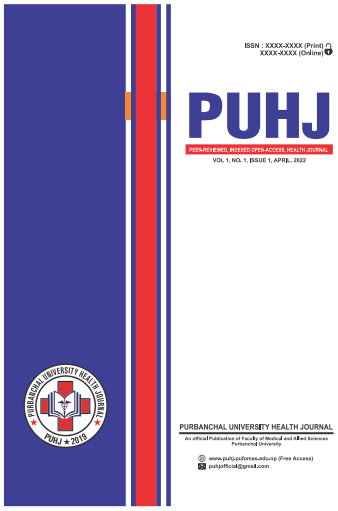

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Clinical and Radiological Outcomes of Open Vs Percutaneous Pedicle Screw Fixation for Traumatic Thoracolumbar Injuries

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Abstract

Introduction: Thoracolumbar fractures represent a challenging clinical scenario with potential for significant neurological deficits and impaired quality of life. Unstable thoracolumbar fractures need surgical stabilization to prevent further neurological deterioration as well as deformity. While open pedicle screw fixation has been the standard surgical procedure, percutaneous pedicle screw fixation is gaining popularity because of its less invasiveness.
Objective: The study aims to compare the clinic-radiological outcomes of open pedicle screw fixation and percutaneous pedicle screw fixation in managing thoracolumbar fractures.
Method: A prospective observational study was conducted at National Trauma Centre involving 42 patients with thoracolumbar vertebral fractures. Patients undergoing surgical management were divided in open pedicle screw fixation(OPSF) and percutaneous pedicle screw fixation(PPSF) group. Demographic data, injury details, clinical outcomes (VAS, ODI score)and radiographic measurements(AVBH, LKA) were recorded preoperatively and postoperatively at day 1,6 weeks and 6 months. Results were compared.
Result: 42 patients were included, 21 in each group, of which29(69%) were male and 13(31%) were female with a mean age of 43 years. Significant postoperative clinical(VAS and ODI score) and radiological(AVBH and LKA) improvements were seen in both groups, as compared to the baseline. Statistically significant difference($p<0.05$) in postoperative VAS and ODI scores was noted in percutaneous group as compared to open group. However, no significant difference($p>0.05$) in radiological outcomes (AVBH, LKA) were observed between the two groups.
Conclusion: Both the techniques showed similar radiological outcomes with no statistically significant differences in AVBH and LKA. However, PPSF exhibited superior clinical outcomes, with significantly lower ODI and VAS scores, indicating its potential as a favourable surgical approach for spinal stabilization.
Keywords: Functional outcome; Open pedicle screw fixation; percutaneous pedicle screw fixation; thoracolumbar fractures; radiological outcome

Introduction

The vertebral column is a complex structure typically consisting of seven cervical vertebrae, twelve thoracic, five lumbar, the sacrum and the coccyx. It provides protection to the spinal cord, helps in load transmission, and also provides capacity for motion. The incidence of spinal fractures is reported to vary between 16-64/100 000 depending on the study area and population concerned.[1]The thoracolumbar spine remains the most common site of vertebral column injuries with 15-20% of patients having neurological involvement.[2]The thoracolumbar junction is a zone of structural and functional transition, which makes it vulnerable to injury. This transition between the rigid thoracic and the relatively mobile lumbar column creates a fulcrum at the thoracolumbar junction, for this reason 75% of fractures occur between T12 and L2 and they are associated with neurological injury in up to 45% of cases.[3]

The primary goals of treatment of these patients include preserving life, protecting neurologic function, and restoring alignment and stability of the spine.[4]Although some of the stable thoracolumbar fractures can be managed conservatively, it has been proven that surgical treatment can achieve better clinical outcomes.[5]Pedicle screw fixation for vertebral fractures is a safe and effective procedure popular worldwide, owing to the fact that pedicle screw systems engage all three columns of the spine and can resist motion in all planes.[4,6] Pedicle screw fixation can be done by open method or percutaneous techniques. Conventional techniques of open lumbar pedicle screw fixation involve a single midline or bilateral paramedian incisions.[7,8]The percutaneous technique eliminates the need of large incision as both the pedicle screws and contoured rods are placed by stab incision, with blunt splitting of paraspinous muscles leading to shorter duration of hospital stay and recovery.[6,9,10]

This study aims to compare the radiological and clinical outcomes of open vs percutaneous technique for pedicle screw fixation of thoracolumbar fractures.

Method

Prospective observational study was conducted at the National Trauma Center in Katmandu, Nepal, over a period of one year from April 2023 to March 2024. The study population consisted of patients with thoracolumbar spinal fractures with intact neurology who were attending the Emergency Department and undergoing surgery. Convenience sampling technique was used, and the calculated sample size was 42(21 in each group).

Sample size calculation;

Sample size $=2(z_\alpha + z_\beta)^2\sigma^2/d^2$

$= 2(1.96+8.84)^2 \times 1.5^2/1.3^2=20.8$(21 in each group)

where,

Z_α =1.96 for 95% confidence interval

Z_β = 0.84 at 80% power

σ = standard deviation = 1.5[11]

d = difference in mean between 2 groups = 3.8.[11] -2.5.[11] =1.3

The inclusion criteria for the study were patients aged 18 years and above with fractures involving vertebrae T10-L5 who had indications for posterior fixation (TLICS score > 4). Multiple level fracture, pathological fracture, osteoporotic fractures were excluded from the study.

Ethical clearance was obtained from the Institutional Review Board (IRB) of the National Academy of Medical Sciences (NAMS). Informed consent was obtained from all the patients. Demographic data, mode of injury, and neurological status were recorded. Radiographs, CT scans, and MRI of the thoracolumbar spine were performed following the hospital's standard protocol. Injury was classified according to AO classification.[12]Surgical treatment was done as per standard protocol and operative indications were divided into 2 groups, one undergoing open fixation and another undergoing percutaneous pedicle screw fixation. Visual Analogue Score (VAS), Oswestry Disability Score(ODI), Anterior Vertebral Body Height(AVBH)and Local Kyphotic Angle(LKA)were calculated preoperatively and postoperatively on day 1, 6 weeks and 6 months.

Result

42 patients were included in the study, 21 in each group, of which 29(69.05%) were male and 13(30.95%) were female with a mean age of 43 years. Figure 1 shows age-wise distribution of the study population.

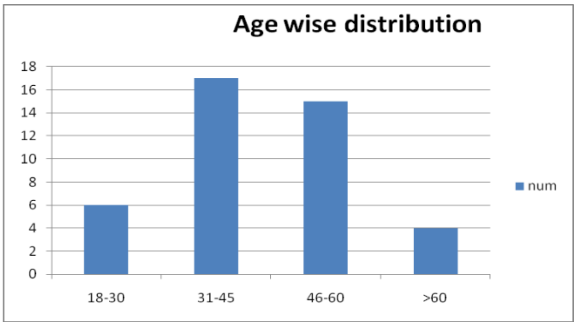

Figure 1: Age wise distribution of study population

Out of 42 patients, 24 had fall injury and 18 had road traffic accidents. The mean preoperative VAS of OPSF group was 8.33±0.80 and postoperative VAS were 4.29±0.85, 2.29±0.78 and 1.76±0.62 respectively at day 1, 6 weeks and 6 months. Similarly, preoperative VAS of PPSF was 8.43±0.68 and postoperative were 4.52±0.75, 1.67±0.58 & 1.24±0.44 respectively at day 1, 6 weeks and 6 months which were statistically significant ($p < 0.05$). Table 1 shows the preoperative and postoperative mean VAS scores.

Table 1: Preoperative and Postoperative visual Analogue Score (VAS)

Procedure group	Preop			Day 1			6 weeks			6 months		
	Mean	SD	P value	Mean	SD	P value	Mean	SD	P value	Mean	SD	P value
OPSF	8.33	0.80	>0.05	4.29	0.85	>0.05	2.29	0.78	<0.05	1.76	0.62	<0.05
PPSF	8.43	0.68		4.52	0.75		1.67	0.58		1.24	0.44	

The mean preoperative ODI of OPSF group was 67.05±3.61 & postoperative ODI were 65.90±3.48 ,10.29±1.45, 7.95±1.36 at day1, 6 weeks and 6 months respectively. Preoperative ODI of PPSF group was 67.76±2.47 and postoperative ODI were 66.43±2.47, 9.52±1.45 and 6.52±1.17 at day 1, 6 weeks and 6 months respectively which was statistically significant ($p < 0.05$) for 6 weeks and 6 months.

Table 2: Preoperative and Postoperative Oswestry Disability Score (ODI)

Procedure group	Preop			Day 1			6 weeks			6 months		
	Mean	SD	P value	Mean	SD	P value	Mean	SD	P value	Mean	SD	P value
OPSF	67.05	3.61	>0.05	65.90	3.48	>0.05	10.29	1.45	<0.05	7.95	1.38	<0.05
PPSF	67.76	2.47		66.43	2.29		9.52	1.40		6.52	1.46	

The mean preoperative AVBH was 60.69±4.67 and mean postoperative AVBH were 89.12±2.98, 87.51±3.21 and 85.67±3.07 at day 1, 6 weeks and 6 months for OPSF. Similarly, for PPSF, preoperative AVBH was 60.77±4.67 and postoperative AVBH were 88.14±3.39 ,86.52±3.08 and 84.76±3.24 at day 1, 6 weeks and 6 months which was statistically insignificant ($p > 0.05$).

Table 3: Preoperative and Postoperative Anterior Vertebral Body Height (AVBH)

Procedure group	Preop			Day 1			6 weeks			6 months		
	Mean	SD	P value	Mean	SD	P value	Mean	SD	P value	Mean	SD	P value
OPSF	60.69	4.67	>0.05	89.12	2.98	>0.05	87.51	3.21	>0.05	85.67	3.07	>0.05
PPSF	60.77	4.67		88.14	3.39		86.52	3.08		84.76	3.24	

The mean pre-operative LKA of OPSF was 22.48±2.38 and the postoperative LKA were 9.10±1.55 ,10.19±1.66 and 11.95±1.83 at day1, 6 weeks and 6 months, respectively. Similarly, preoperative LKA of PPSF was 22.86±2.26 and the post-operative were 9.19±2.06 ,11.10±1.73 and 13.00±1.64 respectively at day 1, 6 weeks & 6 months which was also statistically insignificant ($p > 0.05$).

Table 4: Preoperative and Postoperative Local Kyphotic Ankle (LKA)

Procedure group	Preop			Day 1			6 weeks			6 months		
	Mean	SD	P value	Mean	SD	P value	Mean	SD	P value	Mean	SD	P value
OPSF	22.48	2.38	>0.05	9.10	1.55	>0.05	10.19	1.66	>0.05	11.95	1.83	>0.05
PPSF	22.86	2.26		9.19	2.06		11.10	1.73		13.00	1.64	

Discussion

Open pedicle screw fixation is an established procedure for stabilization of thoracolumbar spinal fractures. Percutaneous method has been developed to minimize the complications associated with open procedures such as postoperative infection, blood loss and longer hospital stay.[13] However, whether adequate stabilization can be achieved by percutaneous method has always been in question. In a study done by Wang et al, significant difference in postoperative VAS and ODI scores were seen between open and percutaneous procedure favouring percutaneous procedure. The study also showed significant difference in improvement of AVBH and Cobbs angle between the two procedures.[13] Significant difference in postoperative Cobbs angle was found in a study done by Kocis et al.[14]

A similar study was conducted by Kumar et al which compared OPSF and PPSF surgical techniques for thoracolumbar burst fractures. Both

methods yielded similar outcomes in terms of radiographic parameters, pain reduction, and neurological improvement.[15]Diniz published a meta-analysis of the articles, compared the use and non-use of fusion in association with internal fixation for the treatment of thoracolumbar burst fractures. The data reviewed in this study suggest that the use of fusion did not improve clinical outcomes and did not promote significant improvement in radiological parameters.[16]

The primary goal of treatment of the thoracolumbar fracture is protecting from the further neural damage and obtaining stability by reconstructing alignment of spinal columns so that early rehabilitation can be done. However, it has been ongoing controversy in determining treatment methods till now.[17] The use of pedicle screws to achieve stability, as well as to restrict movements in all planes, has increased in recent years and is safe and effective for this type of pathology.[18]

Conclusion

From this study, it is concluded that percutaneous technique of pedicle screw fixation for stabilization of thoracolumbar fractures provides comparable clinical and radiological outcomes at short term follow-up. Hence, percutaneous pedicle screw fixation has similar clinical and radiological outcome as open pedicle screw fixation for thoracolumbar spinal fractures and can be used whenever surgical expertise and resources are available. However, studies with large number of participants and long-term follow-up is warranted.

Conflict of Interest

The author declares no conflict of interest.

Financial Disclosure

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