Comparative study between short segment fixation with and without pedicle screw at the fracture level for thorocolumbar fracture

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Abstract— *The most common fractures of the spine occur in the thoracic (mid back) and lumbar spine (lower back) or at the junction of the two (thoracolumbar junction). These fractures are managed surgically. This study was conducted on 50 thoracolumber fracture cases to find out better management modality among open short segment injury level pedicle screw fixation and conventional open short segment pedicle screw fixation. Inference was made with un paried't' test and chi square test. It was observed that average Surgical blood loss and post op drain in open short segment injury level pedicle screw fixation and conventional open short segment pedicle screw fixation is almost similar with insignificant difference ($p>0.05$) only and average surgical time was significantly more in open short segment injury level pedicle screw fixation and conventional. It was observed that the results of open short segment injury level pedicle screw fixation shows significantly better correction of saggital cobb's angle ($p<0.001$). There was no significant difference in other corrections like fractured vertebral body (°) angle, anterior vertebral body height and Posterior vertebral body height. Final outcome after one year follow up as per Modified MacNab criteria was without significant difference in both the groups. In patients treated with open short segment Injury level pedicle screw fixation had developed more infection rate (16%) but lesser or no Hardware failure (0%) in compare to conventional short segment pedicle screw fixation where infection rate is (12%) and hardware failure problem (12%). Hardware failure was significantly less in open short segment Injury level pedicle screw fixation than conventional one. So it can be concluded that open short segment injury level pedicle screw fixation is better than conventional open short segment pedicle screw fixation*

Keywords: Thoracolumbar Fractures, Open Short Segment Injury Level Pedicle Screw Fixation, Conventional Open Short Segment Pedicle Screw Fixation.

I. INTRODUCTION

Spinal fracture is a serious injury. The most common fractures of the spine occur in the thoracic (mid back) and lumbar spine (lower back) or at the junction of the two (thoracolumbar junction). These fractures are typically caused by high-velocity accidents, such as a car crash or fall from height.

The primary treatment of thoracolumbar injures is surgical reduction, decompression and stabilization. Advantage of an operative procedure for treating these injuries is the immediate stabilization of injured spine and an indirect or direct decompression of neural structure. Operative stabilization enables early mobilization without heavy and uncomfortable cast and shortens the hospital stay.

Metallic internal fixation device were first introduced in 1956 Harrington Fusion system introduce laminar hooks and rod for rigid spine fusion but hooks could pullout and cause loss of correction.[1]

Luque's ring and laminar wire were also part of spine instrumentation.[7]Boucher in 1959 has been credited being first to use pedicle screw but it was Roy-Camille in late 1970 was first to use screw and connected them with rod and plate.[2,3]

Steeffi et al. develop the variable screw-placement (VSP) plate, which permitted pedicle screws to be placed according to individual patient anatomy.[4]

The primary goals of treatment for thoracic & lumbar spine fractures include protecting the neural elements and preventing deformity and instability. Surgery often facilitates achieving these goals and often hastens the patient's rehabilitation. Surgery is particularly often beneficial in patients with multiple traumatic injuries. The ultimate decision to operate is based on many factors. Surgical management should be strongly considered when neurologic deficit or significant deformity or instability is present.[5]

As pedicle screw instrumentation was introduced and popularized, the instrumented levels mimicked the historically used hook-and-rod constructs, incorporating two or three levels above and below the level of injury, which came to be called long-segment posterior instrumentation (LSPI).[2]

The biomechanical advantages of pedicle screw instrumentation over hook-and-rod or wiring constructs led to shortening of construct lengths from two or three levels above and below the fractured segment to one level above and below the fractured segment, the latter coming to be known as short-segment posterior instrumentation (SSPI).

Short-segment instrumentation initially involved placing pedicle screws in the vertebra immediately above and below the level of injury, creating a four-screw construct connected by rods spanning, but not directly incorporating, the injured level.[6]

Early clinical reports, however, showed a relatively high rate of instrumentation failure and progressive sagittal plane deformity with short-segment instrumentation.[21] Failure of SSPI reported due to breaking of the screws, vertebral factors (i.e. primary osseous collapse or secondary to osteoporosis), or a combination of both. Other possible factors include inadequate fixation points on the vertebrae and insufficient anterior column support.[6,7]

But recent studies clinically confirmed the increased stability provided by short segment injury level fixation in maintenance of kyphosis correction. This theoretically provides additional stiffness to the construct, thereby reducing the incidence of instrumentation failure, screw pullout, and progressive deformity.[2,4]

So this study was conducted to compare Open Short Segment Injury level Pedicle Screw Fixation with conventional method in management of thoracolumbar fracture patients to find out the better method.

II. METHODOLOGY

This randomized control intervention study was conducted from June 2016 to October 2017 at Department of Orthopedics, S.M.S. Hospital attached to S.M.S. Medical College, Jaipur (Rajasthan) to compare and find out the better method in management of thoracolumber injuries.

This study was conducted on 50 cases of thoracolumber injuries, out of that 25 randomly though chit box method cases were selected for short segment injury level fixation and another 25 cases for conventional method.

For selection of cases more than 18 years aged cases admitted through hospital with unstable dorsolumbar spinal fractures in each group, duration of injury less than 7 days, closed Thoraco-lumbar vertebral (D11-L4) fracture with intact at least one Pedicle of fractured vertebrae determined by radiograph, AO spine TLICS classification TypeA1,A2,A3,A4,B1, neurological injury as ASIA grade D and E only with normal general condition were included in the study. Out of that associated injury cases were excluded from the study. Patients unfit in anesthetic check up and not willing to take part in this study were also excluded from study.

All these patients were managed after complete explanation of treatment plan to patient and written consent by the conventional open short segment pedicle screw fixation or by open short segment injury level pedicle screw fixation technique. All cases were followed up for a minimum period of 1 year. Detailed history was elicited in all cases regarding mode of injury, date and time of injury, associated injuries along with previous treatment history was taken. A detailed examination was carried out with regard to general condition of the patient and any systemic disorder. Local examination included the presence of any visible deformity over back; local tenderness over the back was noted. Whole of the spine was examined for deformity and tenderness to prevent detection of missed injuries. Detailed neurological examination including tone, bulk, power at different joints, coordination, any abnormal movements, superficial and deep tendon reflexes, sensory deficit, bowel and bladder involvement was noted. Perianal sensation and bulbocavernosus reflex was tested in all patients to differentiate between complete and incomplete cord lesion. After thorough neurological examination patients were categorized according to ASIA score/grading. All the patients were routinely investigated to determine fitness to anesthesia. Radiological examination was also done of each study case having a good quality radiographs with anterior posterior and lateral views of injures spine were done to evaluate and classify dorsolumbar injuries. The lateral X-ray was used to measure sagittal Cobb's kyphosis angle and anterior vertebral body height. MRI scan was done to evaluate extent of canal compromise from retro pulsed fragment, assess degree of communication of vertebral body, status of the cord and posterior ligament complex. CT scan was done to make assess the status of presence of both intact pedicle of fractured vertebrae.[8]

Patients were operated as soon as the general condition of the patient permitted as decided previously with the type of implant i.e. Open Short Segment Injury level Pedicle Screw Fixation or conventional.

Post operative i.v. antibiotics were given for 5 days. First wound inspection done on 3rd postoperative day and looked for any discharges, blister, gaping. Drain removed on 3rd postoperative day followed by check X-ray. On 12thpost-operative day stitches removed and patients were called for follow-up after giving certain advises. Patient followed up every month for first six month and at every follow up the relevant information recorded on the Performa. Final results were assessed after a minimum follow up of 1 year like pain score, fractured anterior vertebral body height, fractured vertebrae posterior body height, angle of kyphosis /saggital cobb's angle, Fractured vertebral body angle, Range of motion after fixation etc with complications if any.

The final outcome was measured using Modified MacNab criteria[9]

Excellent	No pain ; No restriction of mobility return to normal work level of activity
Good	Occasional non-radicular pain relief of presenting symptoms; return to modified work
Fair	Some improved functional capacity ; still handicap and Unemployed
Poor	Continued objective symptom of root involvement, additional Operative intervention needed at the index level irrespective of Length of postoperative follow-up

Statistical analysis: Mean corrections in kyphosis and other variables in both methods were compared and inferred by unpaired 't' test and final grading of outcome was compared and inferred by chi-square test.

III. RESULTS

The study was performed on 50 cases in Department of Orthopaedics, S.M.S. Medical College, Jaipur from June. 2016 to Nov. 2017. These 50 eligible study subjects of thoracolumber injury cases were randomly divided into two groups, one for Open Short Segment Injury level Pedicle Screw Fixation and other one for conventional method group.

In this series, most common type was wedge compression fractures, accounting for 56% of the cases. Next common type is burst fracture 44%. Both groups were comparable as per type of fracture and ASIA grading (p>0.05). (Table 1)

Table 1
Characteristic comparison of both groups (N=50)

Variables		Open short segment injury level pedicle screw fixation (N=25)	Conventional Open Pedicle screw Fixation (N=25)
Type of fracture	Wedge compression fracture	16	12
	Burst fracture	9	13
	Flexion distraction injuries	0	0
	Fracture dislocation	0	0
	P Value LS	P = 0.393 **NS**	
ASIA's scoring	A	0	0
	B	0	0
	C	0	0
	D	3	5
	E	22	20
	P Value LS	P = 0.700 **NS**	

Average Surgical blood loss and post op drain in open short segment injury level pedicle screw fixation and conventional open short segment pedicle screw fixation is almost similar with insignificant difference (p>0.05) only and average surgical time was significantly more in open short segment injury level pedicle screw fixation and conventional. (Table 2)

Table 2
Surgical Characteristic comparison of both groups (N=50)

Variables	Open short segment injury level pedicle screw fixation (N=25)	Conventional Open Pedicle screw Fixation (N=25)	P value LS
Average surgical blood loss (ml)	170.80 ± 28.31ml	159.80 ± 35.13 ml	0.228 NS
Average post-op blood drain (ml)	134 ± 17.32 ml	130 ± 16.33 ml	0.404 NS
Average surgical time (mins)	129.7 ±13.5 mins	103.48 ± 12.25mins	0.001 **S**

When outcome was assessed and compared after one year it was found that the surgical results of both Conventional open short segment Pedicle screw fixation group & Open short segment injury level Pedicle screw fixation group are almost similar, except saggital cobb's angle where the results of open short segment injury level pedicle screw fixation shows significantly better correction of saggital cobb's angle (p<0.001). (Table 3)

Table 3
Comparison of surgical results of both groups on final follow up (N=50)

Variables		Open short segment injury level pedicle screw fixation (N=25)	Conventional Open Pedicle screw Fixation (N=25)	P value LS
Saggital cobb's angle(°)	**Pre-operative**	26.76±4.33	29.08±8.30	>0.05 NS
	Post-operative	11.40±2.41	16.92±6.08	<0.001 **S**
	Final Follow up (one Year)	13.60±2.63	21.28±6.12	<0.001 **S**
	Changes	13.16±3.47	7.80±4.60	<0.001 **S**
Fracture body angle(°)	**Pre-operative**	15.32±4.48	17.40±7.118	0.125 NS
	Post-operative	24.72±4.05	27.04±5.83	0.109 NS
	Final Follow up (one Year)	23.12±4.02	24.88±6.18	0.239 NS
	Changes	7.80±1.58	7.48±3.80	0.440 NS
Anterior vertebral body height (cms)	**Pre-operative**	1.62±0.28	1.70±0.31	0.350 NS
	Post-operative	2.45±0.31	2.57±0.27	0.162 NS
	Final Follow up (one Year)	2.24±0.29	2.26±0.28	0.842 NS
	Changes	0.62±0.16	0.52±0.23	0.231 NS
Posterior vertebral body height (cms)	**Pre-operative**	2.50±0.21	2.35±0.27	0.029 S
	Post-operative	2.82±0.14	2.70±0.12	0.260 NS
	Final Follow up (one Year)	2.70±0.14	2.63±0.21	0.150 NS
	Changes	0.22±0.16	0.28±0.17	0.230 NS

It was also found that correction rates of both Conventional open short segment Pedicle screw fixation group & Open short segment injury level Pedicle screw fixation group are almost similar, except saggital cobb's angle where the change in correction rate of open short segment injury level pedicle screw fixation shows significantly better correction of saggital cobb's angle than conventional method ($p<0.001$). (Table 4)

Table 4
Comparison of Correction rate of both groups on final follow up (N=50)

Variables	Open short segment injury level pedicle screw fixation (N=25)	Conventional Open Pedicle screw Fixation (N=25)	P value LS
Saggital cobb's angle(°)	48.78±8.26	26.26±10.10	<0.001 **S**
Fracture body angle(°)	59.31±27.70	47.55±27.47	0.140 NS
Anterior vertebral body height (cms)	39.90±13.31	34.70±18.37	0.260 NS
Posterior vertebral body height (cms)	9.08±7.52	12.42±9.40	0.170 NS

In final grading of outcome as per evaluation with **Modified MacNab criteria,** in the open short segment injury level pedicle screw fixation group,11 patient had excellent result 12 had Good result, & 2 had fair outcome. Whereas in conventional open short segment pedicle screw fixation group, 10 patients had excellent result 11 patients had good result & 4 had fair outcome. Final outcome after one year follow up as per Modified MacNab criteria was without significant difference in both the groups. (Table 5)

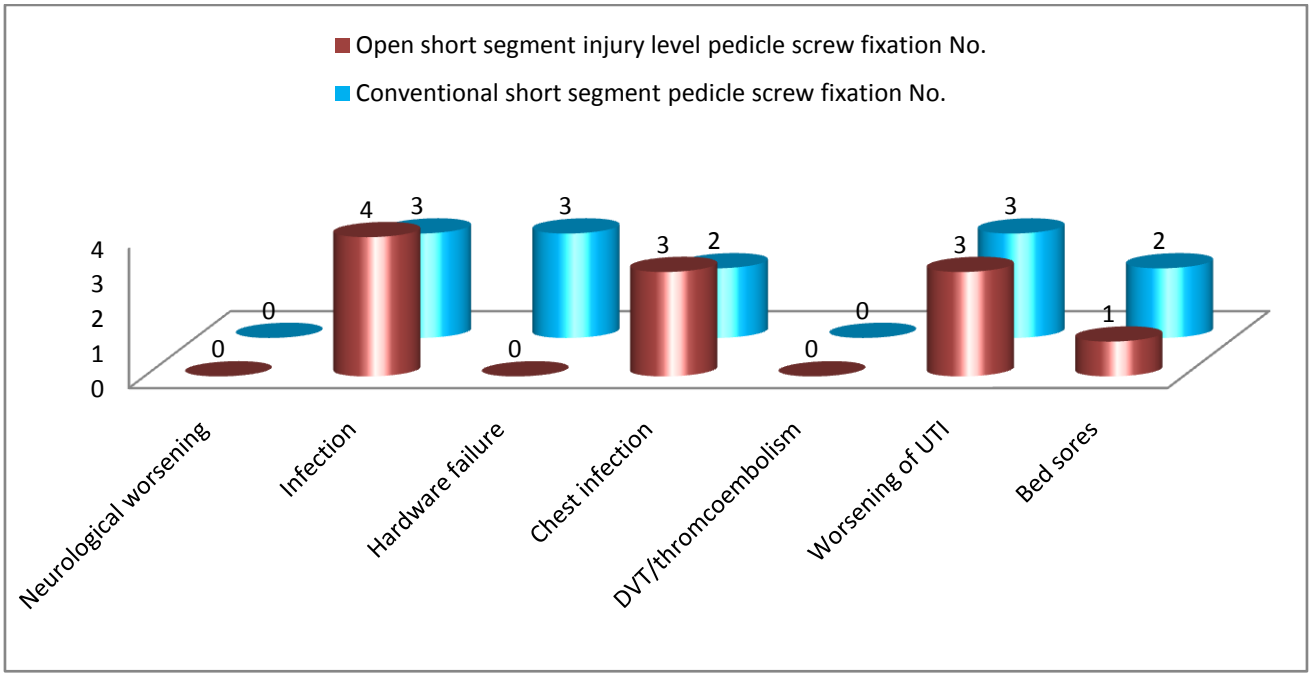
Table 5
Comparison of final outcome grading of both groups on final follow up (N=50)

Excellent	Open short segment injury level pedicle screw fixation (N=25)	Conventional Open Pedicle screw Fixation (N=25)
Excellent	11	10
Good	12	11
Poor/fair	2	4

Chi-square = 0.758 with 2 degrees of freedom; P = 0.685 LS=Not significant

In patients treated with open short segment Injury level pedicle screw fixation had developed more infection rate (16%) but lesser or no Hardware failure (0%) in compare to conventional short segment pedicle screw fixation where infection rate is (12%) and hardware failure problem (12%). Hardware failure was significantly less in open short segment Injury level pedicle screw fixation than conventional one. (Figure 1)

Figure 1
Comparison of Complications of both groups on final follow up (N=25 in each group)



Chi-square = 22.676 with 4 degrees of freedom; P<0.001 LS= **Significant**

IV. DISCUSSION

This present study found regarding Saggital cobb's angle that in open short segment Injury level pedicle screw fixation the average pre-operative Saggital cobb's angle was 26.76±4.33°, the immediate post-op 11.40±2.41° & at final follow-up the correction was 13.60±2.63°and correction rate is 48.77%. whereas in conventional open short segment pedicle screw fixation group the average pre-operative sagittal cobb's angle was 29.08±8.30, the immediate post-op 16.92±6.08& at final follow-up the correction was 21.28±6.12. The average correction was 7.80±4.60 and correction rate is 29.26%. Change in final follow up was with significant difference having significantly better correction in open short segment Injury level pedicle screw fixation than conventional one.

Farrokhi et al study (2010) conventional open short segment pedicle screw fixation group mean sagittal cobs angle pre operatively was 20± 13and at final follow up it is 19±10 average correction was–(minus) 29%. In open short same segment six pedicle screw fixation group mean preoperative sagittal cobb's

angle was 19±13. At final follow up it was 14±8 with correction was 6%. P value of both group preoperatively was insignificant (0.613) and at final follow up it was reported significant (0.008) and correction was significant (0.040).[11]

So open short segment Injury level pedicle screw fixation had better correction of sagittal cobb's angle than Conventional open short segment pedicle screw fixation group

Regarding Fractured vertebral body (°) angle in present stud it was observed that in open short segment Injury level pedicle screw fixation the average pre-op fractured vertebral body angle was 15.32±4.48 the, immediate post-op 24.72±4.05 & at final follow-up the correction was 23.12±4.02. The correction of 7.80±1.58 was achieved. Whereas in conventional pedicle screw the average pre-op fractured vertebral body angle was 17.40±7.11, the immediate post-op 27.04±5.83& at final follow-up the correction was 27.04±5.83. The correction of 7.48±3.80was achieved. It was without significant difference.

Anterior vertebral body height in this study in open short segment Injury level pedicle screw group the average pre-operative Anterior vertebral body height was 1.62 ± 0.28 cm, the immediate post-op 2.45 ± 0.31 cm & at final follow-up the average correction was 2.24 ± 0.29 cm. The average correction was 0.62 ± 0.16 cm and correction rate was 39.9%. Whereas in conventional short segment pedicle screw group the average pre-operative Anterior vertebral body height was 1.70 ± 0.31 cm, the immediate post-op 2.57 ± 0.27cms& at final follow-up the average correction was 2.26 ± 0.28cms.The average correction was 0.52 ± 0.23 cm correction rate was 34.7%. This difference was also found not significant.

Mahar et al. (2007) study shows mean anterior vertebral body height was 58% of normal before surgery. After surgery height was 89% of normal and at final followup, 78%.[11]

Posterior vertebral body height in this study in open short segment Injury level pedicle screw group the average pre-opPosterior vertebral body height was 2.50 ± 0.21 cm, the immediate post-op 2.82 ± 0.14 cm& at final follow-up the average correction was 2.70± 0.14 cm. The average correction was 0.22± 0.16 cm. Whereas in conventional short segment pedicle screw group the average pre-op posterior vertebral body height was 2.35 ± 0.27, the immediate post-op 2.70 ± 0.12cms & at final follow-up the average correction was 2.63±0.21 cm. The average correction was 0.28± 0.17 cm.

Limitation of motion in this study in open short segment injury level pedicle screw fixation group average limitation of motion is19.44±5.37 degree while in conventional open short segment pedicle screw fixation group it is 17.76±5.32 degree. With P value is 0.272 which is insignificant. Farrokhi et al study (2010**)** in convention group it was 19±14 degree and in inclusion group it was 14±14 degree with p value was 0.141(<0.05) insignificant.[10]

Regarding final outcome in this study was without significant difference in both i.e. in the open short Injury level pedicle screw fixation group and convention method.

Regarding complications all other complications are more or less equally distributed in both the groups but Hardware failure was significantly less in open short segment Injury level pedicle screw fixation than conventional one. Farrokhi et al study (2010) also found that implant failures occurred with a higher frequency in conventional open short segment pedicle screw fixation group (21.4%) than in open short segment injury level pedicle fixation group two (5.3%)(P = 0.02)[11]

V. CONCLUSION

This present study conclude that the results of open short segment injury level pedicle screw fixation shows significantly better correction of saggital cobb's angle ($p<0.001$). There was no significant difference in other corrections like Fractured vertebral body (°) angle, Anterior vertebral body height and Posterior vertebral body height. Final outcome after one year follow up was without significant difference in both the groups. Hardware failure was significantly less in open short segment Injury level pedicle screw fixation than conventional one. So it can be concluded that open short segment injury level pedicle screw fixation is better than conventional open short segment pedicle screw fixation.

CONFLICT OF INTEREST

None declared till now.

REFERENCES

[1] Harrington P.R.correction and internal fixation by spine instrumentation. J Bone joint surg Am. 1962;44-A:591-610

[2] Kaneda k,Taneichi H,Abumi k.:Anterior decompression and stabilization with kaneda device for thoracolumbar burst fracture associated with neurological deficits.J Bone joint surg.Am1997,79(1);69-83

[3] Steffe A.D., Biscup R.S., Sitkowski D.J., Segmental plate with pedicle screw fixation. A new internal fixation device for disorder of the the lumbar and thoracolumbar spine. Clin. orthop relat. res 1984;45-53

[4] Esses SI, Botsford DJ,Wright T: operative treatment of spinal fracture with AO internal fixator; Spine(phila pa 1976) 1991;16(3 suppl):s146-50

[5] Carl AL, Tromanhouser SG,Roger DJ. Pedicle screw instrumentation for thoracolumbar burst fracture and fracture dislocation, Spine(phila pa 1976) 1992;17(8):s317-24

[6] Knop C,fabion HF, Bastian L, Blauth M.Late result of thoracolumbar fracture after posterior instrumentation and transpedicular bone grafting spine (philapa 1976) 2001,1;26(1):88-99

[7] Paul of Aegina: landmark in surgical progress. world j surg 2003;27(1): 18-25

[8] Amato V, Giannachi L, Irace C, Corona C.Accuracy of pedicle screw placement in thelumbosacral spine using conventional technique: computed tomography postoperative assessment in 102 consecutive patients. J Neurosurg Spine 2010

[9] Macnab I. Negative disc exploration an analysis of the cause of nerve root involvement in sixty eight patient. J. Bone joint surg.(Am) 1971;53:891-903

[10] Majid-Reza Farrokhi, Ali Razmkon,ZohrehMaghami,Zahra Nikoo. Inclusion of the fracture level in short segment fixation of thoracolumbar fractures Eur Spine J 2010; 19:1651–1656 DOI 10.1007/s00586-010-1449

[11] Mahar A, Kim C, Wedemeyer M, Mitsunaga L, Odell T, Johnson B, Garfi n S. Short-segment fixation of lumbar burst fractures using pedicle fixation at the level of the fracture. Spine 2007;32(14):1503-07.