Evaluation of the Results of Posterior Decompression, Corpectomy and Instrumentation in Traumatic Unstable Thoraco-Lumbar Burst Fractures

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Abstract:

Background: Thoraco-lumbar burst fractures occur as a result of axial load which often causes displacement of the middle column into the vertebral canal. Posterior surgery reduces the morbid outcomes of different other approaches. **Objective:** To evaluate the clinical and radiological success of posterior corpectomy and instrumentation in the management of traumatic unstable thoraco-lumbar burst fractures. **Methods:** It is a prospective interventional study carried out in Bangabandhu Sheikh Mujib Medical University and different private hospitals in Dhaka from July 2008 to December 2011. Total 18 patients; 13 male and 05 female within an age range of 21-40 years were selected. Total 09 cases involved L_1, 05 cases at D_{12}, 02 cases at D_{11} and at L_2 each. Neurological status was assessed by Frankel's grading and pain status by Visual Analogue Score (VAS). Paired t-test was used for statistical analysis. **Results:** All the patients were followed up for minimum 1 year. Eleven out of 12 patients with Frankel grade-B and 04 patients out of 06 with Frankel grade-C recovered fully and could walk without support ($p<0.05$). Overall 03 patients ended with some degrees of persistant neurological deficit. The mean postoperative pain improvement and kyphotic angle correction was significant ($p<0.05$). **Conclusion:** Decompression through posterior approach by laminectomy, corpectomy and fusion by cage with bone graft and stabilization by pedicle screw and rod significantly improves the clinical and radiological outcome in management of traumatic unstable thoraco-lumbar burst fractures.

Key words: Thoraco-lumbar burst fracture, decompression, corpectomy, fusion, instrumentation.

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Introduction:

Spinal column injuries represent approximately 3% of all trauma cases[1] and 90% of these injuries involve the thoraco-lumbar region.[2-5] The thoraco-lumbar segment of spine (D_{10} to L_2) is an unstable zone between fixed dorsal and mobile lumbar spine and an acute injury to this segment is the second most frequent site after cervical spine injury in adults.[6] Thoraco-lumbar burst fractures occurs as a result of axial load on the spinal column after trauma which often causes displacement of the middle column into the vertebral canal and reduces the diameter.[7] This retropulsion bone fragment is unstable and can be the cause of neural injury.[4] The injury, although not associated with high mortality, causes severe morbidity.[7] It is estimated that approximately 75% of patients with thoraco-lumbar injuries sustain some degree of neurological deficit.[8] Though these types of injuries are best treated by vertebral column decompression and stabilization, [9] management plan differs between many of the researchers regarding operative[10, 11] and non-operative[12, 13] approach.

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Thoraco-lumbar burst fractures should be managed surgically to protect and improve the neurological function, stabilize the spine, early mobilization and rehabilitation as well as minimizing the pain and subsequent deformity.[9] Open reduction, arthrodesis, and internal fixation offers the possibilities of immediate stability, correction of deformity, early walking and reduced reliance on orthotic containment, with additional theoretical protection against spinal mal-alignment or neurological injury.[14, 15] Different operative methods exist with the goals of fracture reduction, fixation and decompressing the neural canal. These stabilization procedures can be divided into anterior, posterior and combined anterior-posterior instrumentation.[4] Although removal of the compressing bone fragment from anterior side of spinal cord directly addresses the pathology causing the neurodeficit,[16] the morbidity of the surgery through anterior approach is higher than that of posterior approach.[17] So, there has been a tendency for posterior stabilization and instrumentation as the preferred treatment modality for these type of fractures.[8, 9]

There has been a few study of assessing the outcome of posterior surgery in different literature reviews but in the perspective of our country this approach is new and has

not been assessed regarding the outcome. The purpose of this study is to provide a prospective evaluation of patients having traumatic thoracolumbar burst fractures and to assess the clinical and radiological results of patients treated by decompression through posterior approach by laminectomy, corpectomy and fusion by cage with bone graft and stabilization by pedicle screw and rod.

Methods:

This prospective interventonal study is carried out in Bangabandhu Sheikh Mujib Medical University and different private hospitals in Dhaka city from July 2008 to December 2011. Total 18 patients were selected; 13 male and 05 female within a age range of 21- 40 years. Total 09 cases involved L_1, 05 cases involved at D_{12}, 02 cases involved at D_{11} and at L_2 each. Six (06) patients presented with Frankel grade-C, 12 patients with Frankel grade-B. The patients operated within 07-39 days (average 27 days) after the incident of trauma. Three patients had associated fractures but none required surgery for those injuries. All the patients were followed up for minimum 1 year.

The Inclusion criteria for selection of the study population were – Unstable thoraco-lumbar burst fracture (White and Panjabi scoring >5); ii) incomplete neurological deficit (Frankel grade- B, C, D); iii) progressive neurological deficit; iv) presented within 03 weeks of trauma. Exclusion criteria were as follows: i) stable fractures (White and Panjabi scoring <5); ii) neurologically intact patients (Frankel grade- E); iii) complete neurological deficit (Frankel grade-A); iv) Glasgow coma Scale <14; v) associated fractures requiring operative intervention. The neurological status of all the cases were evaluated both pre and post-operatively and recorded based on Frankel scale showed in table- I & III. The clinical instability was assessed according to the White and Panjabi[18] Scoring as in table-II. Pain severity was assessed by the Visual Analogue Score (VAS) [19] both preoperative and postoperatively. The neural involvement was assessed routinely by MRI in every case and the fracture anatomy was evaluated routinely by X-ray and CT scan as in figure-1(b).

The duration of surgery, intra-operative blood loss and postoperative hospital stay was documented accordingly. All the patients underwent follow-up at 3 months, 6 months and at the end of a year. They were evaluated clinically regarding neurological improvement, functional outcome and complications. The radiological restoration of anatomy and improvement of the kyphotic angle was assessed as in table- III and documented in every follow-up. The improvement of pain status as well as the restoration of the kyphotic angle was statistically analyzed by the paired t-test.

Operative Procedure:

Posterior approach is faster and technically simple to carry out and is suitable for emergency conditions. The level of vertebra involved was identified preoperatively by a skin marking under radiological guidance to aid the peroperative vertebral level identification as well as planning of the extent of incision. All the patients underwent surgery under general anesthesia and in prone position. A midline incision was made and extended both proximally and distally according to the requirement. The cutaneous bleeding points were secured and the para-spinal muscles were retracted up to the level of the transverse processes. The injured level of vertebra was identified and confirmed by using C-arm or a portable X-ray.

The lamina and the facets were cleared off the soft tissues and any bleeding was secured by proper haemostasis using bipolar diathermy. The pedicles were identified by serially using the pedicle probe and pedicle sound; the integrity of the pedicle walls was checked. The position of the probe was confirmed again by using the C-arm or a portable X-ray. Pedicle screws of adequate length and diameter were inserted minimum two levels above and below the injured segment. The sagittal and coronal angulation for screw insertion was maintained with caution. The screw placement was rechecked by portable X-ray or C-arm. The Titanium rod has been measured, cut and fixed on one side to allow distraction in required situations. We commonly used the 5.5mm diameter screws of 35mm to 45mm length and 5mm diameter rods.

The posterior lamina along with its superior and inferior ligamentum flavum of the injured vertebra was removed and decompression of the neural elements was approached by removing the unilateral pedicle of the side where the bony fracture fragment caused the compression or impingement. Adequate distraction was done by using the distractor. Corpectomy (removal of the vertebral body) was done through this space by using the osteotome with care to the neural elements to avoid injury. Complete removal of the body was confirmed and the decompression was checked. The length of the cage required was measured, cut and packed with autografts. A trial was given before finally placing the cage with bone graft with the cage applicator. The bone grafts were prepared from the bony fragments cut from the spinous process and

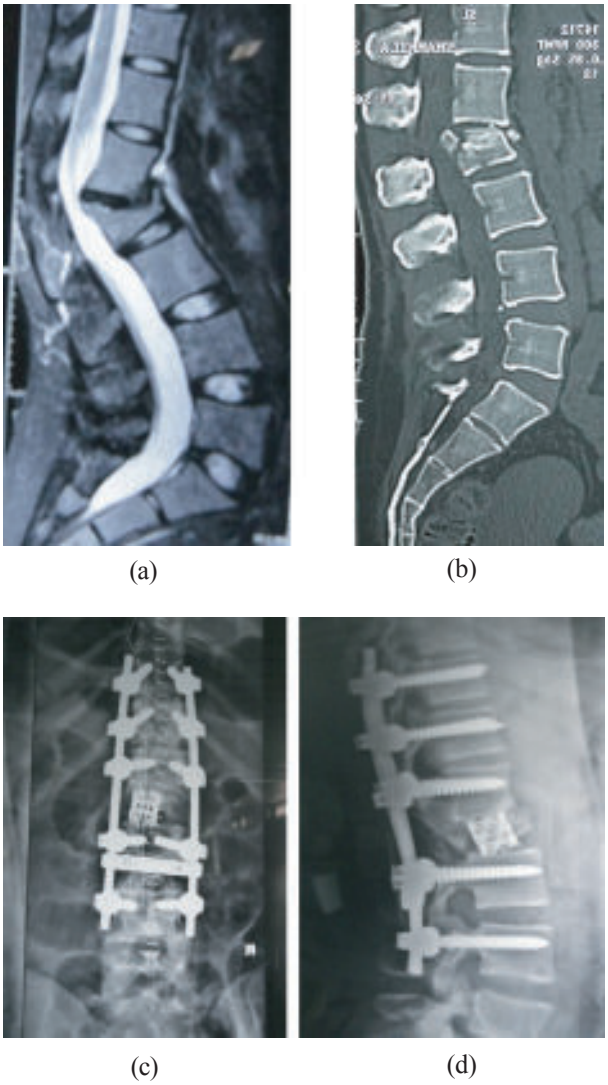
corpectomy. The position of the cage placement was checked with the image intensifiers (C-arm or a portable X-ray). The lateral gaps around the cage was packed with remaining morcelized autografts and impacted with the bone graft impactor. dural tears were repaired after repositioning the neural elements whenever it has been found to be disrupted.

The Titanium rods were measured; cut, bent and placed. Adequate compression was applied and the screws were tightened. Connector bars were fixed both proximally and distally. The prepared bone grafts were again placed postero-laterally for postero-lateral fusion. Well sized spongostum was cut and placed over the decompressed dural sac. Bleeding points were checked and cauterized. The wound was closed in layers with a drain kept in-situ.

Results:

The study comprised of 18 cases during the period of 42 months. Table-II demonstrates the demographic variables depicting that, out of 18 patients, 13(72.30%) were males and 05(27.70%) were females. Most of the patients 12(67.00%) were in 26-30 year age group followed by 06(33.00%) in 21-25 year age group. Male to female ratio was 2.6:1 and the mean age was 32 years. The cause, level of involvement and perioperative outcome of all the patients under study is also elaborated in table-III. Fall was the most common cause of injury 11(62.00%) out of which 07 from trees, 03 fell from roof and 01 from polls. Remaining causes were road traffic accident 07(38.00%). Time between injury and surgery was 07–39 days, mean 27 days. Preoperatively X-ray of the thoraco-lumbar spine was carried out in all patients as well as MRI and CT scan. The most common level of injury involved was L_1 09(50.00%) followed by D_{12} 05(28.00%) and D_{11} and L_2 02(11.00%) each.

All the patients regardless of fracture type were decompressed posteriorly and stabilization was performed in each case by titanium pedicle screws and rods. The pedicles of minimum 2 above segments and 2 lower segments were approached which is showed in figure-I(c). Postoperative X-ray films showed good hardware position in all patients in the study one example of which is showed in figure-I(c),(d). During an average of 14 months (range, 12–36 months) follow-up, no hardware failure was detected. Adequate decompression was achieved in all the cases and no loss of correction was observed. The mean duration of surgery was 03 hours and 14 minutes whereas the mean blood loss was 329 ml.



(a) (b) (c) (d)

Fig.-1: *Case: 05, A 36 years old young male falling from 30 feet height jackfruit tree presenting with incomplete paraplegia due to burst fracture at L2. Preoperative MRI showing a retropulsion fragment compressing over the neural elements of the spinal canal with reduced diameter of the canal (a), Preoperative CT scan assessment of the spinal canal compromise (b) Postoperative X-ray showing satisfactory placement of pedicle screws and correction of kyphotic deformity (c),(d).*

The mean postoperative hospital stay was 9.8 days (range 05-18 days) and all the patients were mobilized in the 1st postoperative day. The preoperative and postoperative pain status was assessed by Visual Analogue Score (VAS) [19]. Mean local thoraco-lumbar back pain at the fracture site was 07.22 (range, 6–9) before operation. Postoperatively, the pain score decreased to 01.78 (range, 1–3) at 3 months ($p< 0.005$), 2.6 (range, 1–4) at 6 months,

Table- I

Shows Frankel scale of motor and sensory index

		Frankel Scale
A	Complete	No motor or sensory function
B	Sensory only	No motor function, preservation of sensory function
C	Motor useless	Some motor function present butnot useful
D	Motor useful	Motor function present but somewhat weak
E	Intact	Normal sensory and motor function

Table- II

Shows White and Panjabi method of diagnosis of clinical instability

Lumbar and Lumbosacral Spine (L1–S1)

Element	Point value*
Anterior elements destroyed or unable to function	2
Posterior elements destroyed or unable to function	2
Radiographic criteria	4
Flexion extension radiographs	
Sagittal plane translation	
>04.50 mm or 15%	(2 pt)
Sagittal plane rotation	
05° at $L_{1/2}$, $L_{2/3}$,$L_{3/4}$	(2 pt)
>20° at L4/5	(2 pt)
>25° at L5–S1	(2 pt)
OR	
Resting radiographs	
Sagittal plane displacement	
>04.50 mm or 15%	(2 pt)
Relative sagittal plane angulation	
>22°	(2 pt)
Cauda equina damage	3
Dangerous loading anticipated	1

Thoracic and Thoracolumbar Spine (T11–L1)

Element	Point value*
Anterior elements destroyed or unable to function	2
Posterior elements destroyed or unable to function	2
Radiographic criteria	
Sagittal plane displacement	4
>02.50 mm	(2 pt)
Relative sagittal plane angulation	(2 pt)
>05°	
Spinal cord or cauda equina damage	2
Disruption of costovertebral articulations	1
Dangerous loading anticipated	1

* A point value total of 5 or more indicates clinical instability.

Table-III

Demographic variables, level of involvement, cause, preoperative and postoperative neurological and pain status. (n=18)

Case No, (Sex), Level involved	Cause of fracture	Associated fractures	Frankel grading Pre operative/ Post operative (1 year)	Visual analogue score (VAS) Pre operative/ Post operative (1 year)	Kyphotic angle Pre operative/ Post operative (1 year)
01 (M) L_1	Fall	Bil.Calcan	C/E	08/02	20°/ 04°
02 (M) D_{11}	Fall	Absent	B/D	09/02	10°/ 00°
03 (M) D_{12}	Fall	Absent	B/B	07/01	20°/ 05°
04 (F) L_1	Fall	Absent	C/D	06/01	22°/ 08°
05 (M) L_1	RTA	Absent	B/E	08/02	25°/ 00°
06 (M) D_{12}	Fall	Uni. Calcan. fibula	B/E	07/03	15°/ 03°
07 (M) L_1	RTA	Absent	C/E	08/01	22°/ 07°
08 (M) D_{12}	Fall	Bil.Calcan	B/E	06/02	24°/ 12°
09 (F), L_1	RTA	Pelvis	C/E	06/03	18°/ 03°
10 (M) L_2	Fall	Absent	B/E	08/01	20°/ 00°
11 (F) D_{11}	RTA	Absent	B/E	07/01	15°/ 05°
12 (F) D_{12}	RTA	Absent	C/E	08/02	26°/ 10°
13 (M) L_1	Fall	Bil.Calcan, Pelvis	B/E	06/02	22°/ 05°
14 (M) L_1	Fall	Absent	B/E	08/01	24°/ 06°
15 (M) L_2	RTA	Absent	B/E	08/03	21°/ 04°
16 (F) L_1	RTA	Absent	C/D	06/02	28°/ 06°
17 (M) D_{12}	Fall	Calcan,Talus,pelvis	B/E	07/02	16°/ 06°
18 (M) L_1	Fall	Absent	B/E	07/01	20°/ 05°

and 1.8 (range, 0–3) at 12 months as documented in table-III. Table-III also shows that maximum patients presented with Frankel grade-B is 12(67.00%), 06(33.00%) patients were Frankel grade-C. Follow up Frankel grading at one year shows all the patients with grade-B has improved to grade-E except 01(05.55%) which improved to grade-D. In 06 patients with grade-C, 04(22.22%) cases improved fully to grade-E and the other 02(11.11%) had improved to Grade-D. Fifteen patients could walk independently but the patient with incomplete recovery walks with crutch support. The postoperative radiology was assessed by three different radiologists regarding the correction of the sagittal curvature of the spinal column (kyphotic angle). The average preoperative kyphosis was 20.44° (range, 10° to 28°) and at 1 year follow-up it was 04.94° (range 0° to 12°). Correction of 10° to 25° of kyphotic angle, mean 15.50° ($p< 0.005$), was achieved postoperatively in I year follow up as described in table-III.

The post operative complication occurred in only 01 patient which was a superficial wound infection that was managed conservatively and cured. There were 04 cases where dura was found to be injured before and repaired during the procedure. No dural injury occurred peroperatively. Associated injuries were found in 05 patients having calcaneal fracture, 03 with stable pelvic fracture and 01 Talar dome fracture which was managed non-surgically.

Discussion:

Majority of patients in our study were young. The mean age was around 32 years. It is clear from many studies that young people suffer spinal cord injuries more often than any other age group. Out of 18 cases, 13(72.30%) were male and 05(27.70%) females. Raja[9] showed 86% male patients in his series of 50 patients, similarly in other studies males are supposed to be more exposed to trauma than females.[20, 21] Fall was the most common cause of injury in 11(62.00%) cases which has also been observed in some studies, [9, 20] but Payer[17] showed road traffic accident is the common cause of injury.

Hyperflexion and axial loading was the common mode of injury observed. Most common level involved was L_1 (50.00%) followed by D_{12} (28.00%). Raja[9] showed 46% involvement of L_1 and 12% involvement of D_{12}, coinciding with our results, other studies Shah et al[22], Hitchon et al[23]

and McCormack et al[24] also showed the common level of injury is D_{12}–L_1. Most common grade found in these types of fractures was Frankel grade B. It was also noted that more severe the canal compromise, worse the neurological deficit. Gerzbein[20] and Hitchon[23] also showed the similar scenario.

It is also important to note that hospital stay was short which is compatible with other studies.[21] Rehabilitation in terms of physiotherapy was started in wards and continued by authors themselves as no proper rehabilitation centers were available to continue the therapy. The average level of discomfort, according to the visual-analog pain scale at the final follow-up evaluation was relatively low as in other studies.[25, 26]

With the advent of modern design and appliances transpedicular screw fixation by a dorsal approach offers a fast, stable and safe means of achieving stabilization and correcting malalignments.[27] In our study all the postoperative follow up X-ray has been evaluated by three different qualified radiologists with an interpretation of good alignment repositioning and restoration of the spinal column and postoperative correction of kyphotic deformity. We have shown that posterior decompression with posterior pedicle screw instrumentation good restoration of the sagittal curve is possible without loss of correction during the healing of the fracture. The average amount of preoperative kyphosis was 20.44° (range, 10° to 28°) and at 1 year follow-up average kyphosis was 04.94° (range 0° to 12°). There was average correction of 15.50° (range 10°-25°) at the end of 1 year and we did not observe any significant loss of correction in this period, moreover no correlation was found between the final amount of kyphosis and the degree of pain reported. Essess et al[14] showed 11.30° correction which is comparable to our result. Many other studies also demonstrated the successful repositioning, kyphosis correction, reliable fracture consolidation and neural decompression as well as good neurological recovery achieved via the dorsal approach, [28, 29] although Verlan et al[30] concluded that no treatment is able to restore the morphology of the vertebral segment to normal physiological levels for thoracolumbar spine fractures.

In our study only one case developed superficial wound infection which was managed conservatively. Herck et al[31] also showed two complications in his series of 30 cases. The complication rate is in agreement with those reported in other studies conducted by McLain et al[21], Benson et al[32] and Stovall et al[33].

Out of the 18 patients 15(83.00%) had complete recovery within 1 year of follow up. Three (17.00%) patient had partial recovery needing walking aids. Avanzi[34] studied on 15 patients treated within 3-6 weeks of the trauma having thoraco-lumbar fractures found improvement of the neurological picture in 60% of their patients. We must consider that these patients operated within 06 weeks of fracture are more likely to have improved neurological picture than those treated after three months[34, 35]. Out of 18 patients of our series 09(50.00%) patients could return to their previous work. Wood et al[32] found 42% patients returning to their previous work and Kraemer[2] found 33% which are almost similar to our studies.

There are limitations of our study as the study population is small and period of follow up of only a year. We also could not determine whether posterior decompression clears the canal adequately as the computed tomography scans were not performed postoperatively. Moreover a long term follow-up is required to assess any sort of loss of correction of kyphosis. Only the functional improvement and radiological alignment were considered and no co-morbid factors were evaluated regarding the outcome of the surgery.

Conclusion:

Posterior decompression and instrumentation provides a safe and effective surgical option for management of traumatic thoracolumbar burst fractures. It effectively decompresses the canal and achieves significant correction of kyphotic deformity. Early significant pain relief ensures early mobilization and rapid recovery.

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