TRANSDIAPHRAGMATIC APPROACH TO THORACOLUMBAR JUNCTION FRACTURES

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ABSTRACT

Objective: The purpose of this study is to share experience with transdiaphragmatic approach to thoracolumbar junctions for adequate exposure, decompression, reconstruction and fixation.

Design: Quasi-experimental study.

Place and Duration of Study: Neurosurgery department Peoples Medical College Nawabshah, from January 1999 to December 2004.

Patients and Methods: Patients with thoracolumbar junction fractures were being studied. Plain x-rays, CT scan, myelography or MRI were done for assessment and planning. Anterior approach by thoraco-phrenico-laparotomy was used for adequate decompression and stabilization with Webb Morley system.

Results: Males dominated. Adults and middle age groups suffered mostly. Neurological improvement was seen in 17 (47.2%) cases. Bony fusion was observed in 32 (88.9%) cases.

Conclusion: Phrenotomy for anterior approach to thoracolumbar junction provides adequate exposure to facilitate decompression of the cord and instrumentation. Patients with partial neurological deficit improve well than with complete neurological deficit. Most of the patients improve by 1 grade on American spinal injury association (ASIA) scale.

Keywords: Spine, thoraco-phrenico-laparatomy, paraparesis, spinal instrumentation, thoracolumbar junction fractures

INTRODUCTION

The thoracolumbar junction needs special attention because here long stiff thoracic kyphotic segment unites with lumbar lordotic mobile segment [1]. The thoracic spine is protected and stabilized by the rib cage and costotransverse ligaments. The lumbar spine is relatively flexible and unprotected. Facet joints in the thoracic spine are oriented in the coronal plane and therefore restrict movements in flexion and extension. In the lumbar spine facet joints are oriented in the sagittal plane, which increases motion in flexion and extension. The superior facet joints of T12 are shaped like those of the thoracic vertebrae, while the inferior ones have the pattern of lumbar facet joints. The disc size and shape that occur at the transition between the thoracic and lumbar spine is also a biomechanical factor.

Denis's three-column theory of spinal stability adds middle column to initial two-column theories which allows specific assessment of that component in the region of neural axis. According to this three-column theory of Denis, injury to the anterior column results in a compression fracture. Injury to both the anterior and middle columns results in a burst fracture with possible retropulsion of bone posterior into the spinal canal (fig. 1,2).

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Louis assigns significance to the vertebral body and the facet joint complexes (lateral masses) on either side. This concept assists in instability assessment process only when predominantly axial loads are considered. It does not facilitate the assessment of the distraction, flexion, and extension components of the injury.

Injury to all three columns results in either a flexion distraction injury or a fracture dislocation. When 2 of 3 columns are disrupted, fracture is considered unstable. The spine is best suited structurally to withstand the forces that produce ventral flexion. Nevertheless the vast majority of fractures in these areas are the result of hyper flexion producing vertebral body failure. Extension injuries at this part are rarely encountered [1].

The Conus medularis lies at this level so the neurological injury may be to purely cord, cauda equina or mixture of both. Avulsions of nerve roots at the conus medullaris may occur [2]. Paraparesis is accompanied with autonomic disturbances including urinary [3], defecation1 and fertility functions [4].

Thoracic cavity and extra-peritoneal space has to be exposed simultaneously for decompression and stabilization of this junction. Thoraco-phrenico-lapatatomy is the ideal exposure for anteriolateral approach to this part of the spine for adequately decompressing the neural elements and fixing the spine in a single exposure [5].

The purpose of this study is to share experience with transdiaphragmatic approach to thoracolumbar junctions for adequate exposure, decompression, reconstruction and fixation.

PATIENTS AND METHODS

This quasi-experimental study was conducted in Neurosurgery department Peoples Medical College over a period of 5 years from January 1999 to December 2004. 36 patients operated upon the D12/L1 thoracolumbar spine were included. Patients having wedge fracture and no neurological deficit were managed conservatively. This study included those patients, which had unstable fractures, fracture dislocation or flexion distraction injury. Patients unfit for anesthesia having any systemic illness like uremia; ischemic heart disease, chronic liver disease etc were excluded and were managed with conservative measures. All patients were assessed clinically noting mechanism of injury and neurological deficit. American Spinal Injury Association (ASIA) impairment scale was used to assess the neurological deficit pre and postoperatively.

Asia (American Spinal Injury Association) Impairment Scale

Grade Description:

- Complete: No sensory or motor function below level of neurological deficit level. Sacral sparing is absent.
- Incomplete. Sensory but not motor function is preserved below the neurological deficit level.
- Incomplete. Motor function is preserved below the neurological deficit level, and the majority of key muscles below the neurological deficit level has a muscle grade lower than 3.
- Incomplete. Motor function is preserved below the neurological deficit level, and the majority of key muscles below the neurological deficit level have a muscle grade higher or equal to 3.
- Sensory and motor intact.

The radiological assessment was done with X-rays, myelography, myelo-CT CT scan or MRI. Left anteriolateral approach was preferred. The exposure was made two ribs above the lesion due to the obliquity of the chest wall. Chest cavity was opened and diaphragm incised in an annular fashion peripheral in its posterior part. Peritoneum was dissected and mobilized anteriorly along with kidney and perinephric fat. Bone and disc material compressing the cord were

removed, sagittal reconstruction of the spine made and bone graft from iliac crest or rib inserted (fig. 3). Segmental spinal fixation was performed with Webb Morley system to prevent collapse or subluxation (fig. 4). The diaphragm was stitched with prolene suture. Wound closed back in layers with a chest drain (fig. 5).

Postoperatively patients were regularly followed for at least 6 months to 2 years and assessed for neurological recovery and bony fusion.

STATISTICAL ANALYSIS

Results were analyzed using SPSS version 10.0. Descriptive statistics i.e mean $\pm$ SD for numerical variables and frequency alongwith percentages were used to describe the categorical variables.

RESULTS

We have operated upon 36 patients including 27 (75%) males and 9 (25%) females over a period of 5 years. Patient ages varied from 18 to 50 years (table-1).

Patients with trauma were either due to motor vehicle accidents 20 (55.6%) cases or fall from heights 16 (44.4%) cases. Common presentations were weakness of lower limbs, backache, deformity, urinary retention and constipation. Mixed type of neurological disturbance (upper and lower motor neuron) was seen due to involvement of both cord and cauda equina. Distal limb involvement was marked than proximal. On radiological examination they have burst fracture or fracture dislocation with disc herniation. Facility of Nerve conduction velocity and electromyography facility was not available in the institute. Associated injuries include hemothorax in 4 (11.1%) cases, retroperitoneal haematoma in 3 (8.33%) and limb fractures in 4 (11.1%) cases.

The time difference between occurrence of trauma and surgery undertaken was from 36 hours to 6 days. None of these patients presented within 6 hours. All of these patients underwent transphrenic anterior decompression, bone grafting and fixation with Webb Morley fixation. Neurological improvement i.e. at least one grade on American Spinal Injury Association scoring was seen in 17 (47.22%) cases at 1 month postoperatively (Table 2). Remaining 19 (52.77%) cases showed no neurological improvement bur the stabilization of spine helped in the earl mobility and avoidance of complications like hypostatic pneumonia and bed sores.

D12 lesions have overactive bladder and L1 involvement showed areflexic features. Sphincter disturbance was a disturbing feature, which even persisted for longer period even after operation. Improvement in autonomic (micturition, defecation and sexual functions) and motor activity was slower than sensory modality. Gut transition time was increased and mostly they were constipated than incontinent (passive leakage). All patients needed catheterization. 16 (44.44%) patients were catheter free at end of 1 month. Bony fusion was observed in 32 (88.9%) cases at the end of 3 months.

These patients were followed for 6 months to 2 years for the neurological recovery, bone fusion and complications. Postoperatively 2 (5.6%) patients had empyema thoracis that needed decortications. Webb- Morley screw fracture was in 1 (2.8%) case and was left as such because bony fusion has already occurred. Intercostal neuralgia was noted in 3 (8.3%) cases, which were managed with analgesics and local anesthetics. No diaphragmatic herniation encountered.

All patients underwent physiotherapy schedule including postural turning, skin care, bladder care and electrical stimulation of paralyzed muscles.

DISCUSSION

This transit zone between thoracic and lumbar spine is vulnerable to trauma. Axial loading and hyper flexion are the commonest mechanism of injury. Nabeshima Y et al [1] have reported hyperextension force and axial

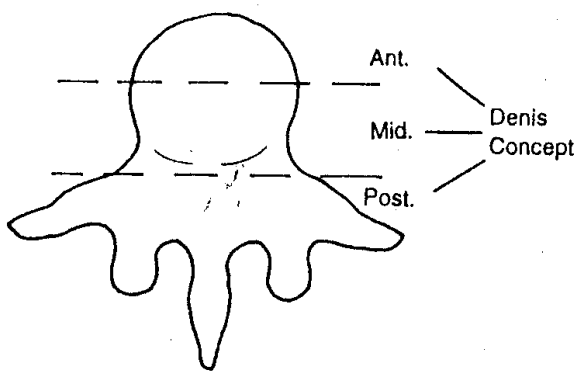

Fig. 1: Denis's three-column concept: anterior column consisting of anterior part of vertebral bodies and intervertebral discs, middle consisting of posterior part of vertebral body and pedicles and posterior column consisting of posterior elements.

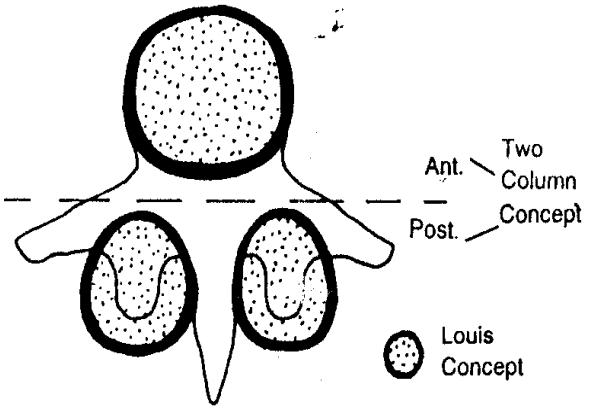

Fig. 2: Three-column theory by Louis: vertebral body and disc and the two joint complexes.

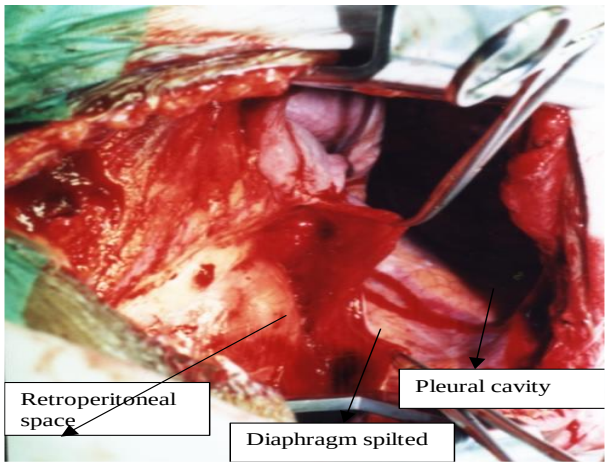

Fig. 3: Opening of diaphragm in annular fashion to open chest cavity and extra peritoneal space.

loading rarely the mechanism of injury to this part of the spine. Operative treatment is preferred in comparison to recumbent treatment that decreases complication rate and patients can be mobilized early [2]. Standard posterior, posterolateral [6] (costotransverse) or anterior approach [7,8] can be utilized to reach the thoracolumbar junction. Posterolateral decompression procedure involves hemilaminectomy and removal of portions of one pedicle with high-speed burr to allow posterolateral decompression of the dura along its anterior aspect. The degree of neurological recovery of spinal cord injury after anterior spinal decompression of thoracolumbar fractures appears more favorable than after other, previously reported techniques that do not decompress the spinal canal [7]. Anterior TL junction is exposed by various methods like transthoracic, retroperitoneal [8] and thoracophrenicolaparotomy. The primary indication for anterior decompression and grafting is narrowing of the spinal canal with neurological deficits that cannot be resolved by any other approach [9]. We prefer anterolateral approach to this area by transsdiaphragmatic route by dividing the diaphragm in an annular fashion and expose a wide area into thoracic cavity and extraperitoneal space.

By this single exposure operating time is minimized. Decompression, bony grafting and instrumentation performed in one sitting. Daniel et al [5] have used thracoscopic transdiaphragmatic approach to this part of the spine and had found excellent access to thoracolumbar junction for proper decompression, reconstruction and instrumentation. Shah and Memon [7] managed traumatic lesions to thoracolumbar spine by anterolateral approach and fixed spine with Webb Morley system. Proper placement of the screws is very mandatory otherwise screw may enter into the canal or the major vessels in front of the vertebral body.

Khurram Shafiq et al [8] have used transpedicular screws to fix the thoracolumbar tuberculous and traumatic lesions utilizing posterior approach and

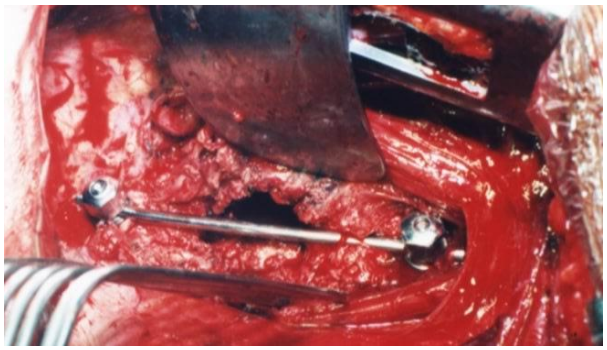

Fig. 4: Webb-Morley implant inserted.

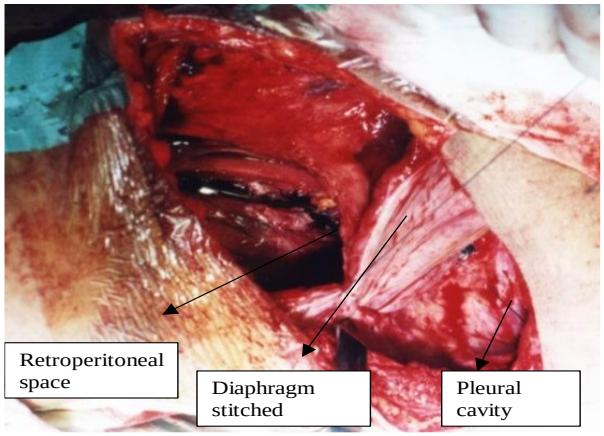

Fig. 5: Diaphragm closed with prolene suture.

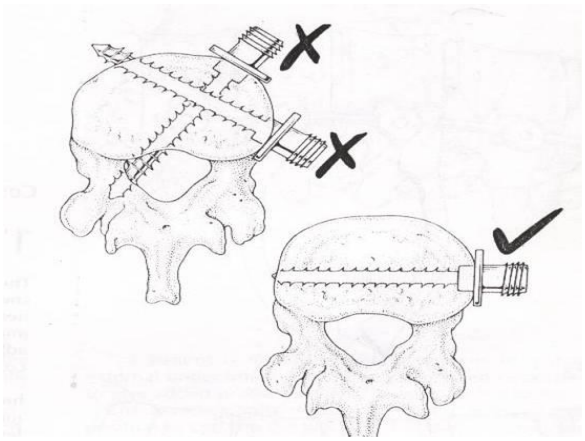

Fig. 6: Proper placement of vertebral body screws. If inserted in wrong direction may enter into spinal canal or major vessels (aorta or inferior vena cava).

Table-1: Age distribution of patients (n=36).

Age Groups	No. of Patients (%)
11-20 yrs	6 (16.7%)
21-30 yrs	8 (22.2%)
31-40 yrs	12 (33.3%)
41-50 yrs	10 (27.8%)

found it satisfactory. Gregory et al [4] have compared costotranseversectomy at this region with other approaches and found lesser complications and useful in patients with medical co morbidity. We have experienced transphrenic approach far better than other approaches because there is direct assess to the fracture site, there is a wide exposure; decompression, bone grafting and instrumentation can be done in one stage. By posterior approach posterior column, which is intact, is further damaged and anterior vertebral body fracture is not properly decompressed. Costotranseversectomy is also not achieving all the three goals that is decompression, fusion and stabilization in one stage.

Along with skeletal involvement there is damage to the conus medularis and descending roots of cauda equina, so there is mixed type of upper and lower motor neuron signs. The neurological improvement was well seen in patients with partial neurological deficit than with complete paraplegia. In patients with complete paraplegia there was some improvement in motor and sensory modalities; and patients were mobilized early and prevented from the complications of bedridden status.

The lesions of the thoracolumbar vertebral junction, where the sacral cord is located, it may be difficult to predict urodynamic dysfunction merely on the basis of the vertebral body involved. Most of our patients needed catheterization for longtime and only 16 patients was catheter free at 1 month [10,11].

CONCLUSION

From this study conducted over a period of 5 years it is observed that transdiaphragmatic approach provides adequate exposure of thoracolumbar junction fractures for proper decompression, alignment and instrumentation. Males were in majority. Adults and middle age groups suffered mostly. Most of the patients had improved by 1 grade on ASIA scale 30 days postoperatively. Neurological improvement was seen in 17 (47.2%) cases. Bony fusion was

Table-2: Change in Asia scale and neurological improvement after 30 days operation (n=36).

Asia scale	No. of Patients (%)		
	Preoperatively (No. of patients)	Postoperative Improved (neurological)	Postoperative Static (neurological)
A	10 (27.8%)	2 (5.55%)	8 (22.2%)
B	4 (11.1%)	1 (2.78%)	3 (8.33%)
C	10 (27.8%)	6 (16.67%)	4 (11.1%)
D	8 (22.2%)	4 (11.1%)	4 (11.1%)
E	4 (11.1%)	4 (11.1%)	0
Total	**36 (100%)**	**17 (47.22%)**	**19 ((52.77%)**

observed in 32 (88.9%) cases at the end of 3 months. Cauda equina lesions have better improvement than Cord lesions. Sphincter disturbance remained for longer period.

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