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NON-OPERATIVE VERSUS OPERATIVE TREATMENT FOR THORACOLUMBAR AND THORACOLUMBAR BURST FRACTURES AND ITS COMPARISON OF SAGITTAL PROFILE OF SPINE

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ABSTRACT

Ninety percent of all spinal fractures occur in the thoracolumbar region, and burst fractures comprise approximately 10% to 20% of such injuries1-4 (fifty-nine [14%] of 412 thoracolumbar fractures in one series3 and 25,000 [15%] of 162,000 fractures in another1). Despite the fact that it is such a common fracture, there are various opinions Researchers have advocated both an operative and a nonoperative approach. Open reduction, arthrodesis, and regarding the ideal management, especially in patients without an associated neurological deficit. internal fixation offers the possibilities of immediate stability, correction of deformity, early walking, reduced reliance on orthotic containment, and the theoretical protection against spinal malalignment or neurological injury when the patient is upright. Nonoperative care, in the form of either a body cast or a brace, offers the avoidance of a surgical intervention with its attendant morbidity. Our aim is to compare the radiological outcome of patients with thoracolumbar and lumbar burst fractures managed operatively and non-operatively in terms of Kyphotic deformity at fractured level, in terms of local Cobb's angle and kyphotic angle, Restoration of vertebral height, in terms of change in anterior and posterior vertebral body heights and Sagittal parameters of spine and pelvis, viz., lumbar lordosis, thoracic kyphosis, sagittal vertical axis, sacral slope, pelvic tilt and pelvic incidence. In standing position vertebral column is subjected to gravitational forces creating forward bending movements as center of gravity lies ventral to S1 vertebra. Fracture of vertebra will shift the axis of rotation posteriorly at the affected segment increasing bending movements of spine and shortens of the lever arm of muscles and ligaments adding to potential instability. Burst fracture results from compression failure of both anterior and middle columns under axial loads. Key feature of this injury is fracture of posterior vertebral body cortex with retropulsion of bony fragments into spinal canal. It is uncommon for a patient to develop neurological deficit with proper immobilization even in the setting of severe canal stenosis. Usual protocol for thoracolumbar spinal fracture management is based on Thoracolumbar Injury Classification System (TLICS). Preservation or restoration of neutral upright sagittal spinal alignment has become priority in both deformity correction and other spinal surgeries. Sagittal spinal alignment has become an important predictor of a patient's functional outcome after spinal surgery. Proper total spinal sagittal alignment is important to not only maintain balanced standing posture, but also reduce the pain component of quality of life. In this study, we have compared the sagittal spinal parameters in follow up cases of thoracolumbar and lumbar burst fractures managed non-operatively and operatively to draw conclusions regarding mode of treatment.

Key words Kyphosis, Retropulsion, Decompression, Burst Fracture. Spinal Injuries, Thoracolumbar trauma, Management.

INTRODUCTION

Fractures of the thoracic and lumbar region constitute a spectrum of injuries ranging from the simple undisplaced fractures to complex fracture dislocations.[1]

Anatomically and functionally, the thoracic and lumbar spine can be divided into three regions – thoracic

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spine (T1-T10), thoracolumbar junction (T10-L2) and the lumbar spine (L3-L5). The thoracic spine is functionally rigid due to coronally oriented facet joints, thin intervertebral discs and the ribcage. Thus, it requires huge amounts of energy to produce fractures and dislocations. The narrow spinal canal in this region predisposes to spinal cord damage resulting in a high incidence of neurological deficit. The lumbar spine, on the other hand, is relatively flexible due to the thicker intervertebral discs, sagittal orientation of facet joints and the absence of the rib cage. The relatively lesser incidence of neurological injury in lumbar fractures can be attributed to the large size of the neural canal and the greater resilience of the cauda equina nerve roots. The thoracolumbar junction (T10-L2) is uniquely positioned in between the rigid thoracic spine and the mobile lumbar spine.

Many reviews have compiled information to compare different treatment modalities. Since 2000, reviews and metaanalyses on surgical strategies have been published on fusion versus nonfusion [2] minimally invasive surgery versus open surgery [3,4] anterior versus posterior approach [5] early versus late treatment [6,7] or looked at a specific treatment types in itself, for example, pedicle screw fixation8 or surgical treatment in general. [8-9] Fewer reviews have been published about conservative treatment options, for example, on the usefulness of orthoses. [10,11]

Our study aim is to compare the sagittal profile of spine in follow up cases of thoracolumbar and lumbar burst fractures treated operatively and non-operatively. and To compare the radiological outcome of patients with thoracolumbar and lumbar burst fractures managed operatively and non-operatively in terms of Kyphotic deformity at fractured level, in terms of local Cobb's angle and kyphotic angle, Restoration of vertebral height, in terms of change in anterior and posterior vertebral body heights and Sagittal parameters of spine and pelvis, viz., lumbar lordosis, thoracic kyphosis, sagittal vertical axis, sacral slope, pelvic tilt and pelvic incidence.

MATERIAL AND METHODS:

A retro-prospective study of patients with thoracolumbar and lumbar burst fractures with or without neurological deficits admitted and treated in Department of Orthopaedics, SLIMS, Pondicherry, the study period from September 2018 to September 2019 during this period a total number of 36 of thoracolumbar and lumbar burst fractures were treated, out of which 4 were ASIA – B, 6 cases were ASIA- C and 26 were ASIA – D.

Information collected included inclusion and exclusion criteria of the respective study, demographic and injury characteristics, treatment details, outcomes concerning clinical, radiological and perioperative parameters, return to activity, adverse events,reoperations, follow-up (FU) time, and the proportion of patients lost to FU. This was completed via a standardized data extraction form.

Inclusion criteria:

An isolated burst fracture in thoracolumbar (D11 to L2) and lumbar spine (L3 to L5) identified in anteroposterior and lateral radiographs and computed tomography (CT) revealing retropulsion of bony fragments into spinal canal. < 4 were managed conservatively and patients with TLICS score 4 were explained both the treatment options. Patients who were not willing for surgery were managed conservatively.

All patients who can stand at the end of 1 year follow up (ASIA D & E) regardless of initial neurological status (ASIA B to D) were included

Exclusion criteria:

Patients with complete neurological injury, patients with osteopenic compression fractures and patients with TLICS score >4 but having medical co-morbidities which come in way in management of spine were excluded from the study.

RESULTS:

Figure 1: Patient managed operatively: (vertebral heights)
Figure 2: Patient managed non-operatively: (vertebral heights)

The age group ranged from 17 to 65 years with mean age of 40.95 years. No differences in involvement in age groups. There are twelve females and fifty-one males in our study, showing males are very commonly affected compared to females.

In our study we found, fall from height being the most common cause of thoracolumbar spine injury comprising more than half of the cases, followed by road traffic accidents, we found that L1 vertebra was the most commonly involved level in thoraco lumbar spine injuries.

At the time of presentation, on neurological examination, 26 patients were ASIA-D, 6 were ASIA-C and 4 patients were ASIA-B out of which 28 patients improved to ASIA-E and 4 to ASIA-D. 2 patients have not improved from ASIA-B and 1 patient were lost for follow-up. All patients with TLICS score > 4, those with TLICS score 4 and willing for surgery were managed operatively (N =17), patients with TLICS < 4, those with score 4 and not willing for surgery were managed non-operatively (N=15).

All patients were followed up for minimum of 1 year and radiological parameters were analysed at the end of follow up. The parameters in the study were randomly distributed in operative and non-operative groups. Both the groups have significant effect on the parameters under study. Effect of groups on Cobb's angle, local kyphotic angle and vertebral height was significant ($p< 0.001$). The improvement in Cobb's angle from post injury to final

follow up was evaluated using Repeated measures ANOVA between the two groups. The mean Cobb's angle improved from 18± 69 to 7.52±3.72 in operative group, where as in non-operative group it is improved from 14±5.1 to 11±6.3 The rate and amount of improvement in Cobb's angle was significant in operated patients ($p< 0.001$). Operated patients have higher baseline Cobb's angle compared to non-operative patients.

The improvement in local kyphotic angle between the groups was evaluated using repeated measures ANOVA. The mean local kyphotic angle is improved from 15.37±8.51 (post –injury) to 8±5.0 (post-surgery); the correction was lost slowly during follow up to reach 11±7.51 at 1year follow up in operative group. In the non-operative group mean local kyphotic angle post injury was 13.60 ±6.21 which was improved to 9.35±4.84 following reduction which was lost progressively during follow up to reach 12.24±6.29 at 1 year follow up. The rate and amount of improvement are significantly higher in operated patients ($p<0.001$).

Sagittal spinal meters, viz., lumbar lordosis and thoracic kyphosis are restored to near normal in operative group compared to non-operative group. The mean lumbar lordosis of operated group was $51^0\pm 9^0$ (normal range - $50^0\pm10^0$) and mean thoracic kyphosis was $40^0\pm 7^0$ (nomal range- $41^0\pm8^0$), where as in non-operative group mean lumbar lordosis was $51^0\pm 10^0$ and mean thoracic kyphosis was $36^0\pm5^0$. However, statically there was no significant difference in sagittal spinal parameters between the two groups ($p>0.05$). Sagittal vertical axis (SVA), a vertical plumb line from spinous process of C7 vertebra, which is a determinant of sagittal plane balance of spine, was measured in full length lateral radiograph of spine. Horizontal distance from SVA and postero-superior corner of cranial end plate of S1 vertebra was measured, ± 5mm of distance between these two lines was considered neutral.

In the non-operative group sagittal plane balance was restored to neutral in 37 % cases (N=6), it was negative in 40 % of cases (N=6) and positive in 23% cases (N=03) whereas in operative group sagittal plane balance was restored to neutral in 55% cases (N=9), it was negative in 24% cases (N= 04) and positive in 21% cases (N=04). As SVA is determinant of sagittal plane balance which is used in evaluation of results from surgical procedures and corrections for different spinal disorders, neutral balance of spine was achieved in more cases of operative group compared to non-operative group.

DISCUSSION:

Patients typically present with a history of trauma following a road traffic accident, fall from height, a direct blow to the spine or rarely gunshot injuries. Axial, nonradiating back pain of stabbing or aching quality is the most common symptom. Patients with neurological injury complain of weakness, paresthesia or anesthesia below the injury level and urinary retention. Thorough inspection of the spine should be performed after a careful log roll maneuver to look for abrasions, tenderness, local kyphosis and a palpable gap in between spinous process. Neurological assessment should follow the standard American Spinal Injury Association (ASIA) guidelines [12]. As the spinal cord ends at the L1-L2 level, and the cauda equina fills the distal canal, varied neurological injury patterns can be observed with thoracolumbar fractures. Neurological injuries above L1 can damage the spinal cord producing a typical upper motor neuron injury. Injuries much below L1-L2 affect only the cauda equina roots involving few or multiple nerve roots resulting in lower motor neuron type injury. Conus medullaris syndrome characterized by exclusive damage to sacral innervations to the bowel and bladder, with intact lumbar nerve roots, is a unique feature of T12-L1 injury.

Standard radiographic evaluation includes antero-posterior and lateral radiographs. Radiographic evaluation should include spinal alignment, presence of any rotation or translation, assessment of the kyphosis, loss of vertebral height, and widened inter-pedicular or inter-spinous distance. Throughout resuscitation in the emergency room and subsequent care, all efforts must be taken to immobilize spinal injury patients safely and intermittently log roll to prevent pressure sore formation. Stabilization of unstable injured motion segments plays an important role in preventing further injury. In a patient with SCI, injury to neural structures occurs both at the time of injury (primary – nonmodifiable) and in the subsequent period due to vascular dysfunction, edema, ischemia, electrolyte shifts, free radical production, inflammation and delayed apoptotic cell death (secondary – potentially modifiable).[13] Numerous pharmacological agents thought to mitigate the secondary injury have been extensively studied. These include the steroids (anti-inflammatory), gangliosides, naloxone (opiate receptor antagonist), calcium channel blockers, free radical scavengers and neurotropic agents.

During nonoperative care, it is common to observe a certain degree of increasing fracture kyphosis in most patients, often closer to the pre-treatment sagittal alignment. However, kyphosis even up to 30° has not been shown to correlate with pain in several studies. The advantages of operative treatment of thoracolumbar fractures over the nonoperative approach include avoiding an orthosis in the presence of multiple injuries, skin injuries, and obesity, immediate mobilization and earlier rehabilitation and better restoration of sagittal alignment. [14,15] Surgical decompression of compressing bone fragments over the spinal cord also reliably provides a better environment for restoration of neurologic function. On the other hand, the benefits of surgical treatment must be carefully weighed against the potential surgical

morbidity. Conventional open surgical techniques can be associated with morbidity because of approach‐related muscle injury, increased infection rates and higher blood loss. The severity of neurological injury is determined by the extent of neuronal injury incurred at the time of primary injury. But it is still worthwhile considering early surgical decompression in patients with incomplete SCI in the presence of spinal cord compression. Manual compression or primary repair of the tear is generally effective at treating this complication. Visceral injuries and postoperative lymphocele, or chyloretroperitoneum are uncommon events. This is usually evident intraoperatively and requires the expertise of the gastrointestinal surgeon to repair. Injuries to the peritoneum are very common but are easily repaired and do not lead to significant problems.

The mean age of injury was 40.84 years (range 17-65) in our study which is comparable to other studies [16,17], males being affected four times more than females. Fall from height was the most common cause of injury followed by road traffic accidents as described in literature.

Thoracolumbar transition zone (D11 – L2) was the most affected region with L1 being the most commonly involved level. Most of the patients were neurologically intact at the time of presentation (N =26). In a prospective randomized study by Wood et al [18], they have compared the outcomes of surgical and conservative treatment in forty-seven patients with thoracolumbar burst fractures (12 treated surgically and 12 treated conservatively with orthoses). Radiographic analysis showed similar results with respect to kyphosis, mean kyphosis at admission was 12.90 and 17.20 at final follow up. In our study, mean Cobb's angle in operated patients post injury was $180\pm7.0^0$and at final follow up was $7.4^0\pm3.8^0$ while in non-operative group, post injury it was $14^0 \pm 5.1^0$ and at final follow up it was $11.0^0\pm6.3^0$which has shown significantly better improvement of local kyphotic deformity in operated patients.

The average progression of the kyphotic deformity in a study by Avanzi et al 2002 [19], was 1.81in a group of 9 patients who were followed for average of 34.7 months. In their retrospective study, Tropiano et al [20] assessed 22 patients treated conservatively with hyperextension brace, reported mean initial kyphosis of 3.40 and mean final kyphosis of 4.60, showing mean increase in the deformity of 1.20. In a study by [16], after non-operative management of 20 patients with orthoses, have reported 190 initial kyphosis, 200 final kyphosis and 10 mean progressions of deformity. Chow et al [21], in their case series of 24 patients treated conservatively with cast or orthoses, reported mean progression of deformity of 2.30, with initial kyphosis of 5.30 and final kyphosis of 7.60. In another study by Avanzi et al 2006 [22], in their patients treated with orthoses, reported initial kyphosis of 200 and final kyphosis of 240, presenting mean deformity progression of 40.

In our study, the mean anterior vertebra height post- injury was 1.8±0.48 cm in operative group and 1.9±0.28 cm in non-operative group. Post –reduction the mean height improved to 2.8±0.39 cm in operated group and 2.3±0.43 cm in non-operative group. At the end of final follow up mean anterior vertebral height is 2.7±0.44 cm in operated group and 2.2±0.43 cm in non-operative group, which has shown significant improvement in operated group which is maintained well throughout the follow up. There was no significant difference in improvement of posterior vertebral height in both the groups. Recently, there is increasing recognition of the importance of sagittal spinal alignment for normal function of spine and with reference to its various disease states. [23,24,25]

The equilibrating capabilities of the spine and pelvis to compensate to for post-traumatic kyphotic deformity is sufficient in 55 % of operated cases, while only 37 % of non-operative group were able to attain neutral sagittal balance. However, despite extensive studies on this common injury, controversies still exist regarding the appropriate radiological investigations, the type of Nonoperative treatment, the indications for surgical management, the timing of surgery, approach and type of surgery, need for fusion and the role of spinal canal decompression.

Figure 1: Patient managed operatively: (vertebral heights)
A. Post-injury,B. Post-reduction,C. At 6 months,D. At 1 year

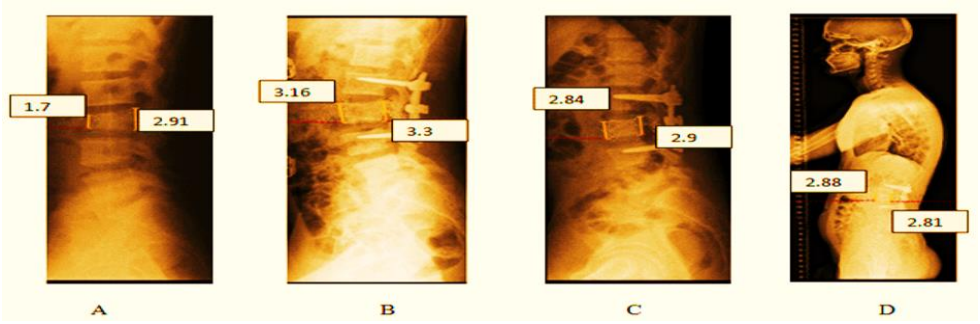
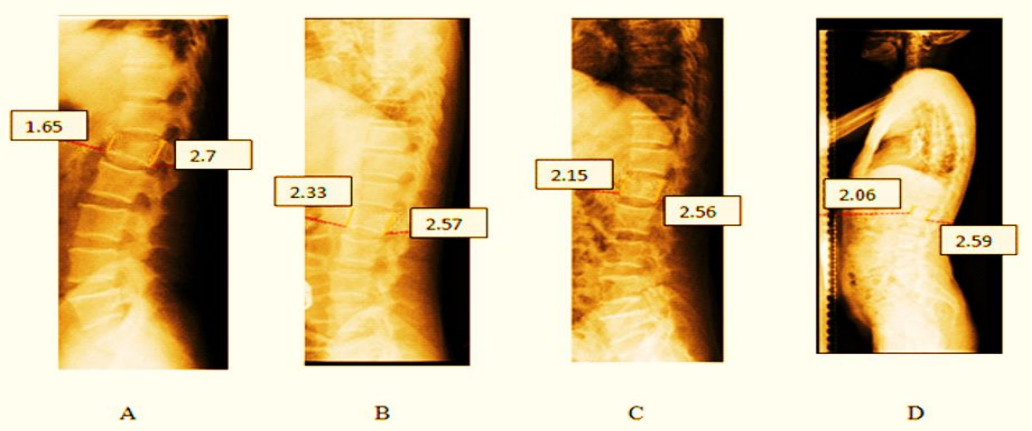


Figure 2: Patient managed non-operatively: (vertebral heights)
A. Post-Injury,B. Post-reduction,C. At 6 months,D. At 1 year



CONCLUSION:

Vertebral height was better restored in operative group than in nonoperative group. Corrected vertebral height was maintained in operative group during follow-up. Operative group had better correction of local kyphotic deformity compared to non-operative group at immediately after reduction, at 6 months and 12 months follow-up. Kyphotic deformity at 6 months follow-up was statistically increased compared to immediate post-reduction in operated patients. The correction was maintained till 12 months follow-up. Sagittal pelvic and spinal parameters were achieved to normal range at final follow-up in both the groups.

There is still lack of consensus in several areas in the management of thoracolumbar fractures. Principally treatment decisions in these patients require a complete evaluation of the neurological status and identification of the presence of spinal instability. It appears simple and includes most information regarding the extent of vertebral body injury, neurological injury and patient modifiers. Involvement of all the three columns, progressive neurological deficit, significant kyphosis >30° and canal compromise in the presence of neurological deficit are accepted indications for surgical stabilization. Compression fractures and stable burst fractures can be treated by nonoperative methods. Posterior surgery remains the most preferred technique, and anterior approach is the access of choice when decompression of the spinal cord is the priority. Minimally invasive surgeries are increasingly used to reduce surgical morbidity in the acutely traumatized patient.

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