

Evaluation of Effective Role of Posterior Longitudinal Ligament in Management of Traumatic Spine Injuries

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Abstract

Introduction: Ligaments are fibrous bands or sheets of connective tissue linking two or more bones, cartilages or structures together. The ligaments provide stability to a joint during rest and movement. Excessive movements such as hyperextension or hyperflexion or rotations may be restricted by ligaments. In the spine, the ligament helps to provide structural stability.

Materials and Methods: The study of 32 patients, with acute dorsolumbar and cervical fractures, admitted to hospital was carried out. Thorough clinical assessment in the form of mechanism of injury, inspection and palpation of spinous process, and neurological examination was carried out. Patients were investigated in the form of X-ray, computed tomography (CT) scan, magnetic resonance imaging, and CT scan showed a pattern of bony injury. White and Punjabi criteria were used to identify instability in vertebral column and treated (conservatively/operatively) accordingly. Fractures are classified by McAfee and modified Magerl (AO/Association for the Study of Internal Fixation) classification system.

Results: In our experience of spine fractures, very minor cases can be treated with bed rest and physiotherapy; 30% of lesions can be managed with closed treatment; only 60% will require surgery. Distraction posteriorly requires intact anterior longitudinal ligament (ALL) (to prevent over distraction-anatomical hinge) with or without intact posterior longitudinal ligament (PLL) but for indirect reduction of fracture fragments retropulsed into spinal canal by ligamentotaxis intact PLL is required. If PLL is ruptured surgeon considered either anterior or posterior approach to directly decompress spinal canal and fusion rather than relying on posterior distraction and fusion alone.

Conclusion: PLL forms important structure stabilizing spine along with ALL and ligamentum flavum and other ligaments, helps in resisting excess of flexion, lateral bending, and spinal rotation to lesser extent. It aids in the indirect reduction of fracture fragments by ligamentotaxis.

Key words: Cervical spine, Intervertebral disc, Ligamentotaxis, Posterior longitudinal ligament, Vertebral column

INTRODUCTION

Ligaments are fibrous bands or sheets of connective tissue linking two or more bones, cartilages or structures together. Ligaments provide stability to a joint during rest and movement. Excessive movements such as hyperextension or hyperflexion or rotations may be restricted by ligaments.

In the spine, ligament helps to provide structural stability. There are two primary ligament systems in the spine. (1) The intrasegmental system: Holds individual vertebrae together include the ligamentum flavum, interspinous and intertransverse ligaments. (2) The intersegmental system: Holds many vertebrae together include the anterior longitudinal ligament (ALL) and posterior longitudinal ligament (PLL) and the supraspinous ligaments. PLL is placed on the posterior surface of vertebral bodies in the vertebral canal attached to bodies of C2 up to sacrum. Its smooth glistening fibers are attached to intervertebral discs, lamina of hyaline cartilage and adjacent margins of vertebral bodies and not attached firmly and allow escape of basivertebral veins. At cervical and upper thoracic levels, the ligament is broad and of uniform width but

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in the lower thoracic and lumbar levels it is denticulated, narrow over vertebral bodies and broad over discs. Longitudinal ligaments transfer tensile loads from bone to bone and when subjected to large loads *in situ* failure may occur either within the ligament or in the bone at the point of attachment and may degenerate with age. McAfee introduced the concept of unstable burst fracture where anterior and middle column fail in compression and posterior column is disrupted. This fracture is unstable as posttraumatic kyphosis and neurodeficit may develop and PLL is ruptured. We have analyzed the role of PLL in traumatic spine injuries.¹⁻⁸

MATERIALS AND METHODS

The study of 32 patients with acute dorsolumbar and cervical fractures admitted to hospital was carried out. Thorough clinical assessment in the form of mechanism of injury, inspection and palpation of spinous process, and neurological examination not forgetting perineal region was carried out. Patients were investigated in the form of X-ray (anterior-posterior/LAT/shoulder pull/open mouth/swimmer's view), computed tomography (CT) scan, magnetic resonance imaging (MRI), and CT scan showed a pattern of bony injury like fracture of vertebral body, pedicle, laminae, and retropulsed fragment in vertebral canal. MRI was done with 1.5T machine and in different views (axial, coronal, sagittal) showed the extent of trauma to spinal cord parenchyma, nerve roots, intervertebral discs, cord edema, contusion, and laceration. Integrity of spinal ligaments specifically PLL (best seen on T2 density images) noted and relationship to outcome assessed. White and Punjabi criteria (based on radiological and clinical parameters) were used to identify instability in the vertebral column and treated (conservatively/operatively) accordingly. Fractures are classified by McAfee and modified Magerl (AO/Association for the Study of Internal Fixation) classification system.

Patient Assessment

White and Punjabi criteria of instability were used when stability was still doubtful as shown in Table 1.

Management

Conservative

- Postural reduction, bed rest, bowel bladder care, proper nutrition, ambulatory bracing producing a vector opposite of injury force, analgesics, waterbed and frequent change of position, observation for neurological worsening.
- A stable injury such as compression fracture, posterior element fractures and low energy osteoporotic compression and burst fracture were treated by a

Table 1: White and Punjabi Criteria of instability

Cervical criteria	Scoring
Cervical white and Punjabi criteria	
Ant element destruction	2
Posterior element destruction	2
Sagittal plane translation >3.5 mm	2
Sagittal plane rotation >11 degree	2
Positive stretch test	2
Medullary (cord) damage	2
Root damage	1
Abnormal disc narrowing	1
Dangerous loading anticipated score >5 instability	1
Thoracic and T-L white/Punjabi criteria	
Ant element destroyed	2
Posterior element destroyed	2
Disrupted costovertebral articulation	1
Sagittal plane displacement >2.5 mm	2
Relative sagittal plane angulation >5 degree	2
Spinal cord or cauda equine damage	2
Dangerous loading anticipated total of 5 or more=unstable	1
Lumbar white and Punjabi criteria scoring	
Ant element destroyed	2
Post element destroyed	2
Flexion extension X-ray criteria	
Sagittal plane translation >4.5 mm or 15%	2
Sagittal plane rotation	2
>15 degree at L1-2, L2-3, L3-4	
>20 degree at L4-5	
>25 degree at L5-S1	
Resting X-ray criteria	
Sagittal plane translation >4.5 mm or 15%	2
Relative sagittal plane angulation >22 degree	2
Cauda equina damage	3
Dangerous loading anticipated	1

standard dose of methyl prednisolone within 48 h of injury and dexamethasone in tapered dose after 48 h of injury.

- Reduction of subluxation/dislocation of the cervical spine was done after Crutchfield tong insertion.

Operative

- Surgery was required in unstable three column injuries and significant neurological deficits examples are fracture dislocations, flexion distraction injuries, and burst fractures with neurological deficits.
- Neurologically intact patients with a compression fracture and burst fractures that have >50% loss of vertebral body height or >30% kyphosis in degenerative lumbar (DL) spine are also consider candidates for surgery.
- Canal compromise >50%, scoliosis (lateral tilt >10°) or posterior ligament rupture, 33 mm interspinous distance on lateral radiograph are other indicators of instability in DL spine.
- The posterior approach is the preferred route when there is a trauma to the thoracic and lumbar spine with neurological lesions. Anterior approach can be used to relieve severe anterior compression. When both

approaches are used, there was usual practice to leave a week between the two stages. The first stage should be the nerve decompression and if required bone graft can be used for facet joint fusion.

- Fixation was done using moss Miami pedicle screws and rods, Harrington rod distraction, Steffi plating, Hartshill fixation, anterior decompression, and fusion with cage and bone graft.

RESULT

- The indirect reduction was most successful in PLL intact or assumed to be intact (intact middle column) cases compared to PLL ruptured cases (success rate of 100%).
- Ligamentotaxis was successful more often with moss Miami/Steffi plate compared to H-rod or Hartshill. Thus, better indirect reduction occurred with devices which restore both lordosis and posterior body height, e.g., moss Miami.
- The indirect reduction resulted in large defect of bone stock in 2 cases and hence bone graft by anterior route was done to prevent fatigue fracture of pedicular screws/Hrod construct.
- Attempted indirect reduction for subluxation/dislocation of the cervical spine by Crutchfield tongs and traction resulted in neurological deterioration in 1 case, in which PLL was found ruptured on MRI/ intraoperatively and cord/root compression by extruded disc had to be dealt with.
- There was no need of compression/distraction in slice fracture and articular process fracture; rotational correction was more important. Hence, there was no difference in results whether moss Miami or Hartshill was used.
- Most people with spinal cord dysfunction presented with the cord intact. Cord injuries as detected by MRI and intra-operative findings suggest 10 cases of contusions or bruising of the cord, 10 cases of compression injuries having pressure on the cord, 6 cases of laceration or tearing, 2 cases of central cord syndrome, and 4 cases of complete severing.

DISCUSSION

- In our experience of spine fractures, very minor cases can be treated with bed rest and physiotherapy; 30% of lesions can be managed with closed treatment; only 60% will require surgery. This 60% which is a high figure can be explained by the fact that ours is a tertiary reference center where cases which require operative treatment mainly are referred.
- It should be emphasize that no treatment can be

implemented safely unless a sufficiently skilled surgical team, sufficiently competent paramedical personnel, and adequate equipment are available.

- Newer imaging techniques have aided the evaluation and treatment of the spine and spinal cord injuries particularly CT (bony) and MRI (particularly PLL and posterior annulus).
- PLL along with posterior aspect of body of vertebra, annulus fibrosus (posterior) forms Dennis middle column which is crucial in determining the stability of spine in fracture spine.
- Distraction posteriorly requires intact ALL (to prevent over distraction-anatomical hinge) with or without intact PLL but for indirect reduction of fracture fragments retropulsed into spinal canal by ligamentotaxis intact PLL is required. If PLL is ruptured surgeon considered either anterior or posterior approach to directly decompress spinal canal and fusion rather than relying on posterior distraction and fusion alone.
- For ligamentotaxis instrumentation should apply both an extension movement and axial distraction. Harrington rod system tends to produce posterior distraction leading to kyphosis and hence should not be preferred in the lower lumbar spine. The indirect reduction was more successful for fracture DL junction than the lower lumbar spine.
- Intra-operative radiographs to confirm that sagittal plane alignment has been restored without over distraction was done to avoid cord damage. Better is C Arm. Postop CT scan to confirm adequacy of canal restoration was done in few cases only. Failure to achieve adequate canal decompression posteriorly necessitated secondary anterior decompression and strut reconstruction/cage in 16.66% cases.
- Ligamentotaxis only was tried in fresh cases and canal compromise <68% as it has been proved beyond doubt by earlier studies that ligamentotaxis succeeds in fresh cases and with less than 68% canal compromise.
- Better indirect reduction occurred with devices that restored both lordosis and posterior body height, e.g., pedicle screw and rod fixation assembly. If reduction resulted in large defect of bone stock in vertebral body (in 16.66% cases), it was necessary to fill anterior defect with anterior corpectomy and bone graft. This prevented fatigue fracture of pedicular screws/Harrington rod construct. In the case of very comminuted fracture with neurological lesion both AP approaches are required.
- Anterior vertebral body excision and grafting were done primarily or become necessary in certain burst fracture with or without intact PLL which presented late and had >68% canal compromise. In flexion distraction

injuries when the posterior and middle column (including PLL) failed by ligamentous disruption posterior spinal arthrodesis with compression system was used. However, in cases in which middle column (including PLL) was determined to be incapable of preventing retropulsion of bone or disc fragments into spinal canal combined AP approach was used.

CONCLUSION

PLL is often adequately visualized on MRI particularly if ruptured and lifted up from posterior aspect of vertebral body. It forms important structure stabilizing spine along with ALL and ligamentum flavum and other ligaments, helps in resisting excess of flexion, lateral bending, and spinal rotation to lesser extent. It aids in the indirect reduction of fracture fragments by ligamentotaxis. Reduction of cervical spine subluxation/dislocation by skeleton traction through Crutchfield tongs should not be tried with ruptured PLL (as disc extrusion may occur causing cord compression). With rupture of PLL evident

on MRI anterior decompression and fusion in addition to posterior instrumentation should be strongly considered as it is a strong indicator of instability in traumatic spine injuries which cannot be tackled only by posterior instrumentation. PLL is ruptured most often in unstable burst fractures (compression mechanism), chance fractures (tension) and translational injuries. It fails rarely if ever due to rotation and extension.

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