



Research Paper

Comparison between short segment pedicle screw fixation and long segment pedicle screw fixation for treatment of neglected single level thoracolumbar burst fracture

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ARTICLE INFO

Article history:

Received 4 June 2020

Received in revised form

15 September 2020

Accepted 16 September 2020

Available online 24 September 2020

Keywords:

Neglected single level thoracolumbar burst fracture

Long segment

Short segment

ABSTRACT

Background: In contrast with acute cases, the treatment for thoracolumbar burst fracture remains controversial between short segment and long segment pedicle screw in neglected cases, in which only little investigation is done about the proper treatment.

Methods: Using cross-sectional study, we assessed all patients with neglected single level thoracolumbar burst fracture underwent short segment or long segment pedicle screw fixation from January 2016 to June 2019 in Wahidin Sudirohusodo Hospital Makassar. We analysed the data for neurological status, radiological kyphotic angle correction, hospital length of stay, and postoperative patients' satisfaction.

Results: Twenty-one samples were analysed. The mean age of patients was 35 ± 13 years old, consisted of 15 males (71,4%) and 6 females (28,6%). The first lumbar vertebra was the most frequently affected site of a burst fracture (71,4%). Based on ASIA Impairment Scale, the difference was insignificant ($p = 0,918$). Kyphotic angle correction of less than three degrees, were achieved in 20% of patients treated with short segment fixation, while the long segment counterpart achieved only 12,5%, with $p = 0,579$. Six out of sixteen patients (37,5%) underwent long segment fixation had poor hospital length of stay (>14 days), while none of the short segments had it, but the difference was insignificant ($p = 0,246$). Patients' complain of pain was significant ($p = 0,047$) in fair category (VAS 3–7).

Conclusion: There were no significant differences in outcome between short segment and long segment pedicle screw fixation for treatment of patient with neglected single level thoracolumbar burst fracture.

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1. Introduction

Burst fractures, caused by axial compression through the “corpus vertebrae,” often result in motor and neurological deficits. Retropulsion fragment of the middle column that cracks into the spinal canal is a characteristic of “burst fracture.” About 90% of all spinal fractures occur between T11 and L4, in which around 14–17% are classified as “burst fractures.” [1–3] (see [Tables 1 and 2](#)).

By assessing the morphology of the fracture, it is possible to determine the severity of the injury and identify patients

neurological healing potential. In our department, there are numerous vertebral fractures cases diagnosed.

In “*Dennis three-column theory*,” the spine is divided into three columns, namely anterior, middle, and posterior columns [2,4]. The anterior column consists of half of the anterior part of corpus vertebrae, the anterior portion of the annulus fibrosus, and the anterior longitudinal ligament. The middle column consists of the posterior half of corpus vertebrae, the posterior portion of the annulus fibrosus, and the posterior longitudinal ligament, while the posterior column consists of the nerve arches, facet joints, ligamentum flavum, and posterior spinal ligaments. Injury to two or more columns causes the spine to become biomechanically unstable (Hafer et al., 1989). This is also supported by Panjabi et al. (1995), who showed that the middle column is the primary determinant of mechanical stability in the spine, especially in the thoracolumbar region. Based on this, all “burst fractures” are unstable [5].

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Table 1
Characteristics of the patients.

Variable		n	%
Gender	Male	15	71,4
	Female	6	28,6
Fracture Site	L1	15	71,4
	L2	2	9,5
	Th 12	4	19,0
Asia Impairment Scale	Normal	4	19,0
	Complete	7	33,3
	Incomplete	10	47,6
Kypotic Angle Correction	<3	3	14,3
	3–9	18	85,7
Hospital Length of Stay	Good	5	23,8
	Fair	10	47,6
	Poor	6	28,6
Patient Satisfaction	Good	8	38,1
	Fair	13	61,9
	Short	5	23,8
Fixation Type	Long	16	76,2

Table 2
Characteristics of patients' outcome.

Variable		Short	Long	Total	P
Gender	Male	4 (80%)	11 (68,8%)	15 (71,4%)	0,55
	Female	1 (20%)	5 (31,2%)	6 (28,6%)	
Fracture Site	L1	4 (80%)	11 (68,8%)	15 (71,4%)	0,708
	L2	0 (0%)	2 (12,5%)	2 (9,5%)	
	Th 12	1 (20%)	3 (18,8%)	4 (19,0%)	
Asia Impairment Scale	Normal	1 (20%)	3 (18,8%)	4 (19,0%)	0,918
	Complete	2 (40%)	5 (31,2%)	7 (33,3%)	
	Incomplete	2 (40%)	8 (50%)	10 (47,6%)	
Kypotic Angle Correction	<3	1 (20%)	2 (12,5%)	3 (14,3%)	0,579
	3–9	4 (80%)	14 (87,5%)	18 (85,7%)	
Hospital Length of Stay	Good (<7 days)	2 (40%)	3 (18,8%)	5 (23,8%)	0,246
	Fair (7–14 days)	3 (60%)	7 (43,8%)	10 (47,6%)	
	Poor (Vas >14 days)	0 (0%)	6 (37,5%)	6 (28,6%)	
Patient Satisfaction	Good (Vas 0–2)	4 (80%)	4 (25%)	8 (38,1%)	0,047
	Fair (Vas 3–6)	1 (20%)	12 (75%)	13 (61,9%)	
	Poor (Vas 7–10)	0 (0%)	0 (0%)	0 (0%)	

Most burst fractures occur at the thoracolumbar junction level, whose vulnerability is partly explained by this region's anatomy and biomechanics of this region. Expanding this explanation, this is due to the radial shape of the “thoracic cage” and the stability provided by the costotransverse ligaments in the thoracic spine, which provide higher resistance to the load in the coronal and sagittal plane, as well as axial rotation [6]. Such protection gives the impression that it is relatively more rigid. Meanwhile, the lumbar spine is more flexible and less protected than the thoracic spine, resulting in a fragile segment called the thoracolumbar transition/junction (T11-L2). Specifically, the study developed by Avanzi et al. found that 83% of injuries occurred between T12 and L2, with the first lumbar vertebrae being the most affected [3]. The handling of thoracolumbar burst fractures is still controversial. In general, the management of thoracolumbar burst fractures is divided into *short segments* and *long segments*, but over time, a new method that started gaining popularity emerged. Now, *short segments* mean one level above and below with the inclusion of the fracture level site, and *long segments* mean two levels above and two levels below the fracture level without the inclusion of fracture site level [7-9]. All of these methods have their own advantages and disadvantages.

In developing countries like Indonesia, there are still many thoracolumbar *burst fracture* patients who have not received proper treatment and eventually become *neglected* patients when they come to the orthopaedic center. There is no research that compared between short segment which is one level above and one

level below the fracture level with inclusion of fracture site level [25] and long segment which is two segment above and two segment below the fracture level without inclusion [26] of fracture site level as the treatment of *neglected thoracolumbar burst fractures*.

2. Materials and methods

2.1. Place and time of research

The study was conducted in the Orthopaedics and Traumatology department of Wahidin Sudirohusodo Hospital Makassar from October to November 2019.

2.2. Research population

The population of this study was patients with neglected single-level thoracolumbar burst fractures who underwent fixation of short-segment pedicle screws or fixation of long segment pedicle screws at Wahidin Sudirohusodo Hospital, Makassar.

2.3. Research samples and method of sampling

In this study, the samples were all patients diagnosed with *neglected burst fractures* treated by fixation of *short segment pedicle screw* or fixation of *long segment pedicle screw* at Wahidin

Sudirohusodo General Hospital Makassar from January 2016 to June 2019. The samples were selected based on inclusion and exclusion criteria.

Total population sampling was used in this study as a sampling method. Patients' medical records were collected as secondary data. Patient satisfaction was assessed by using *visual analogue scale* during the interview when the patient was seated at the clinic, which was done a minimum three months postoperatively after pedicle screw fixation of the *short segment* or *long segment*.

Estimation for sample size needed for this study was done with an estimated proportion of variables 0.500 with a standard deviation value of 1.96 and the chosen level of accuracy of 0.10. The sample size was then determined to be 20 samples.

2.3.1. Inclusion criteria

- Aged 18–55 years
- Agreed to be study subjects
- Patients treated with *short* or *long segment pedicle screw* fixation with a diagnosis of *neglected single-level thoracolumbar burst fracture*
- Patients with normal spinal conditions before the fracture occurred.

2.3.2. Exclusion criteria

- Patients with limitations or disorders before the incident occurred
- Presence of *postoperative surgical site infection*

2.4. Research design

This research is a *cross-sectional observational* study, which has been reported in line with the STROCSS criteria [10,24] and the registration UIN is registered as researchregistry6013, in accordance with the declaration of Helsinki.

2.5. Research methods

Patients with *neglected single-level thoracolumbar burst fractures* who received operative management of *short segment pedicle segment* fixation or *long segment* fixation were identified by tracking the medical records and patients' registers in the Orthopaedic and Traumatology Department of Wahidin Sudirohusodo General Hospital as secondary data.

The term "neglected" in this study, we took at least three weeks after the trauma that delayed in definitive treatment, which is very variable in each study. Patients who met the study criteria had their data collected from medical records as secondary data, which were the duration of treatment, ASIA Impairment Scale, and radiological imaging. Radiological imaging was evaluated to measure the *kyphotic* angle correction using the *Cobb* method. When the patient was seated, the interview was done to assess the patient satisfaction using the *visual analogue scale*, which is collected as primary data.

The assessment was carried out in one phase, which duration postoperatively was at least three months after *pedicle screw* fixation.

The data collected were analysed statistically using the *Fisher exact* test. The interpretation of the data results was then explained in the discussion section and finally concluded.

2.6. Data analysis

Data analysis was performed using SPSS version 25. Statistical analysis was carried out using the *Fisher exact* statistical test. The results of the test were determined to be statistically significant if the p -value < 0.05 .

3. Results

The age of the subjects taking part in this study ranged from 18 to 55 years. The mean (average) age of the subjects was 35 ± 13 years. The incidence most often occurred in men, and the most frequently affected location of the fracture was the first lumbar.

3.1. Gender distribution by fixation type

In percentage, more men underwent *pedicle screw* fixation, both in fixation with the *short segment* (80%) and *long segment* (68.8%). Still, the distribution of men and women in the two types of fixation did not differ significantly ($p > 0.05$).

3.2. Distribution of fracture location by fixation type

The most common location of the fracture was L1 in both categories, with the incidence of 80% (short) and 68.8% (long). The fracture site in L2 was only found in the Long type, but this is not statistically significant ($p > 0.05$).

3.3. Distribution of fracture location by fixation type

The most common location of the fracture was L1 in both categories, with the incidence of 80% (short) and 68.8% (long), fracture site in L2 was only found in the long type, but this is not statistically significant ($p > 0.05$).

3.4. Distribution of ASIA impairment scale by fixation type

More patients with normal neurological status in short type fixation group (20%) compared to the long type fixation group (18.8%). Patients who underwent short fixation experienced fewer incomplete neurological disabilities (40%) than long segment (50%). The difference in ASIA impairment scale between the two types of fixation did not differ significantly ($p > 0.05$).

3.5. Distribution of kyphotic angle correction by fixation type

Kyphotic angle correction of less than 3° accounted for 20% of patients treated with short segment fixation. In contrast, it was only 12.5% for long-segment fixation, but this difference was not statistically significant ($p > 0.05$).

3.6. Distribution of hospital stays duration by fixation type

The length of hospital stay in 6 out of 16 patients (37.5%) treated with long segment fixation was considered to be in the poor category (> 14 days), whereas none of the patients who underwent short segment fixation was grouped in that category. There was no significant difference in the length of hospital stay ($p = 0.246$).

3.7. Distribution of patient satisfaction by fixation type

Patient satisfaction rates, assessed by VAS, were more severe in patients treated with long segment fixation (75%) than short segment fixation (20%). There was a significant difference ($p = 0.047$) in the moderate category (VAS 3–7).

4. Discussion

Burst fractures are the most common type of fracture in the *thoracolumbar vertebrae* (60%) [10]. These fractures usually occur in young male patients [12,13]. The main cause of burst fractures is due to fall from height [12–14]. The thoracolumbar segment of the spine is the most commonly affected area because the adjacent thoracic spine has a more rigid nature. The last segment tends to absorb all of the trauma energy [14,15].

The management of thoracolumbar fractures is still being debated. In the traditional era, the *long segment pedicle screw* fixation, including two upper and lower segments of the *fracture site*, was used. The *short segment pedicle screw* fixation then started to develop, which includes only the *fracture site*. This method later became popular, which was supported by Daniel Gelb et al. (2010), which showed the significant success of *short segment* fixation over long segment fixation, even in cases of comminuted fractures without anterior support or *brace* [16]. In another study, it was stated that the presence of a *pedicle screw* at a fracture site could add stability and better correction of the kyphotic angle compared to not inserting a *pedicle screw* at the *fracture site*. [17,18] In our study, the pedicle screw inserted in the fracture site and including one upper and lower segment of the fracture site is called short-segment pedicle screw fixation.

The management of *neglected* cases in developing countries is still an interesting challenge for operators who face complications that can endanger patients' life, such as decubitus ulcers, urinary tract infections, and back pain [11].

In our study, the age of the subjects enrolled in this study ranged from 18 to 55 years, with an average age of 35 ± 13 years. The majority of the subjects are men (71.4%) compared to women (28.6%).

The highest incidence of *burst fractures* occurred mainly in lumbar 1 (71.4%) compared to the twelfth thoracic (19.0%), and lumbar two (9.5%). This is in accordance with research conducted by Mustard et al., in 1996, due to the shift from less mobile to more mobile areas [20]. Based on the *ASIA Impairment Scale*, there were more patients with normal neurological status after the *short segment* fixation procedure (20%) compared to the *long segment* fixation (18.75%). Patients who underwent *short segment* fixation experienced fewer incomplete neurological disabilities (40%) than *long segment* fixation (50%). However, complete neurological disability was also more common in *short segment* fixation type (40%) compared to the long segment (31.25%). The distribution of the ASIA impairment scale in the two types of fixation did not differ significantly ($p > 0.05$). This result showed that there is no guarantee of the significant improvement in neurological status in neglected cases.

In our study, *Kyphotic* angle correction of fewer than 3° accounted for 20% of patients treated with short-segment fixation, whereas for patients treated with *long segment* fixation, it was only 12.5%. No *kyphotic* angle correction $\geq 10^\circ$ was found in both types of fixation. In contrast from Hayder Alhemiary et al., that long-segment group has a better correction of the local kyphosis angle, although associated with limitation of the motion segment compared with the short segment group. Also short-segment achieve good correction of the lordotic angle postoperatively (cobb's angle) in comparison to the preoperative angle [18]. In a study done by McCormack et al., a higher degree of correction of postoperative kyphosis was closely related to the complications that will follow later in the form of *implant failure* that can cause patients to have to undergo subsequent surgery [19,20]. In this study, the results of kyphotic angle correction had no significant difference between patients treated with short segment and patients treated with the long segment ($p = 0.579$) that consistent with other literature by

Necdet S et al., there was no statistically significant difference in LKA values between long segment and short segment measured using the final follow-up radiographs [21].

The length of hospital stay in 6 out of 16 patients (37.5%) treated with *long segment* fixation was considered to be in the poor category (>14 days). None of the patients who underwent *short segment* fixation is grouped in that category. There was no significant difference in the length of the hospital category ($p = 0.246$).

The level of patient satisfaction assessed by VAS in the good category is found to be 80% in patients treated with the *short segment* than the *long segment* (25%). In the "fair" category, there were more patients treated with *long segment* fixation (75%) compared to short fixation segment (20%), and there was also a significant difference ($p = 0.047$) in the fair category (VAS 3–7). Patient complained less pain in the long segment rather than the short segment on the first-month after surgery. It showed us the superiority of the long segment compared to the short segment in the first month postoperatively in contrast with Necdet S et al. that there are no significant between the short and the long segment pedicle screw fixation in VAS score [21].

Cases of *neglected thoracolumbar burst fractures* have always been challenging, especially in choosing the most appropriate management for patients. From this study, we found that patients treated with the short segments have a shorter treatment period (40%). As assessed by a VAS score of 80%, the level of patient satisfaction, illustrates the success of the *short segment* fixation in the management of patients with *neglected* cases. Short segment fixation is becoming more popular because fewer spinal movements are sacrificed, but there is a high *implant failure* complications compared to the *long segments*, which have better stability. New techniques are developed by adding screws to fracture sites which are expected to provide more stability and prevent failure. Other researchers also had good results with patients treated with *short segments* with minimal postoperative complications [19,21–23]. The key strength of our study is that we added the inclusion of fracture site on short segment pedicle screw fixation which theoretically more stable than traditional short segment, so the chance of failure decreased. The limitations of this study include its retrospective study design and lack of subject compared with other studies. Although all the subject have similar age, preoperative values and operative treatment were performed by a surgeon, so risk bias was eliminated. The lack of subject happened because many subjects have complications of their conditions, such as decubitus ulcer, orthostatic pneumonia, and other complications that were not suitable for our study. Another study that includes a larger sample would provide a stronger recommendation of the best treatment for the patients.

5. Conclusion

In this study, we found that there was a significant difference only in patient satisfaction in the fair category ($p = 0,047$). Other variables showed no significant difference between *long and short-segment pedicle screw* fixation for the treatment of a single-level thoracolumbar *burst fracture*. We suggest using a short segment fixation with inclusion fracture site level rather long segment pedicle screw fixation according to patient satisfaction.

Ethical approval

This study was approved by the ethical board of Hasanuddin University of Makassar. Our patients has signed terms of consent to participate in the research of this original article. The institutional ethical committee has approved the publication of this original article.

Funding

This study was funded independently.

Consent

Written informed consent was obtained from the patient for publication of this case report and accompanying images. A copy of the written consent is available for review by the Editor-in-Chief of this journal on request.

Author contribution

Karya Triko Biakto: Conceptualization, Methodology, Supervision, Data curation, Formal analysis, Validation, Resources, Funding acquisition, Project administration. **Muhammad Andry Usman:** Conceptualization, Supervision, Formal analysis, Validation. **William Limoa:** Conceptualization, Data curation, Formal analysis, Investigation, Validation, Writing - Original Draft, Writing - Review & Editing, Visualization. **Luky Tandio Putra:** Conceptualization, Software, Data curation, Formal analysis, Investigation, Validation, Writing - Original Draft, Writing - Review & Editing, Visualization.

Conflict of interest statement

There are no conflicts of interest.

Research registration number

None.

Guarantor

Luky Tandio Putra.

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