COMPARISON OF PERCUTANEOUS PEDICLE SCREW FIXATION AND PEDICAL SCREW FIXATION IN CONVENTIONAL INCISION IN THORACOLUMBAR FRACTURE

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Abstract

Background: Originally, patients with unstable thoracolumbar spine fracture were treated using pedicle screw fixation, a conventional incision. However, the small incision percutaneous pedicle screw fixation (PPSF), a new device, has been recently introduced which could save surgery time, reduce blood loss and improve clinical recovery.

Objective: This study aimed to evaluate postoperative outcomes of the PPSF, compared with the open pedicle screw fixation (OPSF) in conventional incision among patients with thoracolumbar fracture.

Methods: A retrospective study of 54 cases of patients with thoracolumbar spine fracture without neurological deficit was included in the study. The data were collected from medical records of patients admitted to Rayong Hospital from January 2017-December 2019.

Results: Patients aged from 18-46 years (32.35± 8.52) were mostly males (59.2%). Types of fracture included burst (72.22%). The most common level of thoracolumbar spine fracture was L1 (37.04%). Mostly, the cause of injury was fall from height (53.70%). The mean postoperative stays in the PPSF and OPSF groups were significant, 3.09±.59 and 6.16±1.003 days, respectively (p<0.05). The mean intraoperative blood losses of the PPSF and OPSF groups significantly differed, 44.35±15.02 and 466.13±87.92 mL, respectively (p < 0.01). However, the mean kyphotic angle reduction of the PPSF (24.43±2.74 degrees) and OPSF (24.87±2.55 degrees) groups did not significantly differ (p > 0.1). The mean postoperative pain score (VAS) at the first day in the PPSF and OPSF groups were 6.43±.94 and 6.61±.98, respectively, which did not significantly differ (p > 0.1).

Conclusion: PPSF spinal fracture treatment could reduce the amount of bleeding during surgery and reduce the length of hospital stay. However, the results of both types of surgery did not differ regarding postoperative pain, decreased kyphotic angle and surgical time**.**

Keywords: Thoracolumbar Fracture, Percutaneous pedicle screw fixation, Open pedicle screw fixation

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Introduction

Spine fracture has been found especially at the thoracolumbar junction level (T10-L2) where biomechanical transferred area and considerable motion are involved. [1,2] The incidence of this injury in North America was 160,000 persons per year which caused abnormal spine structure (kyphotic deformity) with neurological injury.

The classification of injury at this area used the three-column concept as described by Denis F.[3] This concept divided patients in four groups under biomechanical theory, namely, compression fracture, burst fracture, flexion-distraction injury and fracture dislocation. In 2005, Vaccaro et al. [4] proposed the thoracolumbar injury and severity score (TLICs) considering three aspects, i.e., biomechanical spine fracture combined with the context of Denis's theory, injury at the posterior ligamentous complex and neurological spinal injury. All of these aspects have been applied and used as guidelines for patterns and treatment methods.

The unstable fracture or TLICs ≥4 with neural injury was treated using the open conventional incision. Pedicle screws were applied to fix at the spinal body and reduction & decompression followed the standard treatment. [5,6]

On the other hand, the unstable spine fracture without neurological injury could be treated using percutaneous pedicle screw fixation which saved time during surgery. In addition, this approach reduced blood loss, decreased dissection tissue and improved clinical recovery faster than the old method. [7,8]

The important instrument assisting percutaneous pedicle screw fixation was a guide wire and a cannulated screw to apply insertion at the pedicle only. Fluoroscope assisted evaluating the proper site and direction of screw during surgery. Open surgery splinted the muscles between the multi fidus and longissimus (Wiltse's approach).[14-16] This retrospective study considered the appropriateness, safety and efficacy of both techniques.

Methods

The retrospective study was conducted at Rayong Hospital and approved by the Ethics Committee of Rayong Hospital (RYH REC No. E030/2563). The inclusion criteria included thoracolumbar and unstable fractures. The exclusion criteria included TLICs <4 scores, neurological deficit, and multiple organ injuries. From January 2017 to December 2019, 54 thoracolumbar fractures operated at Rayong Hospital were enrolled in the study. The data were searched from the patients' medical records, i.e., age, sex, levels of spinal fracture, and causes and outcomes of treatment. The participants presenting TL spine fracture were measured using kyphotic or Cobb angle and identified configuration of fracture from a plain film (TL spine AP-lateral).

The patients were divided in two groups. The percutaneous pedicle screw fixation or the PPSF group constituted the study group while the open splint muscle long segment pedicle screw fixation or the OPSF group constituted the control group. Neither group showed decompression or posterior spinal fusion, and both used an indirect reduction technique in the prone position. A distraction device was applied in the field of surgery and controlled precise operation using fluoroscopy.

The incision using the PPSF technique was nearly out bounder of pedicle 15 mm in length and was checked with fluoroscope in the AP view. The next step was splitting the paraspinal muscle using a small incision to check position of the facet joint. Then a cannulated awl was applied at the outer cortex to insert a guide wire. The guide wire was passed through inside the bone and rechecked with fluoroscopy in the AP and lateral views. When it stayed in a precise position, cannulated tap was applied to make the entry point at the pedicle. The pedicle screw was inserted after removing the guide wire and its position was checked using fluoroscopy. When all pedicle screws were inserted, the proper lengths rod of both sides were replaced. After rechecking the lordotic curve of rods, the nuts were locked above all pedicle screws.

For the OPSF technique, the standard midline longitudinal posterior approach was applied from the upper to lower levels of the pedicle. Wiltse's approach was used to split between the longissimus and multifidus muscles. The screw was inserted using a normal technique and the screw was rechecked using fluoroscopy in AP

and lateral views. The proper lengths of rods were bended and applied, then a nut was inserted.

The measurement technique was used to evaluate the magnitude of the kyphotic deformity, measuring the angle between the inferior endplate of the vertebrae above and the superior endplate of the vertebrae below the fracture vertebrae body.

The data were collected from patients' medical records such as blood loss, length of stay and postoperative pain days 1 and 3 using the visual analogue scale (VAS). The pre- and postoperative kyphotic angles were measured and calculated for kyphotic angle reduction. Data were presented in mean, standard deviation (SD), frequency, percentage and the independent t-test was used to test between the two approaches.

Results

From January 2017 to December 2019, demographic data of 54 thoracolumbar fractures operated at Rayong Hospital showed the mean of age was 32.35 years (SD=8.52), mostly male (29, 59.2%). In addition, configurations of spinal fractures were burst (39, 72.22%), and compression (15, 27.78%). In addition, the levels of the TL fractures were as followed: T11 level (7, 12.96%), T12 level (19, 35.18%), L1 level (20, 37.04%) and L2 level (8, 14.82%). Finally, causes of fractures included fall from height (29, 53.70%), traffic accident (19, 35.18%) and machine contusion (6, 11.12%). Patient demographic data between the PPSF and OPSF groups did not significantly differ (**Table 1).**

Table1. Patient demographic data of the percutaneous pedicle screw fixation and open pedicle screw fixation groups (N=54)

data	PPSF (N=23)	OPSF (N=31)	*p*-value*
Age(year)	31±9	34±8.16	0.56
Gender			
male	11 (47.82%)	23 (74.19%)	0.13
female	12 (52.18%)	8 (25.81%)	
Characteristic of fracture			
Burst Fracture	17 (73.91%)	22 (70.96%)	0.63
Compression Fracture	6 (26.09%)	9 (29.04%)	
Level of fracture			
T11	1 (4.35%)	6 (19.36%)	0.13
T12	10 (43.48%)	9 (29.03%)	
L1	9 (39.13%)	11 (35.48%)	
L2	3 (13.04%)	5 (16.13%)	
Causation of fracture			
Fall from height	11 (47.82)	18 (58.06)	0.51
Traffic accident	10 (43.47)	9 (29.03)	
Machine contusion at back	2 (8.71)	4 (12.91)	

Percutaneous pedicle screw fixation (PPSF), Open pedicle screw fixation (OPSF) *Independent t-test

Preoperative kyphotic angle of the PPSF and OPSF groups were 27.52±2.92 degrees and 27.97±2.76 degrees, respectively with no significant difference. Postoperative kyphotic angles of the PPSF and OPSF groups were 3.09±0.79 and 3.10±0.79 degrees, respectively, without significant difference **(Table 2**). The average kyphotic angle reduction of the PPSF and OPSF groups was equal at 24 degrees.

As shown in **Table 3**, using VAS, postoperative pain was evaluated at the first post-operative day of both groups. The VAS of the PPSF and OPSF groups were 6.43±0.94 and 6.61±0.98, respectively. Furthermore, the pain levels at day 3 of both techniques were 2.78±0.90 and 2.94 ±0.85, respectively. As a result, the average pain level of both groups between days 1 and 3 did not significantly differ. In addition, the length of stay of the PPSF and OPSF groups were 6.04±1.10 and 10.90±0.97 days, respectively (p=0.98). On the other hand, duration of post-operative day of both groups significantly differed at 3.09±0.59 and 6.16±1.00 days, respectively.

For intraoperative period, operative time of both groups were 68.3±7.32 and 66.71±6.59 min, respectively (p=0.23). However, blood loss of both groups significantly differed at 44.35±15.02 and 466.13±87.92 mL, respectively.

Complications

Complications occurring among surgery cases included improper screw in the PPSF group (three cases) but none occurred in the OPSF group. However, this problem could be solved using fluoroscopy assisted without neurological deficit.

Discussion

Fixation of the thoracolumbar spinal fracture using OPSF has been used substantially and constitutes a standard method. However, a new procedure to fix comprises the PPSF a considerably popular technique to correct deformity of the spine including unstable thoracolumbar fracture. The advantage of this new method includes minimizing injury to the musculo-tendinous

Table2. Results of kyphotic angle comparing between the PPSF and OPSF groups

data	PPSF (N=23) mean±SD	OPSF (N=31) mean±SD	*p*-value*
Pre-operative kyphotic angle	27.52(2.92)	27.97(2.76)	0.90
Post-operative kyphotic angle	3.09(0.79)	3.10(0.79)	0.88
Kyphotic angle reduction	24.43(2.74)	24.87(2.55)	0.79

Percutaneous pedicle screw fixation (PPSF), Open pedicle screw fixation (OPSF) *Independent t-test

Table3. Results of outcome comparing between the PPSF and OPSF groups

data	PPSF (N=23)	OPSF (N=31)	*p*-value*
Postoperative pain at Day 1	6.43±0.94	6.61±0.98	0.56
Postoperative pain at Day 3	2.78±0.90	2.94±0.85	0.94
Length of stay (day)	6.04±1.10	10.90±0.97	0.98
Duration of post-operative day	3.09±0.59	6.16±1.003	0.04
Duration of surgery (min)	68.3±7.32	66.71±6.59	0.23
Blood loss during surgery (mL)	44.35±15.02	466.13±87.92	0.01

Percutaneous pedicle screw fixation (PPSF), Open pedicle screw fixation (OPSF) *Independent t-test

unit, reducing blood loss, decreasing length of stay and lessen postoperative pain. [7-13]

This study compared the PPSF with OPSF techniques wherein reduced blood loss was significantly observed (p<0.01). Moreover, the number of postoperative days decreased significantly (p< 0.05) as in other related studies. [9, 10, 18, 19] However, lengths of stay of both groups did not differ due to insufficient operative rooms. For this reason, pre-operative time differed for each person.

Regarding the measured kyphotic angle, the PPSF group was corrected 27.52 to 3.09 degrees while the OPSF group was corrected 27.97 to 3.10 degrees. Both were not divergent as in related studies. [9,10,18,22] In addition, duration of surgery of both methods did not differ similar to those of Dong et al. and Grossbach et al. [20,24] In contrast to other studies [9,18,25], the PPSF revealed shorter operative time than that of the OPSF group; nonetheless, duration of surgery might have been related to experiences of surgeons as well as the use of applied instruments.

Pain levels reported at the first operativeand third operative day did not differ although a related study reported that the PPSF group had pain scores lower than those of the OPSF group. [10,12,18,20]

However, McAnany et al.[9] showed similar results as this study. This study encountered some limitations, i.e., the small sample size could not clarify the difference of postoperative pain which could have occurred. In addition, the instrument used for percutaneous fixation could have increased surgery costs; however, benefits were obtained, i.e., reduce blood loss and lower duration of hospital stay.

Conclusion

The PPSF technique reduced blood loss and decreased length of hospital stay. Nevertheless, both techniques did not differ in terms of postoperative pain, kyphotic angle reduction and surgery duration.

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