Comparison of Surgical Outcomes Following Percutaneous Pedicle Screw Fixation and Traditional Open Pedicle Screw Fixation for Thoracolumbar Fractures Without Neurological Deficit

Kumar Paudel,[1] Somraj Lamichhane,[2] Rajiv Jha[1]

[1]National Neurosurgical Referral Center, Bir Hospital, Kathmandu, Nepal, [2]National Trauma Center, Kathmandu, Nepal.

ABSTRACT

Background: Traumatic thoracolumbar fractures are frequently encountered in blunt trauma patients. The Open pedicle screw fixation has been proven to be effective in stabilizing fractures, deformity correction, early mobilization and improving long term quality of life of patients with thoracolumbar fracture. Percutaneous pedicle screw fixation is a minimally invasive approach that minimizes the tissue injury, enhances early recovery and facilitates rehabilitation program.

Objectives: To compare the surgical outcomes of percutaneous versus open pedicle screw fixation for thoracolumbar fractures without neurological deficit. Single center, Prospective, Comparative study

Methods: A total of 34 patients with thoracolumbar fractures with intact neurology were treated with either percutaneous or open pedicle screw fixation between February 1st 2023 to March 1st 2024 at the National trauma center , Kathmandu. There were 17 patients in each group. The perioperative clinical and radiological parameters were collected using a preformed pro forma. Postoperatively follow-up was conducted at post op day 1, during discharge and 3 months. The clinical and radiological outcomes of percutaneous and open pedicle screw fixation were analyzed and compared.

Results: This study included 24(70.6%) males and 10(29.4%) females. The mean age was 40.73 ±15.44 years. There was a statistically significant difference between percutaneous and open pedicle screw with regard to intraoperative blood loss, fluoroscopy time, operative duration, deambulation day and overall hospital stay ($p<0.05$). Overall, there was a statistically significant improvement in overall pain perception at discharge and three month follow up in both groups. The kyphosis correction in percutaneous group was similar to open pedicle screw fixation technique (mean cobbs angle correction of 4.7 degree).

Conclusions: The percutaneous approach has several advantages over the open pedicle screw fixation with regard to less intraoperative blood loss, less postoperative pain, early deambulation, no was a statistically complications and shorter hospital stay

Keywords: Open pedicle screw; percutaneous pedicle screw fixation; thoracolumbar fracture.

INTRODUCTION

Thoracolumbar fracture accounts for 50% of all traumatic spinal fractures.[1] The incidence of traumatic spine fractures is increasing owing to the rise in high velocity injuries.[2] The thoracolumbar junction (T10-L2) is more vulnerable to fracture owing to the biomechanical stress and considerable motion involved in this region.[3]

Although some patients with thoracolumbar fracture without neurological deficit can achieve favorable clinical outcomes after conservative treatment, Pedicle screw fixation has been proven to be a more effective in stabilizing fractures, deformity correction, early mobilization and improving long term quality of life.[4]

The Open Pedicle screw internal fixation (OPSF) has been proven to be safe and effective in the treatment of thoracolumbar fractures, but detachment of paravertebral muscle, long-time tissue traction are likely to injure the muscles and posterior branch of spinal nerves.[5] The integrity of dorsal musculoligamentous

Correspondence: Dr Kumar Paudel, National Academy of Medical Sciences, Bir Hospital, Kathmandu, Nepal. Email: kumarpaudel01@gmail.com.

complex is equally important to prevent postoperative deformity.[6] Percutaneous pedicle screw fixation (PPSF) is a minimally invasive approach that minimizes tissue injury, enhances early recovery and facilitates rehabilitation program.[7] However, it's use is still limited owing owing to the steep learning curve, procedural cost and uncertainty of posterolateral fusion.[8] This study aimed to compare were to compare the outcomes of thoracolumbar fracture without neurological deficit treated with either percutaneous or conventional open pedicle screw fixation in Nepalese settings.

METHODS

All Patients with a traumatic thoracolumbar fracture with intact neurology treated at National Trauma Center, Bir Hospital between February 1st 2023 to March 1st 2024 were eligible for this study.

A total of 17 patients were required in each group to observe the significant mean difference. The patients were given both options of open or percutaneous pedicle screw fixation. The purposive sampling method was utilized with an allocation of consecutive patient to either of the treatment arm.

The inclusion criteria were: Age group (16-70) years, Injury sustained within two weeks, Dorsal or Lumbar vertebrae involvement, Type A spinal fracture in AO classification, Intact neurology.

Patient with concomitant other organ injury, pathological and osteoporotic fractures and who needs spinal decompressive surgery were excluded.

All the patients in this study underwent a thin slice computed tomography (CT) scan preoperatively for evaluation of fracture morphology, pedicle size, vertebral body height, and Cobb's angle/kyphotic angle as shown in Fig 1.

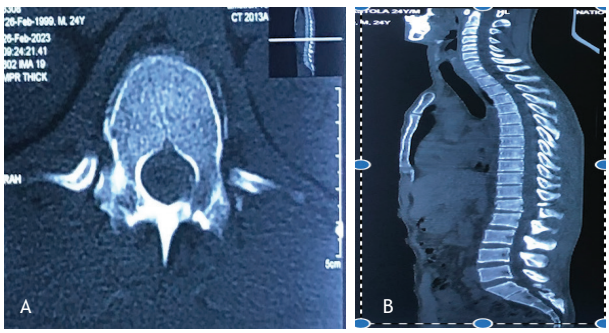

Figure 1. Preoperative CT scan of thoracolumbar compression fracture a) Axial and b) Sagittal image.

The degree of kyphosis (Cobb's angle) is an intersecting angle between the lines drawn perpendicular to the tangents through the superior endplate of cranial and inferior endplate of caudal vertebrae.

In the open pedicle screw fixation (OPSF) technique, the patient is positioned prone in Wilson frame and the fracture level is localized under C arm guidance. Under all aseptic precautions, the standard midline skin incision is given with exposure from the two levels above the index vertebra to two levels below it. The subperiosteal muscle dissection is done and reflected to expose the facet joint and transverse process. The entry points of respective pedicles are localized and K wire are placed. The trajectory is checked under C arm and the screw is inserted maintaining craniocaudal and mediolateral trajectory. The final screw position is checked by X-ray in AP and lateral views. The proper length of the rod is bent to maintain lordotic-kyphotic angle. The screws are connected to a rod and the nut is inserted. Layered closure of muscles, fascia and skin is done.

For percutaneous pedicle screw fixation, the patient is placed in prone position. After painting and draping, localization of fracture level is done under fluoroscopy. The 1.5 cm skin incision is made 4-5 cm lateral to midline at the level of facet. Under the C-arm guidance, the Jamshidi needle is inserted through the lateral aspect of the pedicle and advanced slowly under fluoroscopy guidance into the vertebral bodies. This is followed by guide wire placement via needle. The fascial dilators are gradually placed through the guidewire. Pedicle is tapped to the junction between the pedicle and the vertebral body and the cannulated screw insertion is performed. All the screws have additional towers to guide rod insertion. Then, the rod is inserted through these towers and locked. Finally, the fascia is approximated with interrupted monofilament suture and the wound is stapled.

The following clinical and radiological parameters were recorded using a preformed pro forma: Pre and postoperative visual analog score (VAS) score at day 0, day 1, at discharge and 3 months follow up, pre and postoperative Cobb's angle, duration of surgery, radiation exposure, screw malposition, intraoperative blood loss, day of deambulation, postoperative wound complications. These variables were analyzed to evaluate between group differences in efficacy.

Statistical analyses were performed using SPSS 21.0 software (SPSS Inc., Chicago, IL). Categorical variables

were expressed as frequency (percentage). Continuous variables were expressed as Mean ± SD. The mean difference between different parameters among the two groups was calculated by using *Independent Sample t test*, while the intragroup mean difference was calculated with *the paired t-test*. P value <0.05 was considered statistically significant.

This study was approved by the Institutional Review Board (IRB) of the National Academy of Medical Sciences. All the participants have signed informed consent before enrollment.

RESULTS

A total of 34 cases of thoracolumbar fractures with intact neurology underwent pedicle screw fixation. The mean age was 40.73 ± 15.44 years. The male: female ratio was 2.4:1. The commonest mechanism of injury was fall injury. In addition, the most common site of fractures was L1. There were 10 cases of multiple vertebral body fractures. The mean duration from injury to hospital admission was 72 hours.

The baseline demographics of open and percutaneous pedicle screw fixation groups were similar as shown in Table 1.

Table 1.Baseline characteristics.

BASELINE CHARACTERISTICS			
MODE OF INJURY	**PERCUTANEOUS**	**OPEN**	**TOTAL**
FALL FROM BUILDING	2	2	4
FALL FROM STAIRS	0	1	1
FALL FROM TREE	3	3	6
ROAD TRFFIC ACCIDENT	4	1	5
SLIPPED FROM STANDING HEIGHT	1	1	2
FALL FROM HEIGHT / CLIFF	7	9	16
GENDER			
MALE	12	12	24
FEMALE	5	5	10
LEVEL OF INJURY			
D9	0	1	1
D10	1	1	2
D11	3	2	5
D12	3	4	7
L1	7	4	11
L2	4	2	6
L3	1	2	3
L4	1	1	2
L5	0	0	0
MULTIPLE LEVEL FRACTURE	5	5	10
MEAN DURATION FROM INJURY(DAYS)	3.1	2.9	
COMORBIDITY	N/A	N/A	

The mean difference between different parameters among the two groups was calculated by using *Independent Sample t-test* as shown in Table 2. Intra-operative duration for OPSF and PPSF was 192.8 ± 58.1 min and 109.2 ± 41.1 min respectively (p <0.001). The Intraoperative blood loss in OPSF and PPSF was 229.4 ± 88.5 mL and 56.5±31.2 mL respectively (p <0.001). The intraoperative fluoroscopy time was 1.5±0.94 sec in PPSF, while it was 0.71±0.69 secs in OPSF group (p < 0.008). The day of de-ambulation in the OPSF group was 5.8± 3.9 days and 3.6± 1.4 days in the PPSF group (p = 0.036). The mean duration of hospital stay in PPSF and OPSF was 6.8± 2.9 and 10.8± 4.1days respectively(p<0.003).

Table 2. Mean difference in different parameters between two groups.

Parameter	Percutaneous pedicle screw Fixation (PPSF)	Open Pedicle Screw Fixation (OPSF)	Mean difference	P value
Blood Loss (ml)	56.5±31.2	229.4 ± 88.5	172.94	<0.001
Duration (min)	109.2 ± 41.1	192.8 ± 58.1	83.58	<0.001
Hospital Stay (days)	6.8± 2.9	10.8± 4.1	4.1	0.003
De-ambulation day	3.6± 1.4	5.8± 3.9	2.26	0.036
Fluoroscopy time (second)	1.5±0.94	0.71±0.69	0.84	0.008

The pre and post operative degree of kyphosis (Cobb's angle) in the percutaneous pedicle screw fixation group (PPSF) was 17.4±6.4 and 12.7 ±8.1 with a mean difference of 4.7 (p=0.11) as shown in Table 3.

Table 3. Comparison of Cobb's angle before and after operation in PPSF group.			
Cobb's Angle Preoperative	**Cobb's Angle Postoperative**	**Mean difference**	**P value**
17.4±6.4	12.7 ±8.1	4.7	0.11

Interpretation: *The results showed the Cobb's angle decreased by 4.7 from preoperative to post operative but it was found to be statistically insignificant (p=0.11).*

The pre and post-operative degree of kyphosis (Cobb's angle) in percutaneous pedicle screw fixation group was 21.1±7.5 and 16.4 ±7.2 with a mean difference of 4.8 respectively in the OPSF group (p=0.113) as illustrated in Table 4.

Table 4.Comparison of Cobb's angle before and after operation in OPSF group.			
Cobb's Angle Preoperative	**Cobb's Angle Postoperative**	**Mean difference**	**P value**
21.1±7.5	16.4 ±7.2	4.8	0.113

Interpretation: *The results showed that the Cobb's angle decreased by 4.8 from preoperative to post operative but it was found to be statistically insignificant(p=0.113).*

Three patients in open pedicle screw fixation developed wound dehiscence and resuturing was done. There was no surgical site infection in either group. Screw pullout was noticed in one patient who underwent percutaneous screw fixation. Two patients in the PPSF group complained of radicular pain on 3 month follow up which was managed conservatively.

The Visual analog scale score (VAS) was used to assess the pain preoperatively, on postoperative day1, during discharge and on 3 month follow up. The mean difference in VAS score at different time periods was calculated by using *Paired t-test*.

Table 5. Mean difference of VAS score in OPSF group in different time intervals.			
Day 1	**During Discharge**	Mean difference	P value
5.9±1.5	3.5±1.2	2.4	<0.001
During Discharge	**3 months**		
3.5±1.2	1.6±0.8	1.8	<0.001
Day 1	**3 months**		
5.9±1.5	1.6±0.8	4.2	<0.001

The results showed that there was a significant decrease decrease in VAS score VAS score from Day 1 to Discharge(p<0.001) which was maintained in 3 month follow up (p<0.001). The mean decrease in pain as measured by VAS scale score was by 4.2 at end of 3 month.

Table 6.Mean difference of VAS score in PPSF group in different time intervals.			
Day 1	**During Discharge**	Mean difference	P value
5.1±1.2	2.6±0.7	2.5	<0.001
During Discharge	**3 months**		
2.6±0.7	1.1±0.2	1.5	<0.001
Day 1	**3 months**		
5.1±1.2	1.1±0.2	4	<0.001

The results showed that there was a significant decrease of the VAS score of 2.5 from Day 1 to Discharge(p<0.001) which was maintained in 3 month follow up (p<0.001).

The results showed though both groups had a significant decrease in pain intensity at discharge the mean decrease in pain was more in a percutaneous group. However, there was no significant difference in the mean decrease in pain intensity between the two groups at the end of 3 months.

DISCUSSION

Open pedicle screw fixation is a traditional method with proven efficacy in the management of thoracolumbar fractures. Percutaneous methods of pedicle screw fixation under fluoroscope or O arm navigation are evolving to minimize the negative consequences of open instrumentation including greater blood loss, prolonged operation time, postoperative pain and longer hospital stay.[9] There are only a few studies that have compared the efficacy of these two techniques. In this prospective 3-month follow-up study, we have closely observed the demographic profile, clinical and radiological parameters of patients managed with open and percutaneous pedicle screw fixation.

There was male predominance in this study with a male-to-female ratio of 2.4:1. Motor vehicle accident-related injuries were more frequent in male patient while the mode of injury in females was falling from significant height. mean age of the patient was 40.73 ± 15.44. On gender-wise analysis mean age of male patient was 40.05 ± 14.31 while of female patients was 42.18± 18.04. The patients demographic profile in our study was similar to the findings of a previous study by Bajracharya et al.[10] This highlights the fact that the working age group population are more vulnerable to spinal trauma.

In this study, the most common cause of spine vertebral fracture was a fall from height followed by a road traffic accident. Similarly, Bajracharya et al in their retrospective review noted that 39% of spinal injuries in eastern Nepal were due to the fall from height.[10] Philipp et al conducted an epidemiological study of traumatic spine fracture which showed fall related injury in 39% followed by traffic accidents (26.5%)).[11] Similarly, the most common reason of spinal trauma in patients with thoracolumbar fracture was a fall from height (35%) followed by motor vehicle accidents (27%) and ground level fall (16%) in a prospective study by Reinhold et al.[12] Multiple vertebral fractures was presents in patient of motor vehicle accidents who fell from significant height while trivial injury like fall from standing height were associated with single level fracture. The most common site of fracture was L1(32.3%) followed by D12(20.5%) and L2(17.6%).

In this study percutaneous pedicle screw fixation techniques were found to be superior to open pedicle screw fixation in terms of reduction in intraoperative blood loss, operative duration and postoperative pain. The day of ambulation in the PPSF group was 2.6 days earlier than the OPSF group (P<0.03). The results of our study are consistent with the findings of several other studies.[13, 14] The intraoperative radiation exposure time was significantly high in a percutaneous group (1.5 min vs 0.71 min) owing to frequent x-ray exposure to guide the screw advancement in the pedicle.

In our study both PPSF and OPSF group had a significant reduction of Visual Analog Scale Score at immediate post op day, discharge and 3 month follow up(p<0.001). However, the mean VAS score at discharge and 3 month follow up was 2.6±0.7, 5±1.2 1 and 1.1±0.2, 1.6±0.8 in PPSF and OPSF respectively. The decreased postoperative pain encourages earlier mobilization and shorter overall hospital stay. It shows superior clinical outcomes in PPSF compared to OPSF group. Fan et al also stated that percutaneous approaches could avoid unnecessary paraspinal muscle injuries to drastically reduce postoperative back pain.[15]

Radiographically, the mean sagittal cobbs angle correction was 4.8 degrees in OPSF and 4.7 degrees in PPSF. However, there is no significant intergroup difference in kyphosis correction. Similarly, in a study by Kocis et al the cobbs angle improved by 4.5 degrees in PPSF and 3.8 degrees in OPSF.[14]

This is a single-center performed over a year. The number of patients included was small with a short-term follow-up of 3 months. Thus, future multicenter randomized controlled trials with large participants and longer follow-up are warranted.

CONCLUSIONS

In a type A spinal fracture with intact neurology, the percutaneous pedicle screw fixation is a promising method for spinal stabilization. The Percutaneous approach provided several advantages over the open pedicle screw fixation with regard to less intraoperative blood loss, improved postoperative perception of pain, no wound-related complications, early deambulation and shorter hospital stay. Percutaneous pedicle screw fixation is a safe and efficacious alternative to open pedicle screw fixation in thoracolumbar fractures.

CONFLICT OF INTEREST

There are no conflicts of interest.

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