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Outcome of Long Segment Posterior Spinal Stabilization Incorporating the Fractured Vertebra for Unstable Thoraco-Lumbar Junctional Brust Fracture

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ABSTRACT

Objectives: To evaluate the outcome of long segment posterior spinal stabilization incorporating the fractured vertebra with posterolateral fusion for unstable thoraco-lumbar junctional brust fracture.

Background: Thoracolumbar junction is the commonest site of traumatic spinal injury. Now a days, it is managed surgically most of the time because it is often associated with the spinal cord injury. Its mode of surgical management is a field of controversy. Huge debate is still going on between the superiority of long & short segment stabilization. In this study, we evaluated the outcome of long segment posterior spinal stabilization incorporating the fractured vertebra

Materials & Method: This prospective interventonal study included 30 case of thoraco-lumbar junctional unstable brust fractures was carried out in the Spine unit of Orthopaedic surgery department of Bangabandhu Sheikh Mujib Medical University, Dhaka and other private hospital in Dhaka City, Bangladesh, from January 2016 to July 2022. All the patients with positive clinical findings, X-ray, MRI & CT scan findings and underwent long segment posterior spinal stabilization incorporating the fractured vertevra with posterolateral fusion. Average follow-up period was 12 months. Pre & Post-operatively, neurological assessment was done by the ASIA Impairment Score, improvement of pain control by VAS score, fusion rate by Bridwell's criteria, Kyphotic angle was measured by Cobb's angle measurement method & Overall functional assessment by modified Odom's score.

Results: Total number of patients was 30. Average age was 34 years (range 21- 47). ASIA score improved from B to C in 5 patients, B to D in 5 patients, C to D in 8 patients , C to E in 3 patients, patients, D to E in 7 patients. 2 patient did not improved following surgery. Fusion was achieved in 29 patients & 1 patient developed pseudoarthrosis. Pre & Post- operative VAS score was 7.30±1.9 & 3.3±1.8 respectively. The average kyphotic correction was 15 $^{\circ}$. In our series, we have no bedridden patients after surgery. There was no radiographic progression after surgery.

Conclusion: Early treatment within 21 days of injury with long segment posterior spinal stabilization incorporating the fractured vertevra with posterolateral fusion is a very effective surgical procedure with preservation of the motion segment to treat unstable thoracolumbar junctional brust fracture.

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Introduction

Each year more than 5000 new cases of spinal injuries are occurring in our country, of which majority involves the thoracolumbar region (Bangladesh Bureau of Statistics 2020). Most traumatic thoraco-lumbar fractures (50-60%) occur at the thoraco-lumbar junction (T11-L2) [1-3].

According to Denis, who developed 3 column concept of spinal fracture, stated burst fractures are failure of the anterior and middle columns due to compressive forces [4]. Denis also defined characteristic features of burst fractures, including comminution of the vertebral body, increase of interpediculate distance, vertical fracture of the lamina, retropulsion of body fragment into the spinal canal, and loss of posterior vertebral body height. Unstable fracture is defined as any two column injury including middle column which account for 25%-50% of all fractures in thoraco-lumbar region. Their incidence is more common in younger patients and carries a great impact on their day to day activities [5].

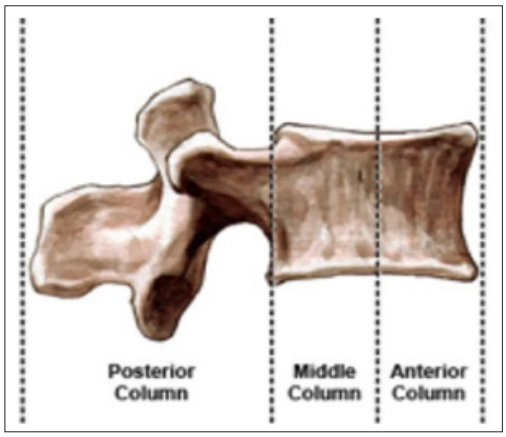

Figure 1: The Denis 3-column model of spinal stability

Thoracic and lumbar spine are divided into three regions – thoracic spine (T1-T10), thoracolumbar junction (T11-L2) and the lumbar spine (L3-L5). The thoracic spine is functionally stable with coronally oriented facet joints, thin intervertebral discs and the attachment of the ribcage. Thus, huge amounts of energy is required to produce fracture and/or dislocation. On the other hand, the lumbar spine is very flexible due to the thicker intervertebral discs, sagittal orientation of facet joints and the absence of the rib cage. The incidence of neurological injury is lesser in lumbar fractures. But, the thoraco-lumbar junction (T11-L2) is positioned in between the rigid thoracic spine and the mobile lumbar spine. So, significant biomechanical stress are created in this transitional region of the less mobile thoracic spine with its associated ribs and sternum to the more mobile lumbar spine [6,7]. With the fulcrum of increased motion at thoraco-lumbar junction, vertebral body often collapses with associated kyphotic deformity, which inevitably collapses the spinal canal, may causes neurological deficit [8].

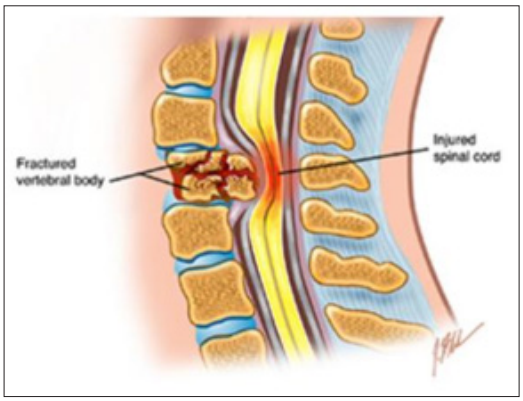

Figure 2: Thoracolumbar fracture & spinal cord injury

All the suspected spinal trauma patient should be evaluated by the basic principles of trauma assessment tool of ATLS protocol in the emergency room [9]. Once life-threatening injuries are addressed, a careful history of the occurrence including mechanism of injury and information of any back or neck pain and neurological symptoms are to be taken. Patients usually present with a history of trauma following a road traffic accident, fall from height, direct blow to the spine or even gunshot injuries. Non-radiating back pain is the most common symptom. Patients with neurological injury complain of weakness, numbness or anesthesia below the injury level with or without bowel and bladder dysfunction. Careful inspection of the spine should be performed after a proper log roll maneuver to search for abrasions, tenderness, local kyphosis and a palpable gap in between spinous processes. Neurological assessment should be done according to the standard American Spinal Injury Association (ASIA) guidelines [10]. As the spinal cord ends at the L1-L2 level, and the distal canal is filled by the cauda equina, varied degree of neurological injury patterns are observed with thoraco-lumbar junctional fractures. Neurological injuries at or above L1 can damage the spinal cord produces upper motor neuron type injury. Injuries below L1-L2 typically affect the cauda equina roots resulting in lower motor neuron type injury. Conus medullaris syndrome characterized by damage to sacral innervations to the bowel and bladder, with intact lumbar nerve roots, is a unique feature of T12-L1 injury resulting poor neurological outcome [11].

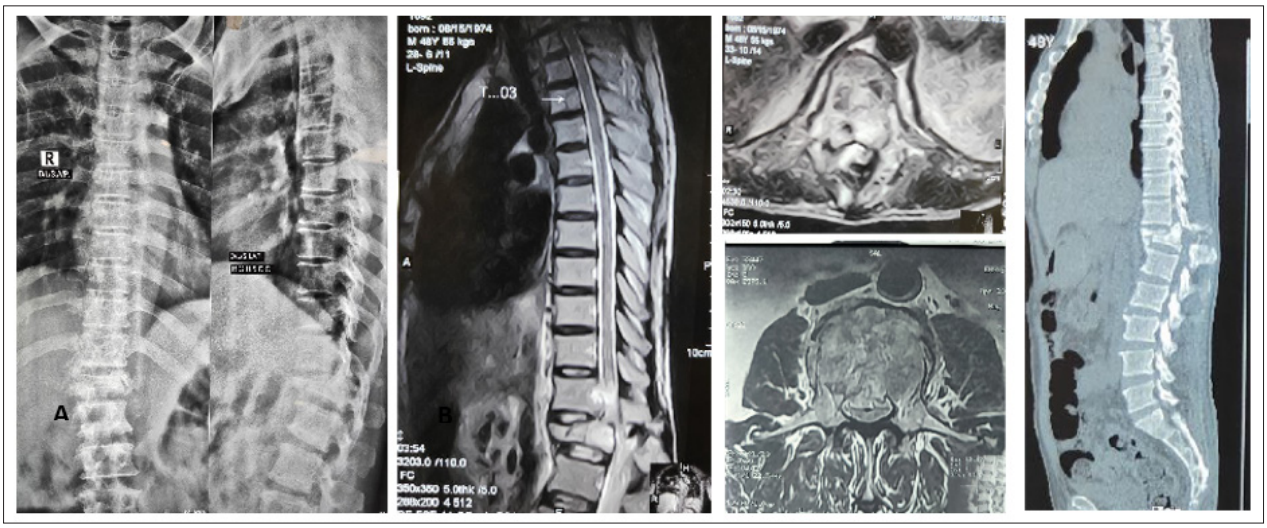

Figure 3: X-ray, MRI, CT Scan shows Brust fracture of D12 vertebra

Radiological evaluation includes antero-posterior and lateral skiagram gives information of the spinal alignment, presence of any rotation or translation, kyphosis, any loss of vertebral height, and increased inter-pedicular or inter-spinous distance. CT scan of the injured levels provides with the degree of canal compromise & morphology of fracture [12-14]. Approximately, 25% of burst fractures are misdiagnosed as compression fractureswithout CT Scan [15]. MRI scan gives information of the neural structures such as spinal cord or root injury, presence of cord edema and its extent and any hemorrhage or epidural hematoma. Another advantages of MRI are it can evaluate any additional injury to the intervertebral discs and PLC, and identify the presence of skip injuries through screening of the whole spine [16].

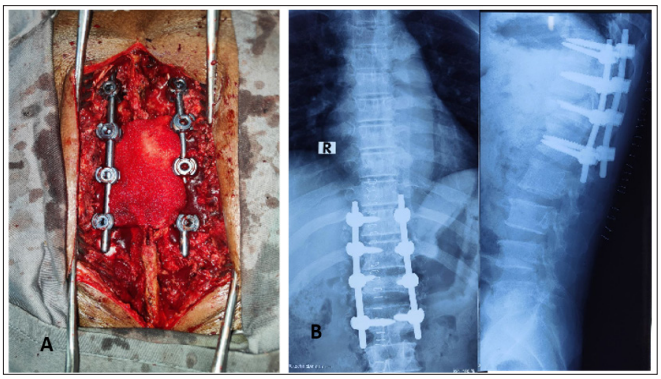

Figure 4: Per- operative image(A), Post operative follow-up X-ray. (B) Antero-posterior, Lateral view)

In 2005, Vaccaro et al described the TLICS (Thoracolumbar injury classification and severity score) to develop a protocol that can comprehensively describe thoracolumbar injuries and aid decision-making [17]. It accounts injury morphology, the integrity of the posterior ligamentous complex (PLC), and neurological status, with each of these factors being scored individually by summing the sub-scores. The authors noted that a total severity score of 3 or less could typically be managed nonoperatively; whereas, a severity score of >4 warrants surgical intervention. Severity scores of 4 gives the the surgeon independence to take decision either be handled conservatively or surgically. One retrospective series concluded as there was no potential risk after the conservative management of injuries with a score of 4 initially [18]. One recent meta-analysis of clinical studies found TLICS was safe and useful with regards to preservation and/or improvement of neurological condition [19]. However, in spinal fracture, deterioration of neurology is a widely accepted absolute indication for early surgical intervention [20-22]. Early studies suggested that instrumentation provides for better outcome for patients with thoraco-lumbar burst fractures [23].

Actually, number of surgical approaches are available for the treatment of thoraco-lumbar fractures: posterior, anterior, open, minimally invasive, and combined posterior-anterior ones etc [24]. For the past three decades, tendency for posterior stabilization and instrumentation as the preferred treatment modality for thoraco-lumbar fractures has been popularized [25]. Chadha and Bahadur preferred patients to be treated after 03 weeks of injury with the posterior approach. Our aim of this study is to evaluate the outcome of long segment posterior spinal stabilization incorporating the fractured vertebra with posterolateral fusion for unstable thoraco-lumbar junctional brust fracture [26].

Materials & Method

This prospective interventonal study included 30 case of thoraco-lumbar junctional unstable brust fractures was carried out in the Spine unit of Orthopaedic surgery department of Bangabandhu Sheikh Mujib Medical University and another private hospitals in Dhaka city, Bangladesh from January 2016 to July 2022. All the patients with positive clinical findings, X-ray, MRI & CT scan findings and underwent long segment posterior spinal stabilization incorporating the fractured vertebra with posterolateral fusion. Average follow-up period was 12 months. Pre & Post-operatively. Neurological assessment was done by the ASIA Impairment Score. It assigns the spinal cord injury a grade based on its severity. Grades range from A to E, with A being the most severe injury and E being the least severe. In Grade A, complete sensory or motor function loss below the level of injury, in Grade B, sensation is preserved below the level of injury, but motor function is lost, in Grade C, motor function below the level of injury is preserved, with more than half of the main muscles receiving a less than 3 grade on the ASIA motor score, in Grade D, motor function below the level of injury is preserved, with more than half of the main muscles receiving at least a 3 or greater grade on the ASIA motor score and in Grade E, normal sensation and motor function is preserved. Improvement of pain control by VAS score from 0 to 10 where 0 is no pain & 7-10 describes severe pain. Fusion rate by Bridwell's criteria from 1 to 4 where 1 is complete fusion & 4 is absence of fusion. Kyphotic angle was measured by Cobb's angle measurement method. Overall functional assessment done by modified Odom's score graded as excellent, good, fair & poor outcome. Excellent and good were considered clinically satisfactory, whereas fair and poor scores were unsatisfactory. IBM-SPSS V26 software was used for statistical analysis where p value was used as cutoff (< 0.05).

Selection of the patients for surgery

Inclusion criteria: Patients with spinal unstable brust fracture between T11-L2 level (thoraco-lumbar junctional) with positive clinical findings, X-ray, MRI & CT scan findings with 50 percent or more canal compromise.

Exclusion criteria: Patients with stable thoracolumbar spinal fracture, fracture involving above or below T11- L2, open fracture of thoracolumbar region, nontraumatic thoracolumbar spine injury, associated head injury and thoracic or abdominal injuries were not included in this study.

Operative Procedure

Under general anesthesia, patient was prone and two parallel pillows on a radiolucent table ensure the abdomen hangs free. After proper cleansing, painting and draping of the operative area, a posterior midline incision was made extending from spinus process of above & below the healthy vertebra adjacent to the involved one. The skin, subcutaneous tissue was cut in a single line, and the deep fascia and supra spinus ligaments cut in a same plane by diathermy. Then para spinal muscles made retracted subperiosteally upto the tip of transverse processes bilaterally. Pedicle screw insertion points was identified by intersection method and finally under C-Arm guidance. After confirmation, poly-axial pedicle screws were inserted bilaterlly in the fractured vertebra and a vertebra above and below it. Posterior decompression was then carried out by bilateral laminectomy of the involved vertebra. Retropulsed fragments were impacted anteriorly whenever needed by the impactor. Pre-bent rod was then placed on the pedicle screws on each side and finally stabilized by placing and tightening of the screw heads. Bone grafts achieved from the spinous process and

lamina was then prepared and placed postero-laterally. A drain tube was then placed in the submuscular plane and wound closure was done accordingly.

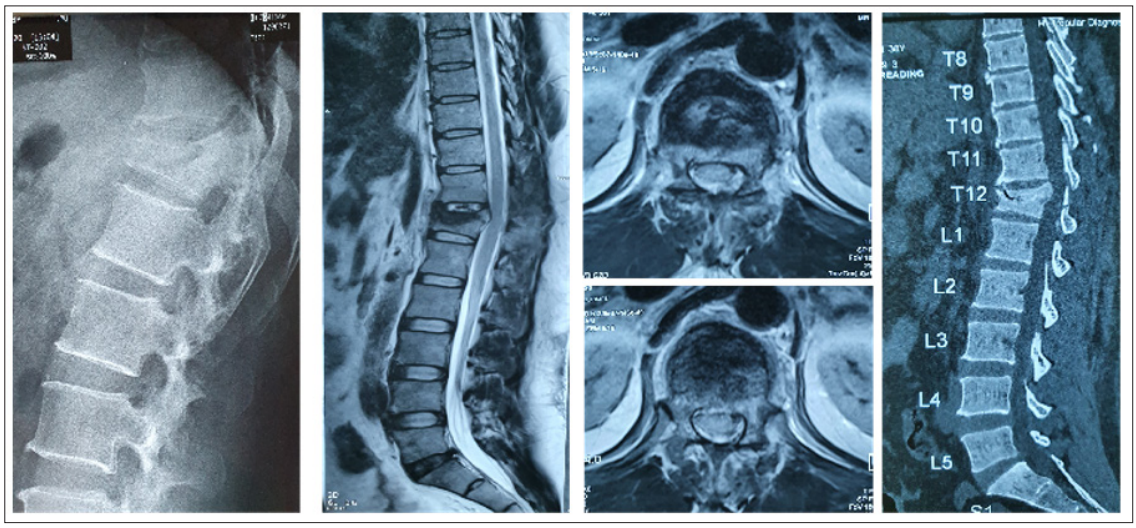

Figure 5: X-ray, MRI, CT Scan shows Brust fracture of D12 vertebra

Results

Total number of patients was 30. Average age was 34 years (range 21- 47). Among them, 24 was male and 6 was female. Their Hospital stay was 11.60±3.26 days. Surgery time was 148.80±30.47 min. Peri-operative Blood loss was 438±66.67 ml. Follow-up period was 12±3 months. Regarding the involved vertebra, 4 patients has T11, 8 patients has T12, 16 patients has L1 and 2 patients has L2 fracture. ASIA score improved from B to C in 5 patients, B to D in 5 patients, C to D in 8 patients, C to E in 3 patients, patients, D to E in 7 patients. 2 patient did not improved following surgery & 6 patients had no neurology pre-operatively. According to Bridwell criteria, 26 patients shows fused, 3 patient has probably fused, 1 patient has no radiographic sign of union on 12 months follow-up. So, fusion was achieved in all but 1 patient. Pre & Post- operative VAS score was 7.30±1.9 & 3.3±1.8 respectively (p value <0.05). Pre & Post-operative Cobb's angle was 21. 6±4.4 and 5.7±3.4 respectively (p value <0.001). The average kyphotic correction was 15°. In our series, we have no bedridden patients after surgery. There was no radiographic progression of kyphotic angle after surgery.

Table 1: Demographic Distribution of Patients

Gender (Male/female)	24/6
Age (years)	34 ±13
Hospital stay (days)	11.60±3.26
Surgery time (min)	148.80±30.47
Blood loss (ml)	438±66.67
Follow-up (months)	12±3
Involved Vertebra	
T11	4
T12	8
L1	16
L2	2

Table 2: Pre-operative and post-operative ASIA Impairment score

Score	Pre operative	Post Operative
A	1	1
B	11	1
C	11	5
D	7	13
E	0	10

Table 3: Pre operative and post operative comparison of pain after 12 months (n=30) According to VAS score

Score	Pre operative (Mean ± SD)	Final follow-up (Mean ± SD)	p value
VAS	7.30 ± 1.9	3.3 ± 1.8	<0.05

Table 4: Radio-logical fusion status after 12 months of operation (n=30) According to Bridwell criteria

Number of patients		12 months after operation n (%)
Fused	26	87
Probably fused	3	10
Non-union	1	3
Total	30	0

Table 5: Pre-operative and post-operative correction of kyphosis

	Pre-operative (Mean±SD)	Post- operative (Mean±SD)	p value
Cobb's angle	21.6 ± 4.4	5.7 ± 3.4	<0.001

Table 6: Distribution of patients according to post operative clinical outcome (n=30) According to Modified Odom's Criteria (Odom et al, 1958)

Comprehensive outcome	Frequency (n)	Percentage (%)
Excellent	24	80
Good	4	13
Fair	2	7
Poor	0	0

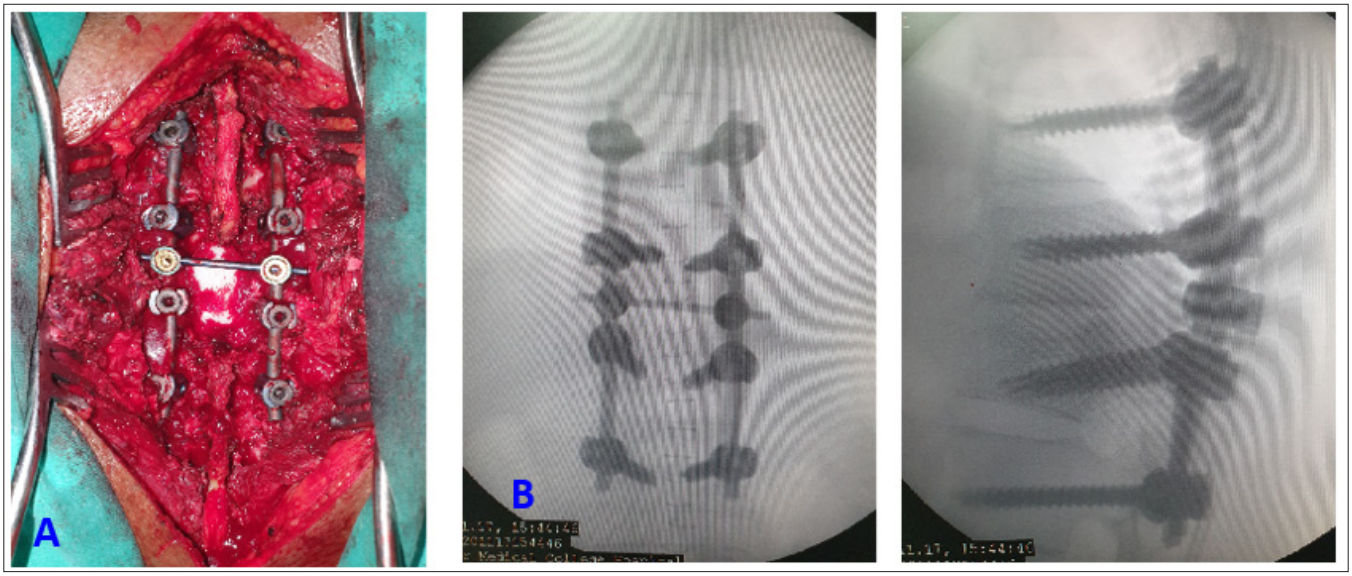

Figure 6: Per- operative image(A), Per operative C-arm image (B)

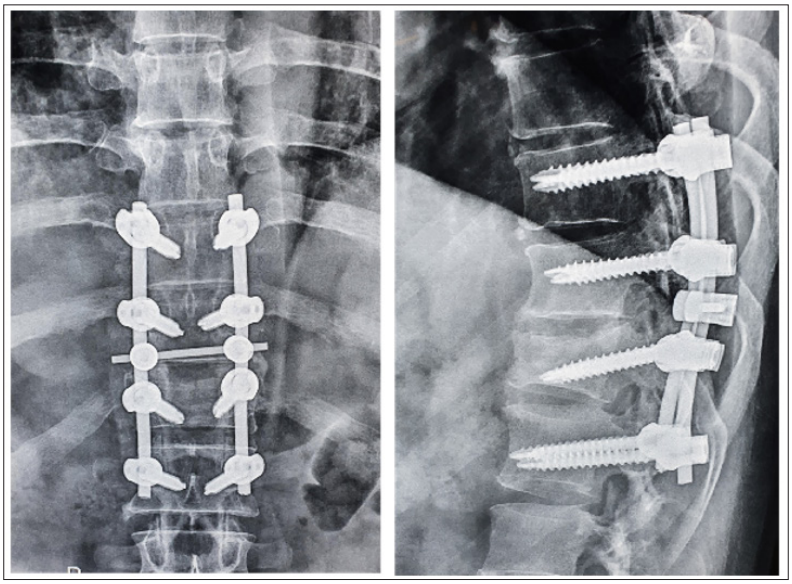

Figure 7: Post operative follow-up X-ray.(Antero-posterior, Lateral view)

Discussion

In this study, total number of patients was 30. Average age was 34 years (range 21- 47). This is comparable to the study of Choudhury et al. who found the Mean age was 31.5 years within the range of 31–45 years. Among our 30 patients, 24(80%) was male and 6(20%) was female, male to female ratio was 4:1. Raja RA showed 86% male patients in his series of 50 patients [27,28]. Younger male who are the more active group of people in this subcontinent shows higher predilection of this kind of injury. In this study, most commonly injured level was L1 (53.3%) and followed by D12 (26.6%). Altay et al. showed 51.6% involvement of L1 and 29% involvement of D12. The surgery time was 148.80±30.47 minutes. Peri-operative blood loss was 438±66.67 ml. This This is also comparable to the study of Choudhury et al. who showed the mean duration of surgery was 150±21 minutes whereas the mean blood loss was 392.47 ml [29].

In our series, all the patients presented with neurological involvement. Among them 2 (6.7%) patient did not improve after surgery. 20(67%) patients improved by one grade and 8(26.3%)

improved by two grade. No patient underwent neurological deterioration. Dobran et al. found seven patients out of 11 (63.3 %) showed neurological improvement [24]. In our series, all the patients who showed improvement of neurology by two grade. underwent surgery within 4-8 days of injury. Those who underwent surgery within 21 days of injury improved at least by grade one except in one patient who had ASIA-A injury underwent instrumentation on18th day of injury did not improved. Another patient presented with ASIA-B injury underwent instrumentation on 26th day did not improved. In a study by La Rosa et al. also recommended early instrumentation. Rajasekaran et al. also recommended early instrumentation within 5 days for preserving spinal cord function [30-35].

In our series, the mean pre-operative Cobb angle was 21.6±4.4 and at final follow-up was 5.7±3.4(p value <0.001) with average kyphotic correction was 15 º. Similar results 19.7±2.67 and 6.4±2.22 at final follow up showed by Moon et al. [31]. Pre & Post- operative VAS score was 7.30±1.9 & 3.3±1.8 respectively (p value <0.05).Kim et al. also found similar result at final follow-up(3.13±1) [32].

In this series, fusion rate was almost 97% (Bridwell I & II). Fusion rate with pedicular fixation with posterolateral fusion (99%) were significantly higher in several recent studies by Lee et al. & Choudhury et al. 2021[28]. 1(3%) patient did not show any sign of radiological fusion in 12 months follow-up. Kaneda et al. also found 93% fusion rate in a study of 150 consecutive cases [34].

Post-operative superficial wound infection was in 2 (6.7%) patients. Wound infection was managed conservatively by antibiotics according to culture and sensitivity report, improvement of nutritional status, removal of stitch, regular dressing & secondary wound closure. Peroperative dural leakage occurred in 1 patent who was treated by direct repair with non-absorbable atraumatic suture. In our series, there was no hardware failure.

In our study, 24 (80%) patients got satisfactory results and 4 (13%) patients got Good result in 2 (7%) case had fair outcome according to the Modified Odom's Criteria. In our series, we have no bedridden patients and no radio-graphic progression of kyphosis after surgery.

Conclusion

Early treatment within 21 days of injury with long segment posterior spinal stabilization incorporating the fractured vertebra with posterolateral fusion is a very effective surgical procedure with preservation of the motion segment to treat unstable thoracolumbar junctional brust fracture.

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