

# THE ACCURACY OF THE PEDICLE SCREW FIXATION BY CONVENTIONAL AND COMPUTER NAVIGATION TECHNIQUE IN TRAUMATIC THORACOLUMBAR SPINE FRACTURE

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## Abstract

The goal of the treatment of the unstable thoracolumbar injuries is optimizing neural decompression while providing stable internal fixation over the least number of spinal segments. Either anterior, posterior or both approaches is less extensive. Pedicle screw device allows immediate stable fixation as the screw traverse all the three columns. Screw passed one level above and one level below the fractured vertebra via posterior approach. All the patients were initially assessed in the outpatient department or casualty according to their presentation and then they underwent a detailed evaluation of their hemodynamic, spine, neurological status and other injuries if associated with trauma. The patients and their attendant were interviewed, their epidemiological, historical, subjective and physical findings were noted. In this study Mean value for total hospital stay was 29.23 days in conventional method and 28.38 days in navigation method. In our study we had 2(15.39%) patients with malplacement of pedicle screw with lateral and medial pedicle cortex breach and 01 (7.69%) patient with wound infection, were noted in conventional method and had 01(7.69%) patients with malplacement of pedicle screw with lateral pedicle cortex breach and 01 patient with wound infection, were noted in navigation method. No neurologic complications were noted in the patient with misplacement of screws.

**Keywords:**pedicle screw fixation, computer navigation technique, traumatic thoracolumbar spine fracture

## Introduction

The thoracolumbar injuries are the most common spinal injuries occur due to fall from height, road traffic accident and sports injuries. Spine injuries are reported to occur in approximately 6% of trauma patient. The treatment of unstable fractures and fracture dislocation of thoracolumbar spine remains controversial. The goal of the treatment of the unstable thoracolumbar injuries is optimizing neural decompression while providing stable internal fixation over the least number of spinal segments<sup>[1]</sup>. Either anterior, posterior or both approaches is less extensive. Pedicle screw device allows immediate stable fixation as the screw traverse all the three columns. Screw passed one level above and one level below the fractured vertebra via posterior approach. The pedicle screw fixation has been commonly used for spinal stabilization in spine surgery. The biomechanical advantage of transpedicular screw fixation for spinal fracture include three-column control of vertebsegments and fixation of vertebral segment in the absence of posterior elements. Biomechanically, it is better than the hook-rod system and allows more corrective force application on the spinal column. Incorrect placement of pedicle screw may adversely affect the reduction of spinal fracture, which in turn can lead to neurovascular injury, so the position of pedicle screws is critical in fixation of thoracolumbar and other spine fracture<sup>[2]</sup>.The advent of high speed computer and computed tomography (CT) has revolutionized medical imaging in preventing postoperative complication, and allow spine surgeon to perform CT based image guided surgery. The image guided system has appeared to improve the surgical accuracy and safety of pedicle screw placement. Radiographic image and postoperative computed tomography scan were reviewed to evaluate the accuracy of pedicle screw placement with CT assisted navigation in thoracolumbar spine fractures. Since the introduction of spinal pre-operative CT based navigation by NOLT in year 1995. A preoperative axial CT scan is performed a few week ago before the surgery using with 2mm thick film. Usually before the surgery surgeon plan the screw path on the navigation unit to accommodate for an entry point, screw trajectory, screw size, screw alignment. The computer navigation system improves the accuracy of pedicle screw fixation. It has the disadvantage of requiring a lengthy registration process and increasing operative time. It has the advantage of

adequately imagine the bone, showing 3D anatomy and preoperative planning<sup>[3, 4]</sup>.

## Methodology

Total 26 cases of fracture thoracolumbar spine were evaluated and managed during the study period 13 cases under conventional method and 13 cases under navigation method.

All the patients were initially assessed in the outpatient department or casualty according to their presentation and then they underwent a detailed evaluation of their hemodynamic, spine, neurological status and other injuries if associated with trauma. The patients and their attendant were interviewed, their epidemiological, historical, subjective and physical findings were noted. After initial investigations and haemodynamic stabilization, patients were assessed neurologically in detail. A neurological chart was maintained for each patient.

All the patients had routine X-rays of thoracolumbar spine in both Anteroposterior and Lateral views. In all the patients MRI spine and 3D CT of spine with 2mm thick film uploaded in navigation machine which gives 3D image of the vertebrae. After registration in navigation machine, the pedicle screw trajectory, size and length planned and placed in the center of the pedicle.

The pre-operative neurological status was graded on the basis of ASIA grading. It was also used to assess post-operative recovery and follow-up.

The indication for the surgery was spinal instability for which instrumentation was needed to restore spinal stability and to protect neurological elements.

## Inclusion criteria

1. Age group >18yrs.
2. Traumatic thoracolumbar unstable fractures with neurological deficits.

## Exclusion criteria

1. Age < 18 yrs.
2. Traumatic cervical spine fractures and sacral spinal fracture.
3. Spinal instability due to congenital spinal abnormality.
4. Patients not willing for surgery.
5. Medically unfit for surgery.
6. Pathological fracture.
7. Traumatic thoracolumbar unstable fractures treated with method other than pedicle screw fixation.

## Results

**Table 1:** Duration of injury to admission

Duration of injury to admission	Conventional Method		Navigation Method	
	No. of Cases	Percent	No. of Cases	Percent
< 72 Hours	07	53.84%	07	53.84%
> 72 Hours	06	46.15%	06	46.15%
Total	13	100%	13	100%

**Table 2:** Duration of injury to surgery

Duration of injury to surgery	Conventional method		Navigation method	
	No. of Cases	Percent	No. of Cases	Percent
<10 Days	01	7.69%	02	15.39%
> 11 Days	12	92.31%	11	84.61%
Total	13	100%	13	100%

**Table 3:** Total stay in hospital

Total stay in hospital	Conventional method		Navigation method	
	No. of Cases	Percent	No. of Cases	Percent
<20 days	01	7.69%	03	23.07%
>21 days	12	92.31%	10	76.92%

Total	13	100%	13	100%
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**Table 4:** Mean kyphotic angle

Mean kyphotic angle	Conventional method	Navigation method
Pre-OP	22.38°	19.86°
Post-OP	6.3°	4.8°

**Table 5:** Complication

Complication	Conventional method		Navigation method	
	No.of Cases	Percent	No.ofCases	Percent
Pressure sore	01	7.69%	00	00%
Infection	01	7.69%	02	15.39%
Malpositioning of screw	02	15.39%	01	7.69%
Total	04	15.3%	03	11.5%

**Table 6:** MalPlacement of Screw (Gertzbein classification)

Grade	Conventional method		Navigation method	
	No. of Cases	Percent	No. of Cases	Percent
Grade 0	11	84.61%	12	92.31%
Grade 1	01	7.69%	01	7.69%
Grade 2	01	7.69%	00	0%
Grade 3	00	0%	00	0
Total	13	100%	13	100%

**Table 7:** MalPlacement of Screw (Heart Classification)

Grade	Conventional method		Navigation Method	
	No. of Cases	Percent	No. of Cases	Percent
Grade 1	11	(84.61%)	12	92.31%
Grade 2	01	(7.69%)	01	7.69%
Grade 3	00	(0%)	00	0%
Grade 4	01	(7.69%)	00	0%
Grade 5	00	(0%)	00	0%
Total	13	(100%)	13	100%

**Table 8:** Functional Outcome (Denis Work Scale)

Denis work Scale	Conventional Method					Navigation Method						
	No. of Cases	PREOP (%)	4 <sup>th</sup> wk post OP (%)	6 <sup>th</sup> mth post OP(%)	post	No. of Cases	PREOP (%)	4 <sup>th</sup> wk post OP (%)	6 <sup>th</sup> mth post OP (%)	post		
W 1	00	(0%)	00	(0%)	01	(7.69%)	0	(0%)	0	(0%)	02	(15.39%)
W 2	00	(0%)	03	(23.07%)	03	(23.07%)	00	(0%)	02	(15.39%)	02	(15.39%)
W 3	00	(0%)	04	(30.74%)	04	(30.74%)	00	(0%)	07	(53.84%)	08	(62.53%)
W 4	00	(0%)	05	(38.46%)	02	(15.39%)	00	(0%)	03	(23.07%)	01	(7.69%)
W 5	13	(100%)	01	(7.69%)	03	(23.07%)	13	(100%)	01	(7.69%)	00	(0%)
Total	13	(100%)	13	(100%)	13	(100%)	13	(100%)	13	(100%)	13	(100%)

**Table 9:** Functional Outcome (Denis Pain Scale)

Denis Pain Scale	Conventional Method			Navigation Method		
	PREOP (%)	4 <sup>th</sup> wk post OP (%)	6 <sup>th</sup> month post OP (%)	PREOP (%)	4 <sup>th</sup> wk post OP (%)	6 <sup>th</sup> month post OP (%)
P 1	00 (0%)	02 (15.39%)	03 (23.07%)	00 (0%)	03 (23.07%)	07 (53.84%)
P 2	00 (0%)	05 (38.46%)	07 (53.84%)	00 (0%)	07 (53.84%)	05 (38.46%)
P 3	00 (0%)	05 (38.46%)	03 (23.07%)	00 (0%)	03 (23.07%)	01 (7.69%)
P 4	13 (10%)	01 (7.69%)	00 (0%)	00 (0%)	00 (0%)	00 (0%)
P 5	00 (0%)	0 (0%)	00 (0%)	13 (100%)	00 (0%)	00 (0%)
Total	13 (100%)	13 (100%)	13 (100%)	13 (100%)	13 (100%)	13 (100%)

### Discussion

In this series the mean kyphotic angle was 22.38° on admission, 6.4° post operatively in conventional method whereas 19.86° on admission, 4.8° post operatively in navigation method. Nasser M.G *et al.*, noted the kyphotic angle was 23.6° on admission, 7° post-operatively. Gregory F. Alvine *et al.*, noted that sagittal plane angulation was 12° pre operatively, 1° post operatively. Rick C. Sasso *et al.* noted that the kyphotic angle was 17.6° pre operatively, 3.5° post operatively. Razak M. *et al.* noted that the average kyphotic angle was 20° pre operatively, 7° post operatively<sup>[5-7]</sup>.

In this study the duration from injury to surgery was a mean of 17.24 days in conventional method and 14.38 days in navigation method. Mean value for total hospital stay was 29.23 days in conventional method and 28.38 days in navigation method. Rick C. Sasso *et al.*, noted in their study that average time interval between time of injury to time of surgery was 4 days and mean hospital stay was 16 days. Razak M *et al.*, noted that average time duration to surgery was 5.6 days and average hospital stay was 24 days<sup>[8]</sup>.

In our study we had 84.61% patients with accurately placed pedicle screw with no lateral and medial pedicle cortex breach, were noted in conventional method and had 92.31% patients with accurately placed pedicle screw with no lateral or medial pedicle cortex breach and, were noted in navigation method. Carbone *et al.*, (conventional method), in their study noted that there was 86.5% patients with accurately placed pedicle screw. Razak M *et al.*, in their study noted that there was 88 patients with accurately placed pedicle screw<sup>[9]</sup>.

In our study we had 2(15.39%) patients with malplacement of pedicle screw with lateral and medial pedicle cortex breach and 01 (7.69%) patient with wound infection, were noted in conventional method and had 01(7.69%) patients with malplacement of pedicle screw with lateral pedicle cortex breach and 01 patient with wound infection, were noted in navigation method. No neurologic complications were noted in the patient with misplacement of screws. Khan. I *et al.*, in their study noted that there was 1 patient with superficial wound infection. Razak M *et al.*, noted 3 misplaced pedicle screws<sup>[10]</sup>.

### Conclusion

- The accuracy of pedicle screw placement is critical for thoracolumbar spine fracture fixation and reduction.
- Computer navigation method exhibit higher accuracy in pedicle screw placement and reduce pedicle perforation rate as compared to conventional method.
- Computer navigation method require less revision surgeries with reduced radiation exposure to patient doctor and OT staff than conventional method.
- Computer navigation method having slight more operating time than conventional method.

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