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Management of Thoracolumbar Fracture Without Neurologic Deficit

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Abstract:

Thoracolumbar fractures represent one of the most common spinal injuries and frequently occur at the thoracolumbar junction due to the transition between the rigid thoracic spine and the more mobile lumbar spine. Management of thoracolumbar fractures without neurologic deficit remains controversial, particularly regarding the choice between conservative and operative treatment. Several factors including fracture stability, degree of vertebral body collapse, kyphotic deformity, and patient-related characteristics influence treatment decisions. Recent advances in spinal instrumentation and minimally invasive techniques have expanded surgical options, while conservative management remains effective in selected stable fractures.

Keywords: Thoracolumbar fracture, Neurologically intact patients, Conservative treatment, Pedicle screw fixation, Minimally invasive spine surgery.

Introduction:

The management of thoracolumbar fractures continues to evolve. Strong agreements exist in certain aspects of care, but significant controversy remains in many other areas. A treatment plan is never based only on assessment of the anatomy of the fracture. Patient assessment is fundamental in choosing the treatment options of thoracolumbar spinal injuries. Only after a thorough patient evaluation of patient's social, educational background, age, occupation, spinal level of the injury and patient's expectations do we make an individualized treatment plan.(1)

The aim of treating thoracolumbar fractures is:(2)

1. Healing of spine without progressive kyphosis.
2. Prevent neurological deterioration and to improve neurological function.
3. Prevention of instability and pain.
4. To allow early mobilization and avoid long bed rest complications.
5. To minimize hospital stay.

Treatment options:

a) Conservative treatment.

b) Operative treatment.

<u>A. Conservative treatment:</u>

- Bed rest.
- Pain medications.
- Bracing.
- Postural reduction.

- Observation.

Indication for conservative treatment in stable fractures: (3)

• Neurologically intact patient.

• Less than 25% loss of vertebral body height.

• Less than 20° kyphosis.

• Patients with 3 or less points of TLICS are non-operative.

• Patients with 3 or less point of TLAOSIS are non-operative.

• Type A0 and A1 according to AO spine classification system.

Disadvantages of non-operative treatment: (4)

- Expensive in terms of both person-hours and financial resources.
- Late deformity and the sequel of late pain are uncertain.

B. Operative treatment:

- ***Fixation after (Decompression with or without fusion):***

I. Direct decompression

1. Decompressive laminectomy.

2. Posterolateral decompression.

3. Anterior decompression.

4. Combined anterior and posterior surgery.

II. Indirect decompression (Ligamentotaxis):

Ligamentotaxis reduces fragments by tensing the posterior longitudinal ligament (PLL) and to a lesser extent the anterior longitudinal ligament (ALL).(5)

- ***In situ fixation by:(6)***

I. Open pedicle screw fixation.

II. Percutaneous pedicle screw fixation.

Operative vs Nonoperative Treatment:

There is conflicting evidence to recommend for or against the use of surgical intervention to improve clinical outcomes in patients with thoracolumbar burst fracture who are neurologically intact.(7)

Number of fixed levels:(8)

Numerous pedicular fixation methods through a posterior approach have been described. One of the main differences between them is the number of fixed segments. Short segment fixations, with fewer stabilized and fused uninjured segments, can preserve the maximum thoracolumbar movement (Fig.1). This type of fixation involves pedicle screw placement one level above and one level below the injured segment and by adding intermediate screw at the fractured vertebrae, a stiffer construct can be gained. Long segment fixation with pedicle screws and rods two levels above and below the fracture level provide good fixation; however, increasing length of posterior fusion segment should be considered carefully especially in the more mobile segments of the lumbar spine (Fig.2).(9, 10)

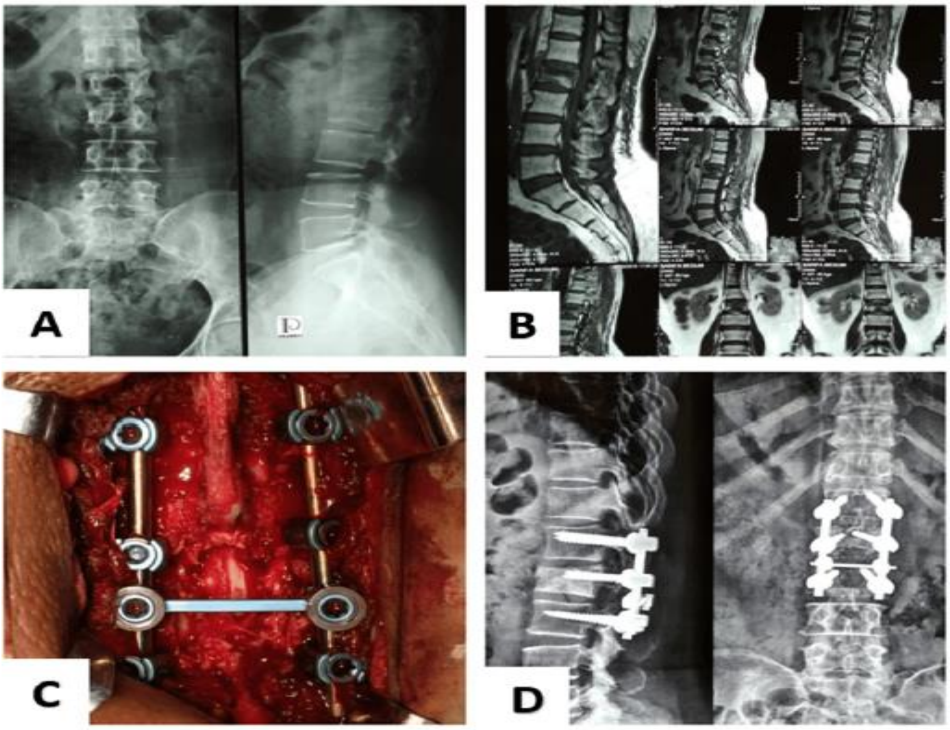

FIGURE (1): SHORT SEGMENT FIXATION OF L2 FRACTURE (A) PRE-OP X-RAYS (B) PRE-OP MRI (C) INTRA-OP PICTURE OF INSTRUMENTATION (D) POST-OP X-RAYS.(10)

Intermediate screw applied in the fractured level in management of thoracolumbar burst fracture improves the correction and maintenance of local kyphosis in short segment fixation like long-segment construct with saving vertebral motion levels from being fixed.(11)

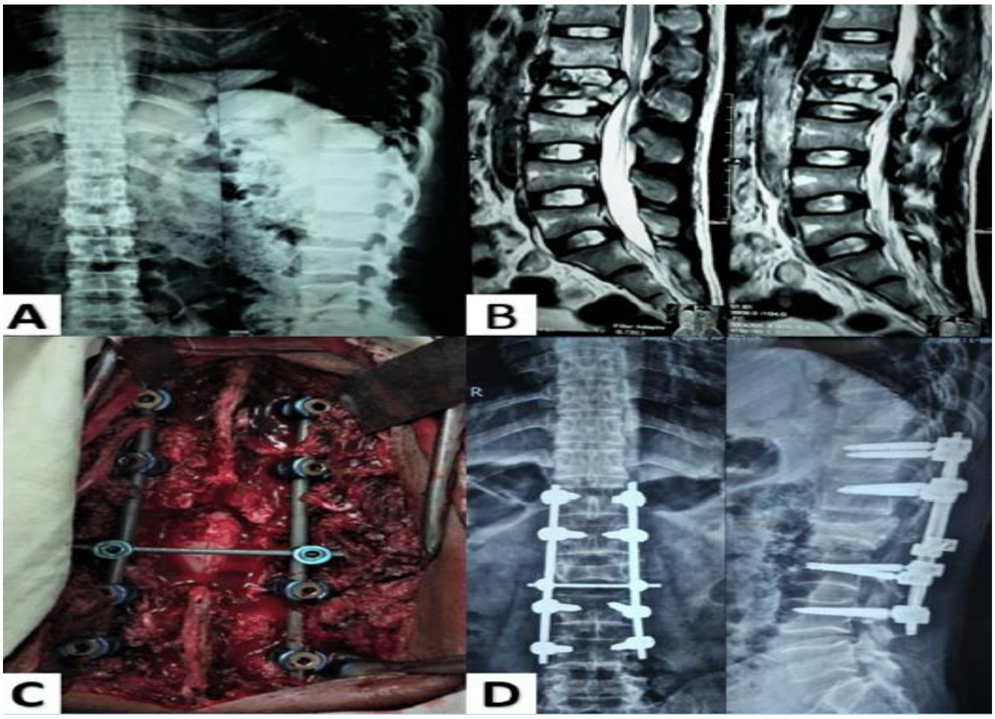

FIGURE (2): LONG SEGMENT FIXATION OF L2 FRACTURE (A) PRE-OP X-RAYS (B) PRE-OP MRI (C) INTRA-OP PICTURE OF INSTRUMENTATION (D) POST-OP X-RAYS.(10)

Posterior pedicle screw fixation had gained popularity in the management of thoracolumbar spine fractures. The biomechanical stability of the different pedicle screws constructs had been studied thoroughly and long-segment fixation shown stiffer construct and more stability in comparison to short-segment fixation.(12)

Theoretically, decreasing the number of fixed levels will lead to better patient surgical outcome considering postoperative pain and function and adding pedicle screw in the fractured level had shown increased stability of the short-segment constructs in several biomechanical studies.(13, 14)

Open technique

Indications of open technique for spine fractures: (Table 1)

• Open spinal injuries. These may be caused by external forces (gunshots, incisions).

• Neurological deficits with relevant narrowing of the spinal canal.

• Highly unstable fractures (type C).

• Patients with vertebral body fractures and preexisting condition leading to instability such as in patients with ankylosing spondylitis.(15, 16)

Absolute indications	**Relative indications**
Incomplete paraparesis.	Pure osseous lesions.
Progressive neurological deficit.	Desire for early return to regular activities.
Spinal cord compression without neurological deficit.	Avoidance of secondary kyphosis.
Fracture dislocation.	Concomitant injuries (thoracic, cerebral).
Severe segmental kyphosis (>30°).	Facilitating nursing in paraplegic patients.
Predominant ligamentous injuries.	

TABLE (1): INDICATIONS OF OPEN FIXATION OF THORACOLUMBAR FRACTURES.(17)

Limitations:

Conventional open spine surgery has several reported limitations including:(18)

- Extensive blood loss
- Post-operative muscle pain
- Infection risk
- The paraspinal muscle dissection involved in open spine surgery can cause muscular denervation, increased intramuscular pressure, ischemia, necrosis and revascularization injury resulting in muscle atrophy and scarring, often associated with prolonged post-operative pain and disability.(19)

Minimally Invasive Spine Surgery: (20)

It is the latest technology available to perform spinal surgeries through small, less than one-inch-long incisions. It involves the use of special surgical instruments, devices (endoscopy and operating microscope) and advanced imaging techniques to visualize and perform the surgery through such small incisions e.g. percutaneous pedicle screw fixation.(21)

- ***Advantages of Minimally Invasive Spine Surgery***

MISS is aimed at minimizing damage to the muscles and surrounding structures. It possesses numerous benefits over the traditional spine surgery which include:

- Small surgery scars
- Reduced risk of infections

- Less blood loss during the surgery
- Less postoperative pain
- Shorter hospital stay and quicker recovery
- Quicker return to work and normal activities

- ***Risk and Complications of Minimally Invasive Spine Surgery***

The risks and complications of the surgery may include infection, bleeding, nerve injury, or spinal cord injury due to small field and long learning curve.

<u>Percutaneous fixation:</u>

Over the last 20 years, there has been a trend toward minimally invasive techniques in spinal surgery, including percutaneous pedicle screw fixation of the thoracic and lumbar spine.(22)

History of percutaneous fixation:

Percutaneous transpedicular screw fixation (PPSF) was first introduced by Magerl in 1977 who used an external fixator (Fig.3) and then in 1995 Mathews and Long first described and achieved entirely percutaneous lumbar pedicle fixation techniques in which plates were utilized as longitudinal connectors.(23-25)

To overcome the complication of both conventional posterior spinal fixation and the complication of superficially placed hardware, other systems of percutaneous spine fixation have been developed in which the hardware is placed in close contact to the bone allowing fixation comparable to open positioning of screws.(26)

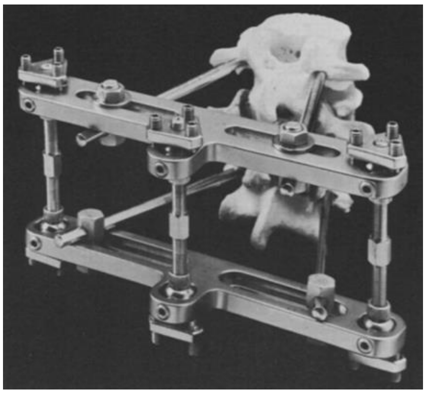

FIGURE (3): EXTERNAL PEDICLE SCREW FIXATION DEVICE INTRODUCED BY MAGERL.(23)

Indications of percutaneous spine fixation in thoracolumbar fractures: (27)

- ***Trauma*** is the most common indication for percutaneous pedicle screw fixation in the thoracic and lumbar spine.(22)
- Patients with No neurological deficits.(28)
- Recent fracture (within 2 weeks).(29)
- Type A2, A3, A4, and B1 according to AO classification system.(30)

Contraindications are:

- Fracture dislocation.
- Neurological affection.
- Previous surgery at site of fracture.

Advantages:

- ✓ Sparing the paravertebral muscles helps in avoiding muscular atrophy due to denervation and devascularization of the muscle.

- ✓ The studies appear to show a decrease in the amount of blood lost intraoperatively, small skin incisions a reduced need for blood transfusion.
- ✓ A decreased risk of infection and a decrease in postoperative pain and reduced loss of muscle strength.
- ✓ Reduction in the hospitalization period, making rehabilitation easier and faster.
- ✓ The fixation material used in percutaneous osteosynthesis is usually removed 8-12 months when needed after stabilization of the fracture through the scar at the insertion site of the screws, thus allowing the removal of the material without extensive approaches.(31)

The importance of PERCUTANEOUS FIXATION was shown as:

Percutaneous minimally invasive pedicle screw fixation has the characteristics of shorter operative time, less bleeding, and less pain, but it needs more radiation times.(32, 33)

Surgical technique: it will be mentioned in (Patients & methods) chapter.

Pedicle screw insertion:(34)

- ***Trajectory:***

  Each level has its preferable angles (Fig.4) but usually convergence of pedicle screws by 30° in the coronal plane can increase the pullout strength by 28.6% (Fig.5). Insertion of the screws without convergence, however, is more stable in terms of longitudinal linkage.(35, 36)

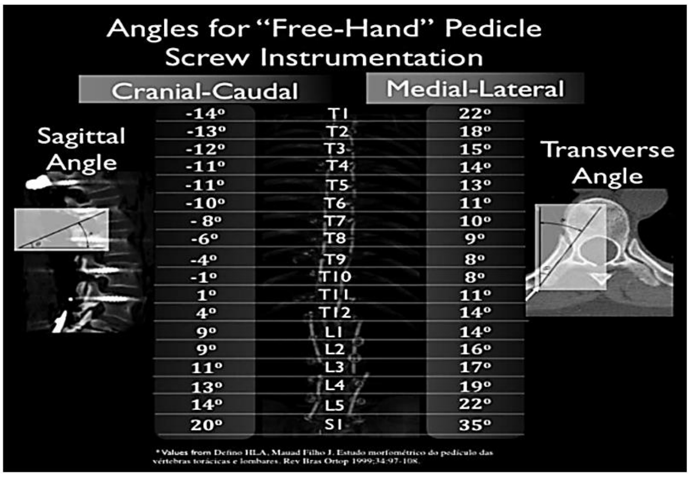

FIGURE (4): SAGITTAL (CRANIAL-CAUDAL) AND TRANSVERSE (MEDIAL-LATERAL) ANGLES FOR PEDICLE SCREW PLACEMENT IN THE THORACOLUMBAR AND SACRAL SPINE.(37)

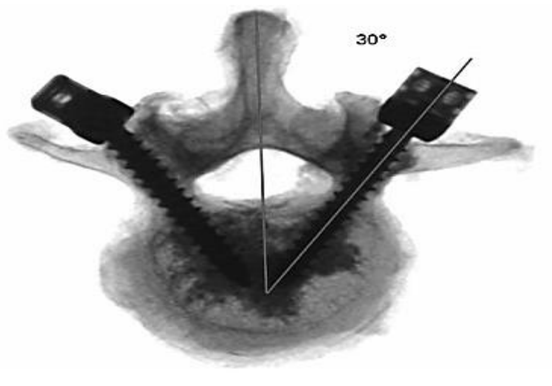

FIGURE (5): FLUOROSCOPIC (C-ARM) VIEW FOR THE PEDICLE SCREWS INSERTED INTO THE SEPARATED CADAVER SPINE.(38)

More recently, a laterally directed cortical bone trajectory was found to have similar biomechanical characteristics to the more traditional medial trajectory (Fig.6). This cortical trajectory is especially effective in poorly trabeculated osteoporotic bone.(39)

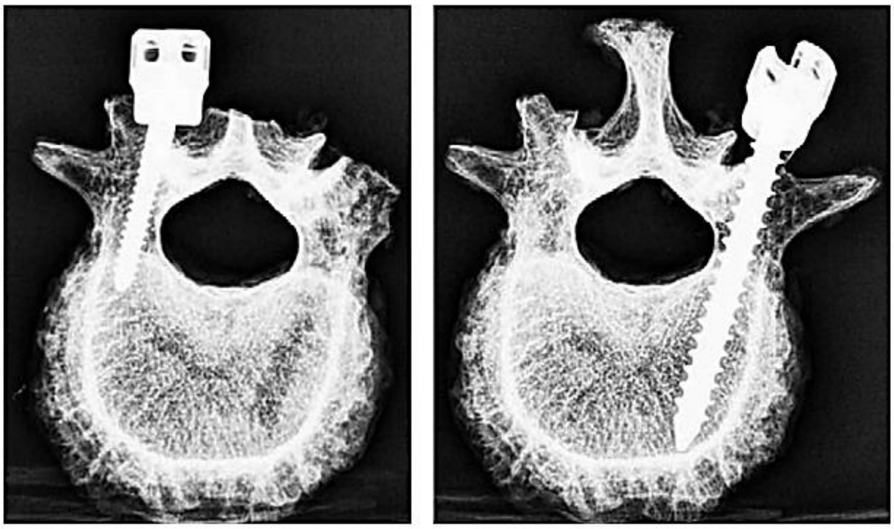

FIGURE (6): NEW CORTICAL TRAJECTORY (LEFT) VERSUS TRADITIONAL TRAJECTORY (RIGHT).(40)

- ***Insertion depth:***

About 80% penetration depth is considered sufficient. 80% penetration is 32.5% stronger than 50% penetration. Up to 75% of maximum insertional torque can be achieved with engagement of the junction between body and neural arch.(41)

- ***Salvage (pedicle screw augmentation):***

Various methods of augmentation can be used for revision or in severely osteoporotic patients, including cement augmentation, additional hooks and wires, and larger, expandable or hydroxyapatite-coated screws.(42-44)

<u>Postoperative evaluation methods:</u>

Classic studies of pedicle screw placement have considered CT scan as gold standard method for evaluating the position of pedicle screws as well as its relation to adjacent structures. But now many spine surgeons consider antero-posterior and lateral plain X-rays as adequate imaging modality for the assessment of the final positions of pedicle screws. (45)

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