

Radiological and Clinical Outcome of Thoracolumbar Burst Fracture Following Short Segment and Long Segment Pedicle Screw Fixation

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ABSTRACT

INTRODUCTION: The indications for operative treatment and type of stabilization procedures for the treatment of thoracolumbar fracture remains controversial. Long-segment pedicle screw fixation permits correction of kyphotic deformity while short-segment pedicle screw fixation preserves motion segments, reduces costs and time of surgery. Our aim is to study the correlation and comparison between clinical and radiological outcome of both fixations and identify factors that might contribute to the outcome. **MATERIALS AND METHODS:** 60 patients with thoracolumbar spine fracture from 2017 to 2022 were identified. Age, gender, mechanism of injury, classification of fracture, duration of hospital stays and one-year post-operative outcome of Visual Analogue (VAS) pain score, and Oswestry Disability Index (ODI) score were documented. Pre- and post-operative AP/Lateral radiographs measurements of local kyphotic angle, Cobb angle were measured. Signs of fixation failure were examined at follow-up. **RESULTS:** Subjects mean age is 42.4, male predominance (85%) and work-related. The highest incidence was at level of L1 (56.7 %) in the long-segment and 46.7 % in short-segment. Most common injury was burst fracture (AO classification A3 A4 group) due to fall from height. There is shorter hospital stay documented in the short-segment fixation. Radiological outcome measured in both groups were comparable with no signs of fixation failure. Short-segment fixation group also resulted in better clinical and functional outcome at one-year follow-up. **CONCLUSION:** There is no significant difference in radiologic outcome of Cobb and kyphotic angle in both fixation groups. Short-segment fixation has significantly better clinical and functional outcome post-operative and at 1-year follow up.

Keywords

Thoracolumbar fracture, Short-segment fixation, Intermediate screw

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INTRODUCTION

Thoracolumbar area is commonly affected in spine fractures, representing about 90% of all vertebral fractures.¹ The region between (T10 to L2) is prone to injury because of stress concentration at this transitional zone, between mobile lumbar spine and the stiffer thoracic spine.^{1,2} General consensus on the best approach to treat thoracolumbar burst fracture is absent.² Fixation of thoracolumbar burst fracture can be done through an anterior surgery, posterior surgery, or a combination of anterior and posterior surgery. Many studies reported better functional results including less pain, less surgical blood loss and early return to work in patient treated with posterior only surgery.³ A combined approach has better

correction of sagittal deformity, but has significant operative morbidity with longer surgery time, more blood loss and more tissue damage.

Initial report in 1993 revealed higher rate of implant related complications when short segment fixation (SSF) is used for thoracolumbar burst fracture suggests that posterior fixation alone may not be sufficient when Cotrel Dubousset instrumentation was used for SSF.⁴ However, University of Missouri Medical Centre reported successful treatment with SSF and post operative spinal bracing for less comminuted fractures.⁵ Long segment fixation (LSF) provides superior results in term of radiological outcome

and implant failure when compared to short segment fixation (SSF). However, more motion segments are sacrificed and results in a stiffer back. SSF with additional index screw inserted at the fracture site became popular and supported by reports in early 21st century which shows good result with SSF over LSF even in cases with comminuted fractures.⁶

Study in Changsha, China similarly shows that addition of index pedicle screw at the fractured vertebra could also give added stability and improved correction of the kyphotic angle compared to no screw at the fracture site.^{7,8} In a meta-analysis, no significant difference of the radiological outcome was found between the SSF and LSF groups.⁹ The study objective is to compare the clinical and radiological outcome between SSF and LSF in thoracolumbar burst fracture and to identify the possible mechanism involved and possible factors that contribute to the outcome.

MATERIALS AND METHODS

We reviewed retrospectively the results of thoracolumbar burst fracture of 60 consecutive surgically treated patients without major neurological deficit in our institution from 1st January 2017 to 31st December 2020. Indication for surgery includes loss of 50% anterior vertebral height, kyphotic angle more than 20 degrees or posterior ligamentous complex involvement.

Inclusion criteria

- 1) Patient with single level thoracolumbar fracture between T10 to L2
- 2) Fracture type A3, A4, B1, B2 AO classification with burst component.
- 3) Patient age above 18 and below 65 years old.
- 4) Operated using posterior pedicle screw.

Exclusion Criteria

- 1) Pathological fracture due to infection/ tumour / metabolic bone disease
- 2) Polytrauma ISS > 20 (involving lower limb) and patient with intracranial bleed
- 3) Multiple level burst thoracolumbar fracture
- 4) Post operative infection require more 2 weeks' antibiotic

- 5) Requires second surgery at the same level
- 6) Incomplete follow up data
- 7) Had complete neurology deficit post operatively
- 8) Require external immobilisation post operatively.

This retrospective study was approved by the National Medical Research Registry (NMRR) with Research ID: NMRR ID-22-01101-KU4 (IIR). We reviewed 60 who fulfilled the inclusion criteria that had been identified from the operative record of the computerised operating theatre documentation system (COTDS) in Sarawak General Hospital from 2016-2020. The following clinical data of selected subjects was reviewed and collected from the individual medical record (such as case notes and the outpatient department card (OPD) during their 1-year follow-up. Only relevant parameters: age, gender, source of admission, comorbidities, Oswestry Disability Index (ODI), Visual Analogue Scale (pain score) Numeric scale, time taken for surgery, date of surgery, pre and post operative Asia Impairment scale (ASIA scale), duration of hospital stay, and one-year post-operative outcome (ODI and VAS score) will be stored in questionnaire forms.

Functional outcome was grouped by using ODI and VAS score at discharge post surgery and at one year follow-up. X-ray measurements of pre-operative kyphotic deformity by using the Cobb angle and Kyphotic angle was measured. Measurement of Cobb's angle was calculated from superior endplate of upper vertebra and inferior endplate of lower vertebrae of fracture site. Kyphotic angle is the angle between the superior and the inferior end plate of the fractured vertebra. Immediate post operative Cobb angle and kyphotic angle and at one-year follow up was obtained and percentage of angle of correction was measured using standard weight bearing thoracolumbar Anterior Posterior (AP) and lateral radiograph. All these are measured using *Radiant DICOM Viewer software* and *Image Meter* which is a mobile application. The amount of Cobb angle correction after the surgery and correction loss during the follow-up were measured and documented.

AO spine thoracolumbar classification system was used to classify all the fracture configurations. Any radiological finding of fixation failure related to the implant was

scrutinized during follow-up imaging. Subject who defaulted or lost from follow-up will be contacted via phone to obtain the one-year post-operative outcome. If subject had passed away within the one-year period, cause of death and mortality date will be recorded. All the data will be recorded in Microsoft Word form format or excel form for interpretation. Statistical analysis was performed by the Statistical Programme for the Social Sciences, version 28.0 (IBM SPSS Statistics for Windows, IBM Corp, Armonk, NY) and Microsoft Excel 2011 version 14.6.5 from Microsoft Office for Windows 10.

We are using paired t-test to compare changes in mean values after one year of studies for quantitative variables. Results were considered significant if p value <0.05.

RESULTS

The patients age ranged from 19 to 64 years with the mean of 43.4. The mean age for the long-segment group was 40.1. The mean age of patients in the short segment fixation group was 41.5. There were 51 males and 9 females in the study group. It affects males more, and the most common injury was work-related accident.

A total of 39 patients (65.0%) had burst fractures (type A3/A4) and 21 patients had burst fractures with posterior tension band disruption pattern (B1 and B2) (35.0%). Most of the burst fractures were due to falling from the height, while posterior tension band disruptions or shear injury fractures group were mainly due to road traffic accidents.

Cobb angle and kyphotic angle pre and post operative for long segment fixation and short segment fixation had almost the same mean and comparable percentage of correction as in Table 1.

The Cobb angle correction is better in the long segment group 61% as compared to short segment 58.6%. The percentage of Cobb angle correction at 1 year for long segment group was 57.2 % as compared to 54.5% for the short segment group. However, the difference was not significant with p value >0.05 for both.

Table 1: Cobb Angle and Kyphotic Angle at Pre-Operative, Immediate Post-Operative and at 1 year follow up with percentage of correction.

Variables	Long Segment fixation N (%)	Short segment fixation N (%)	p - value	
	Mean	Mean		
Cobb Angle	Pre-operative	21.1	20.22	0.394
	Post-operative	7.89	8.080	0.840
	% of correction	61.0 %	58.6%	0.612
	At 1 year follow up	8.91	8.85	0.950
Kyphotic Angle	% of correction at 1 year	57.2 %	54.5%	0.581
	Pre-operative	20.24	19.42	0.395
	Post-operative	9.26	10.30	0.058
	% of correction	57.4 %	55.5%	0.058
At 1 year follow up	10.09	11.00	0.135	
	% of correction at 1 year	53.4%	49.5%	0.087

Percentage of kyphotic angle correction immediate post operative and at 1 year for long segment group were 57.4% and 53.4% respectively, which was better as compared to short segment fixation group with correction of 55.5% and 49.5%. These differences were not statistically significant (p>0.05). During follow up, a few degrees of correction were lost, however the degree of initial Cobb angle correction as well as amount of correction loss did not differ significantly between the two groups (p=0.840 and p=0.950 respectively).

Table 2: Distribution of patient clinical outcome by Visual Analogue Scoring (VAS) score at 1 year follow-up.

Variables	Long segment fixation N (%)	Short segment fixation N (%)	P- Value
	VAS Score at 1 year follow up		
Good VAS score (0 to 2)	7 (22.6%)	24 (77.4%)	< 0.001
Fair VAS score (3 to 6)	23 (78.6%)	6 (21.4%)	

Patients' satisfaction rate assessed by the VAS score improved better among the short segment group as compared to the long segment group during follow-up at one year. Short segment fixation with 24 (77.4%) patients had better outcome with good VAS score of 0 to 2. A total of 23 (78.6%) patients in the long segment group fall in the category of fair VAS score of 3 to 6.

Table 3: Distribution of patient's clinical outcome by Oswestry Disability Index (ODI) score at 1 year follow-up.

		Long segment fixation	Short segment fixation	p-Value
Variables		N (%)	N(%)	
ODI at 1 year of follow up	Minimal disability (0-20)	12 (30%)	28 (70%)	< 0.001
	Moderate disability (21-40)	18 (88.9%)	2 (11.1%)	

There were more patients in the short segment fixation group that is grouped into the group of minimal disability (0-20) at 1 year follow up with a total of 28 (70%). In the long segment fixation group, more patients fell into the group of moderate disability (ODI 21-40) which was 18 patients (88.9%). Both groups shows statistically significant changes in the ODI scores at 1 year follow-up period (p value <0.001) with long segment fixation and moderate disability had 13.1 odd ratio.

DISCUSSION

Until today, management of thoracolumbar fractures still have many controversies.³ Multiple variables need to be considered which include type of fracture, fracture stability, amount of fracture comminution, and severity of neurological impairment.¹⁰ With the advent of latest medical device technology and instrumentation design, pedicle screws for posterior instrumentation have become the preferred approach in most of the cases. We are in favour of posterior fixation to treat thoracolumbar fracture when surgery is indicated. Posterior approach alone maybe inadequate in some cases to maintain the correction of the injured spine, making the anterior approach frequently needed for anterior support to avoid implant failure, especially in SSF. The incidence of Implant failure may vary from 9 to 54% with SSF.⁴

In early 1990s, University of California had reported short segment fixation failure in their case series.⁴ To overcome implant failure, anterior column requires augmentation with cage or bone graft or by improving the biomechanical strengths of the posterior construct.¹¹ In this study we inserted the screw in both pedicles at the fracture site to increase the stiffness of the construct as suggested by the Korean study.¹⁶ In our centre, we always insert an intermediate screw to improve the mechanical strength of our short segment construct. Afraid of implant

failure, for years thora-columbar fractures were treated with long constructs with 4 screws above and below the frac-ture level. LSF provide more stability with less risks of implant failure but sacrificing motion segments. LSF exaggerates movement at the adjacent disc spaces leading to higher disc pressure. These changes will accelerate degeneration of the adjacent disc.¹² This study reports a short-term outcome following fixation and it is too brief a time for disc degeneration to occur.

However, increased intradiscal pressure distal to the fixation will manifest as persistent back pain after surgery. Therefore, in this study we measured pain according to VAS and Oswestry disability index. The University of Maryland Medical Centre study had shown there was no difference in outcome between SSF and LSF in a single level burst fracture regardless the scoring in load sharing criteria without post operative bracing. Subsequently, more research was being conducted to review the outcome of SSF as compared to LSF. In our study, all the patients did not use brace post operatively. No difference in outcome was found and was in agreement with the study mentioned before.⁶ However, the Korean Society of Spine Surgery report noted a significant difference in the changes of correction angle between LSF and SSF, in cases with severely comminuted fracture with a score of >6 points.¹³

In the study of biomechanical differences between LSF and the SSF, LSF had better correction of local kyphotic deformity and better correction of vertebral height. Nevertheless, there was no clinical advantages of the LSF as compared to the SSF in his study.¹⁴ In our study we did not exclude any patients with load sharing score above 6 from SSF. Our results had a similar outcome with a study in 2015 that compared LSF and SSF. The team concluded that the clinical and radiological outcome was not significantly different between the LSF and SSF group.¹⁵ Bundang Jesaeng General Hospital in their study, compared SSF with intermediate screw with LSF for 5 years (load sharing score >6) to assess the amount of correction loss, hardware failure, and revision surgery. No significant difference in outcome between the 2 groups was noted. He concluded, the use of intermedi-ate screw added strength to SSF.¹⁶

In the late 2010s, an Egyptian prospective study compared SSF with index screw at fracture site to LSF, angle of correction was maintained in SSF and comparable to LSF. SSF also had lesser complications and lesser pain that resulted in better clinical outcome.¹⁷ No significant difference of the deformity correction between SSF with index screw and LSF was also reported by the Turkish team.⁸ All these studies show a similar result to ours. In our study, SSF screw insertion at the fractured level was adequate in burst fracture type A and type B fracture with burst component. There might be a slight recurrence of kyphosis at one year, but it was not statistically significant, and the clinical impact was minimal. There was a similar report that concluded SSF was sufficient for almost all type A and B fractures in a non-ankylosed spine. There might be a slight recurrence of kyphosis with minimal clinical impact. The author emphasizes that the index screws increase biomechanical strength of SSF and able to reduce the rate of fixation failure.¹⁸

The SSF group had less pain immediate post operatively with rapid pain relief, most likely due to preservation of the mobile segment and became minimal once fusion is achieved. Segregations of VAS score into good outcome (VAS 0-2), fair outcome (VAS 3- 6) and poor VAS score (VAS 7-10) were similar to a study in Indonesia.¹⁹ We also studied the amount of back pain via VAS scoring and the Oswestry Disability Index at the end of 1 year. We found that the SSF group had less pain at one year follow up as compared to LSF group who had higher pain scores documented. Both groups show relatively good ODI score at one year follow-up however, ODI score was better in SSF group with most of them scoring in the range of minimal disability (0–20).

Dong A reported a good pain outcome with short segment pedicle screw fixation with index screw with a mean VAS score of 3.0 at last follow up.¹³ Long segment instrumentation will sacrifice more motion segment thus resulting in less flexibility and more susceptibility to low back pain. This shows that the long segment fixation group will have a tendency of ending up with a stiffer back and pain upon strenuous activities due to longer fusion level and reduced spine mobility. These findings support

the hypothesis that SSF has a better improvement in clinical and functional outcome than LSF.

CONCLUSION

There is no significant difference in relation to radiologic outcome of Cobb and kyphotic angle post operatively and at one year of follow up between SSF and LSF in thoracolumbar burst fracture. SSF significantly has a better clinical and functional outcome according to ODI score and VAS score post operatively and at one year of follow up.

LIMITATION

This study has some limitations. The sample was small, it was a retrospective study, and no randomization was done for the treatment options. This could be the source of potential bias. The follow up is only for one year and we propose a longer study in future to enable more accurate outcome measurement as complications may occur years after the index surgery.

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CONFLICT OF INTEREST

The authors declare no conflict-of-interest.

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INSTITUTIONAL REVIEW

Verbal informed consent were obtained from the patient for inclusion in this case report. This retrospective study was approved by the National Medical Research Registry (NMRR) with Research ID: NMRR ID-22-01101-KU4 (IIR).

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