

ORIGINAL ARTICLE

Short Segment Pedicle Screw Fixation for Thoracolumbar Burst Fractures. Percutaneous without Fusion Versus Open Pedicle Screw Fixation with Posterolateral Fusion

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ABSTRACT

Background: Fixation of thoracolumbar burst fractures (TLBF) with short segment pedicle screw construct has become popular over last few decades. Spine surgeons have started to deal advanced degenerative spinal pathologies with percutaneous pedicle screw fixation (PPSF) as well. Short segment PPSF has been demonstrated to be an effective treatment option for TLBF fixation in fewer studies so far. This study compared the short segment open pedicle screw fixation (OPSF) with fusion to a short segment PPSF without fusion in the management of TLBF.

Methods: Between December 2019 and October 2021, fifty nine patients underwent short-segment pedicle screw fixation, 32 PPSF while 27 OPSF for TLBF. Each of the three follow-up examinations included radiographs to ensure that the spinal column had recovered to its pre-injury state. A lateral thoracolumbar radiograph was used to calculate the Cobb angle, vertebral wedge angle, and vertebral body compression ratio. In this study, patients' pain and function were assessed using the VAS, the Frankel grading system, and the Low Back Outcome Score (LBOS). Additionally, the volume of blood loss and the time required to finish the procedure were also noted.

Results: Regional Cobb angle improved post operatively in both groups without any disparity when assessed the two groups, which was noticed till three months. Operative time and blood loss was less in PPSF. LBOS and VAS markedly improved during early follow ups in PPSF group compare to OPSF. Concluding follow up did not show significant difference between PPSF and OPSF.

Conclusions: Open or percutaneous short-segment pedicle fixation with or without fusion is secure and efficient treatment option for TLBF. PPSF alone resulted in a greater reduction in pain and improvement in functional ability than the OPSF during initial time period which substantially improve overall outcome in management of TLBF.

INTRODUCTION

This is the most common type of spinal injury following road traffic accidents or fall from the height. The mechanism of injury is axial loading with or without flexion of the spinal column. Thoracolumbar fractures account for more than half of all spinal fractures in adults, 10% to 20% of those striking the persons under the age of 35. The retropulsion of fractured segments and damaged posterior complex is leading to kyphosis and spinal canal compromise, manifesting neurological deficits. If not managed accordingly TLBF may cause severe disability and poor long term outcome. Patient's sagittal balance worsen may cause severe back pain, neurological damage and pseudo arthrosis, restricting physically. The disability as sequel of TLBF managed improperly has eminent impact socioeconomically on individual patient as well as on the society at large. According to others, the higher kyphotic angle in the non-operative TLBF therapy group may not represent a barrier to favorable clinical outcomes. Between 10% to 20% of TLBF managed non surgically eventually needed surgical intervention. [11].

Non-operative preferences usually include bed rest initially with minimum moments with external arthrodesis. It has been generally agreed upon that surgery must be contemplated in case when the, kyphotic angle >30, loss of vertebral height >50%, spinal canal narrowing of >40%-50% and patient is having progressive or partial neurological deficit.

Operative approaches towards TLBF has also been evolved over past several years. Different anterior thoracoabdominal approaches revealed good spinal stabilization but at the cost of high morbidity, needed posterior fixation to make it stable biomechanically which substantiate the morbidity. With practice of posterior only approach has greatly improved the overall results in management of TLBF. When TLBF fixed one level above and one below is considered short segment, which has been resulting same outcome as that of long segment while markedly improving outcome in terms of early recovery due to less pain and less bleeding. Minimal muscular trauma also improves disability score post operatively.

With advent of PPSF has revolutionized the treatment of TLBF. This minimally invasive procedure has greatly reduced the operative time, peroperatively bleeding, postoperative VAS and disability spinal score while providing same results as that of OPSF. With PPSF it is difficult to do fusion which was found advantage of OPSF, therefore researchers are working to find the functionality of PPSF without fusion.

METHODOLOGY

Participants in Investigation: Between December 2019 and March 2021, the department of neurosurgery at Civil Hospital Larkana used PPSF short segment without fusion (Group 1) or open short-segment (Group 2) OPSF to treat all fifty-nine patients having Denis's two column vertebral

column injury. Regional kyphotic angle more than 30 degrees, spinal canal stenosis greater than 40% without neurological deficit has been considered for short-segment surgery. Pathological fractures, concomitant spinal anomalies and fractures involving the pedicle were excluded. All patients needed spinal canal decompression were also excluded from the study.

Techniques and Strategies Employed: Under general anesthesia, in prone position on radiolucent operative table with the help of C arm fluoroscopy surgery was done via posterior approach only. After placing the open free hand pedicle screws, two views x-ray performed to confirm the proper placement of the construct. Decortication of facet and TPs was done to facilitate fusion, bone putty and demineralized bone chips used aiding osteogenesis.

In PPSF as the procedure totally depending upon x-rays and surgeon's expertise. We start with true AP view revealing two pedicles with centrally location spinous process. 1-2 cm lateral to pedicle skin incision is made on skin and subsequently cut fascia, then with the help of tools localization of pedicle head with jamshedi needle is introduced till it reaches medial pedicle wall. X ray is moved to lateral position and confirmed the tip of needle being in body of vertebrae. Guide wire follow the jamshedi and placement of screw is guided by the wire. Steps repeated at all levels and confirmatory x ray done after placement of rod and fixed (Figure 01). We did not do fusion in OPSF.

TLSO advised for both groups unless patient refuses, to resume rehabilitation and physical exercises.

Patient's Radiological Measures: Plain radiographs were taken prior to, during, and immediately following operation. Using radiographs collected at neutral lateral angles, the Cobb angle differential (DbVC) and vertebral body compression ratio (VBCR) were determined (Fig. 2). Calculating the Cobb angle between adjacent vertebrae's upper and lower endplates revealed the fracture site's change in segmental curve. To determine the angle between the superior and inferior endplates of the shattered vertebra, the superior and inferior endplates were measured. Typically, the morphology of a damaged vertebra reflects its anatomical shape. Preoperative CT images were used to determine the severity of burst fractures defined by Denis and LSC [10, 20].

Patient's Clinical Measures: Following the procedure, the duration of anesthesia, blood loss, and neurological status of the patient were all monitored. Time rewinding Annual assessments of the patient's neurological and lower back functioning were required. The Frankel grading system was used to determine the level of neurologic function. Pain and occupational status were quantified using the Low Back Outcome Score (LBOS). Back pain severity and its impact on daily life and activities can be determined using a visual analogue scale (VAS), as well as alternative methods such as participation in sports or social events, relaxation, or consultation with a healthcare specialist.

This test has a maximum score of 75 points. VAS scores were used to assess a patient's back discomfort prior to, three months after, and one year after surgery. Three, six, and final follow-up visits were used to assess back function.

Analyzing data through the use of statistical techniques: In terms of demographics, radiological data,

and clinical results, it was compared to open short-segment pedicle screw fixation with bone fusion. The data were analyzed using three statistical tests: SPSS for Windows V17.0 for Windows and SPSS for Macintosh V16.0 (SPSS, Chicago, IL, USA). The mean and standard deviation are used to represent the data. A p-value of <0.05 was considered statistically significant in all analyses.

RESULTS

The median follow-up length after percutaneous or open surgery was 30 months, but the median follow-up period after no surgery was 39.7 months (ranging from 27 to 72 months). There were no significant variations in age, gender, fracture location, or origin of injury between the two groups. Prior to surgery, there were no significant variations in Cobb angles, vertebral wedge angles, the DbVC ratio, Denis type, or LSC score between the two groups (Table 1).

Cobb angles fell considerably and were stable in both groups following surgery (p>0.05). Both percutaneous and open surgical groups experienced a similar reduction in kyphosis correction (p =0.628). After surgery, both percutaneous and open surgery groups experienced only a modest drop in average vertebral wedge angles (p0.05), indicating only a minor restored loss (Table 2).

Preoperative neurologic symptoms were similar in both groups of patients who underwent percutaneous and open surgery. Neurological function does not decline in any of the classes of neurological illnesses defined by Frankel (Table 3).

Preoperative VAS scores of 8.26 and 8.42.3 in the percutaneous and open groups, respectively, indicated considerable reductions in back pain following surgery (p0.05). At the final follow-up, only participants who had undergone percutaneous versus open surgery exhibited a statistically significant difference in VAS scores (P =0.445). Additionally, to the information included in the following table, more information is available. At three and six months following surgery, the LBOSs in the percutaneous group were significantly larger than those in the open group (P = 0.228). Table No. 5

Both open and percutaneous surgery resulted in an abnormal amount of intraoperative blood loss. Percutaneous surgery was less painful and required less blood than open surgery (Table 6).

Table 1: COBB Angles, Vertebral Wedge Angles, The DBVC Ratio, Denis Type, or LSC Score

	Group A	Group B	P value
Visits (follow up) in months	30.24	39.73	
No of Patients	32	27	
Gender (M/F)	19/13	20/7	0.625
Age in years	45.60±15.71	48.21±12.33	0.785
CA (pre operatively)	15.84±8.26	16.74±7.62	0.744
VVA (Pre operatively)	20.22±5.71	22.30±4.69	0.821
VBCR (Pre operatively)	38.24±8.73	40.11±10.90	0.545
Denis (type) A/B	13/19	13/14	0.176
LSC (scores)	5.43±1.33	5.91±1.65	0.792
DbVC	5.21±4.64	5.82±4.17	0.379

One screw-rod failure with nonunion occurred in the open surgery group, as did two postoperative infections. Postoperative infections induced by clinically unexplained

screw failure were treated with irrigation and debridement. The wonderful news was enthusiastically received by all three patients. In the group, there was just one case of screw withdrawal using the percutaneous approach. At the patient's most recent consultation, positive results following a course of conservative treatment were reported.

Table 2: COBBS Angle Vertebral Wedge Angles

	Group 1	Group 2	P value
CA (Pre operatively)	15.82±8.24	16.71±7.66	0.746
CA (Post operatively)	6.23±5.12	6.52±3.94	0.954
CA (last)	9.31±5.70	9.90±5.22	0.532
VWA (Pre operatively)	20.22±5.73	22.32±4.64	0.821
VWA (Post operatively)	9.81±3.40	10.43±3.11	0.273
VWA (last)	11.94±3.88	12.74±2.17	0.372
CA (Last visit)	3.13±1.99	3.55±2.70	0.628

Table 3: Neurological Symptoms

	Frankel grade (Last)				
	A	B	C	D	E
Group 1 (Pre operatively)	A		1	4	1
	B				
	C				
	D			3	7
	E				16
Group 2 (Pre operatively)	A		1	3	1
	B				
	C				
	D			2	5
	E				15

Table 4: Visual Analogue Score

VAS Scores	Pre operatively	3 months	6 months	End Follow-up
Group 1	8.01±2.61	2.90±1.52	2.21±1.24	1.76±1.11
Group 2	8.42±2.33	4.02±1.33	3.52±1.66	1.92±1.43
P value	0.865	0.0082	0.0031	0.4450

Table 5: Low Back Outcome Score (LBOS)

LBOS Score	3 months	6 months	End Follow-up
Group 1	56.21±15.62	61.14±12.81	66.73±11.22
Group 2	47.29±17.27	50.66±16.82	61.45±13.91
P value	0.0321	0.0111	0.2280

Table 6: Blood Loss and Time of Surgery

Time of surgery in minutes	Blood loss intraoperatively in ml
Group 1 83.22±26.11	262.55±86.91
Group 2 154.91±39.20	684.33±239.90
P value 0.0040	0.000



Figure 01

DISCUSSION

It has been observed that nonoperative treatment is associated with an increase in regional kyphotic deformity over following year of follow-up, as well as with suboptimal clinical and functional outcomes for TLBFs without

neurologic impairments. We found that the preoperative Cobb angles were both 15.8° and 16.7°, while the postoperative Cobb angles were 9.3° and 9.9°. According to the findings of this study, individuals with thoracolumbar burst fractures may benefit from percutaneous or open posterior stabilization. Numerous investigations have demonstrated that the individuals with short-segment PSF are more susceptible to screw withdrawal and fracture. Burst fractures are stabilized with extra pedicle screws in both open and percutaneous PSF patients to avoid postoperative problems. In the instance of a fractured vertebra, additional screws may be used to stabilize the anterior column. As a result of this innovative technique, screw loosening and kyphosis corrective loss will be decreased. Carl and colleagues [4] and Cho and colleagues [7] demonstrated the efficacy of first-time kyphosis surgery. However, in these two groups, the majority of the early postoperative kyphosis correction had been lost on final follow-up radiographs. Kyphosis was corrected in the PPSF and OPSF groups utilizing short-segment approaches with fracture level. In terms of correction of kyphosis, this study discovered no statistically significant difference between the PPSF and OPSF groups. A short-segment fixation strategy that incorporates the fractured level into percutaneous or open surgery may be a more effective early technique for reversing kyphosis loss and restoring physiological kyphosis.

During this study, no posterior-lateral bone fusion done in the PPSF group. The medical literature generally accepts recommendations for the management of lower back pain (TLBF). In a few cases, PSF without bone fusion has been described. According to Sanderson et al. [25], pedicle fixation without fusion of the postero-lateral bone may result in favorable radiographic and clinical outcomes in TLBF. According to Wang [30], there was no difference in clinical or radiologic outcomes between the non-fusion and fusion groups in unstable TLBF. According to the findings, PPSF can be utilized to treat TLBF without the requirement for bone fusion. Significant paraspinal stripping is required for posterior-lateral bone fusion and open posterior pedicle screw fixation. As a result of prolonged dissection and retraction, the paraspinal muscles may atrophy and become denervated. Dissection and retraction might result in long-term back pain or muscular dysfunction due to the heat effect from unipolar cautery and ischemia to the paraspinal muscles. PPSF eliminates the morbidity associated with OPSF. Kim and colleagues discovered that PPSF-induced paraspinal muscle injury is less severe than OPSF-induced paraspinal muscular injury.

At three and six months postoperatively, the PPSF group had lower VAS scores and higher LBOS scores than the OPSF group. At the conclusion of their follow-ups, there was no significant difference in VAS and LBOS scores between the two groups. Our conclusion is that the use of minimally invasive surgical techniques and the extent of paraspinal muscle dissection both contribute to the early recovery of back pain and functional mobility following surgery. The PPSF took an average of 83.2 minutes, and lost 262.5 milliliters less blood intraoperatively than the open OPSF group (averaged 154.9 minutes and 684.3 cc). The PPSF demonstrated a considerable reduction in surgical procedure-related injuries when compared to open.

Both the PPSF and OPSF groups had instrumentation issues. A screw loosening above the fractured vertebrae resulted in the PPSF group. A low BMD t-score may indicate screw loosening. As a result, TLBF with an abnormally low BMD t-score warrants additional research. At the three-months follow-up, only one patient who had undergone OPSF surgery had a broken screw. Complications at the donor site may occur during an OPSF with bone fusion. In 10% to 39% of bone grafting surgeries, donor site complications result in unsatisfactory clinical results [3, 6, 18, 26]. As long as donor site complications are avoided, a favorable radiologic result is possible with PPSF. According to the literature, OPSF is associated with a higher rate of pedicle screw misplacement than PPSF.

This research contains the following flaws: The trial used non-randomized individuals despite the fact that there were no statistically significant differences in preoperative clinical data between the two groups. To verify the findings of this investigation, randomized controlled experiments should be done. Comparing muscle enzyme changes and paraspinal muscle volume across two groups revealed no evidence of paraspinal muscle atrophy or damage, despite the notion that degenerative spinal disease has been associated with paraspinal muscle atrophy or injury [16, 17]. During surgery, artefacts obscured the paraspinal muscles, and pretreatment muscle enzyme levels increased. Third, both groups experienced short intervals between follow-up visits. Due to the fact that the spines of the PPSF group were not fused, kyphosis may recur and demand additional surgery. It is vital to analyze screw removal in order to compare PPSF and open TSF in the management of TLBF.

CONCLUSION

This research revealed that short segment pedicle screw fixation is both safe and effective in treatment of TLBF. PPSF and OPSF with fusion were found to be safe and effective in terms of clinical and radiologic outcomes, but PPSF without bone fusion resulted in a greater degree of pain relief and functional improvement in immediate post-operative period and on subsequent follow up. Nonetheless the study has certain restrictions the PPSF without fusion need to be encouraged for treatment of TLBF. Furthermore, similar research at larger scale might be required to determine how spinal mobility and alignment alter following the removal of PPSF screws in TLBF patients.

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