumentation penetrating into the spinal canal or contralateral foramen, and performed under intraoperative radiographic control. The success of any anterior instrumentation depends on adequate vertebral body reconstruction. Autologous bone struts are preferable (tricortical iliac crest or fibula), although allografts, and titanium or carbon fiber cages, can be used successfully.[6,13,19]

Conclusions

Posterior and anterior spinal instrumentation systems are very effective for the reconstruction of severely damaged vertebral bodies of the thoracic and lumbar spine. They can provide immediate adequate reconstruction and retention of the fragments as a solid supporting construct of the spinal columns until the body fusion takes over the load. Most of the complication that occur during or after the surgery can be avoided by careful and appropriate patient selection and excellent operative technique. Operative versus nonoperative management of thoracolumbar fractures should NEVER be made based solely on one factor. Only after a thorough physical, neurological, and spinal examination, and an assessment of patient's prior activity, social and educational background and future plans, we then review the patient's radiographs and CT scans to determine the risks and benefits of operative versus nonoperative care. For those patients in whom operative care is recommended we then determine whether the patient is reliable enough to allow for short-segment instrumentation and fusion.

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