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RESEARCH ARTICLE

Study of Progression of Spinal Deformity in Dorsolumbar Spinal Injuries Managed by Internal Fixation

[1]Shekhar Singal, [2]Akshdeep S Bawa, [3]Ankur Dogra, [4]Alia Yamin

ABSTRACT

Introduction: Spinal injuries are frequently seen in India at the thoracolumbar junction. Surgical interventions like pedicle screws are aimed to stabilize the spine preventing long term backache. Studies on the loss of reduction and progression of kyphotic deformity have been reported in the literature but are relatively scarce, and the clinical significance of recurring deformity is uncertain. This study investigated the progression of spinal deformity after management of spinal injuries with short-segment pedicle screw fixation.

Materials and methods: Patients admitted between January 2008 to May 2013 in Dayanand Medical College and Hospital Ludhiana with dorsolumbar injuries and managed surgically with pedicle screw fixation were studied retrospectively and prospectively. At follow up, the patients were examined radiologically on lateral radiographs, neurologically and for pain scales by Denis evaluation score. The correlation between progression of Cobb's angle with a change in anterior wedge compression angle and intervertebral disc heights was analyzed by regression analysis.

Results: The loss of correction of Cobb's angle and the decrease in the upper intervertebral disc heights at follow up was found to be statistically significant only anteriorly ($r = 0.545$, $p = 0.013$) but not significant at the middle and posteriorly. The back pain was well tolerated at the follow up with 50% patients having no pain and 40% mild pain.

Conclusion: Even as the deformity progresses, the pain is well tolerated by the patients. Significant pain was present in patients who had inadequate postoperative alignment or reduction.

Keywords: Deformity progression, Denis evaluation score, Dorsolumbar injuries, Short-segment pedicle screw fixation.

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[1]Assistant Professor, [2,3]Senior Resident, [4]Intern

[1,2,4]Department of Orthopedics, Dayanand Medical College, Ludhiana, Punjab, India

[3]Department of Orthopedics, Government Medical College,Chandigarh, Punjab, India

Corresponding Author: Akshdeep Singh Bawa, Senior Resident, Department of Orthopedics, Dayanand Medical College, Ludhiana, Punjab, India, e-mail: bawa.akshdeep@gmail.com

INTRODUCTION

Spinal injuries are frequently encountered in our clinical practice. In today's fast-paced world, the incidence of spinal injuries is on the rise. Spinal cord injuries often have a devastating effect on the patients physically, mentally and socioeconomically.[1] Post-traumatic spinal deformity may become progressive as the line of gravity shifts forward, and as posterior erector muscles, weaken.[2] Patients with deformity of >30° are at increased risk for having chronic pain in their kyphotic region and may occasionally develop progressive neurologic deficit.[3-5] Compensatory hyperextension of the lower lumbar spine has been linked to a higher incidence of low-back pain, degenerative facet arthritis, and painful spondylolysis.[6,7] Spinal injuries are frequently seen in India. The most common fractures of the spine occur in the thoracic and lumbar spine or at the thoracolumbar junction. These fractures are typically caused by high-velocity accidents. The dorsolumbar spine is more vulnerable to injury as it is the zone of structural and functional transition.[8]

Surgical treatment of spinal injuries is still controversial. Surgical interventions are aimed to stabilize the spine preventing long term backache and deformity progression.[9] Various surgical modalities are established, and pedicle screw instrumentation is most widely used. The spinal vertebral fractures can be effectively reduced over a short segment with pedicle screw instrumentation. It provides powerful vertebral body height and local lordosis reduction. Also, this instrumentation can be installed through a posterior approach which is quite familiar with most orthopedic surgeons.[10]

Loss of reduction and progression of kyphotic deformity have been reported in the literature. But studies on this issue are relatively scarce, and the clinical significance of recurrent deformity is uncertain. This study investigated the progression of spinal deformity after management of spinal injuries with short-segment pedicle screw fixation.

MATERIALS AND METHODS

Patients admitted between January 2008 to May 2013 in Dayanand Medical College and Hospital Ludhiana were studied retrospectively and prospectively. The patients had spine injuries (dorsal/dorsolumbar/lumbar spine)

and were managed surgically with posterior short-segment pedicle screw fixation.

Inclusion Criteria

- Dorsal/dorsolumbar/lumbar spine injury

Exclusion Criteria

- Evidence of infection or tumor
- Congenital deformities of the spine
- Degenerative disc disease

Total of 24 patients was included in the study out of which 4 were lost to follow up. All the patients admitted before December 2012 were studied retrospectively and were followed after at least one year after surgery. The patients admitted between January 2013 to May 2013 were studied prospectively and were also followed after at least one year after surgery. The standard posterior approach was used for short segment pedicle screw fixation. The spine system used was One Lock Spine System from Adler or the Spine System from Sharma Surgical (SSEPL). The preoperative and postoperative lateral radiographs and neurological status of the patients at admission were reviewed. At follow up, the patients were examined radiologically on lateral radiographs, neurologically and for pain scales by Denis evaluation score.

Measurements of deformity were made in accordance with the Cobb's angle on lateral radiographs done preoperatively, postoperatively and at follow-up. Measurements of reduction of fractured vertebral body were done in accordance with anterior wedge compression angle. The anterior wedge compression angle was measured on lateral radiographs preoperatively, postoperatively and at follow up. The reduction of fractured vertebral body achieved postoperatively, and the change in the reduction of the fractured vertebral body on follow up was deduced (Figs 1 and 2).

The neurological status of the patients at the time of admission and at follow-up was assessed, and patients were graded with Frankel's Grading System (Table 1).[11]

The postoperative period after which sitting and standing were initiated and the period for which braces were used by the patients was noted.

The patients were also evaluated for pain at the follow-up and were classified according to Denis evaluation scale.[12]

The collected data was analyzed using descriptive analyses. Students t-test were applied for a change in follow up compared to postoperative values. The correlation between progression of Cobb's angle with a change in anterior wedge compression angle and intervertebral disc heights was analyzed by regression analysis and was

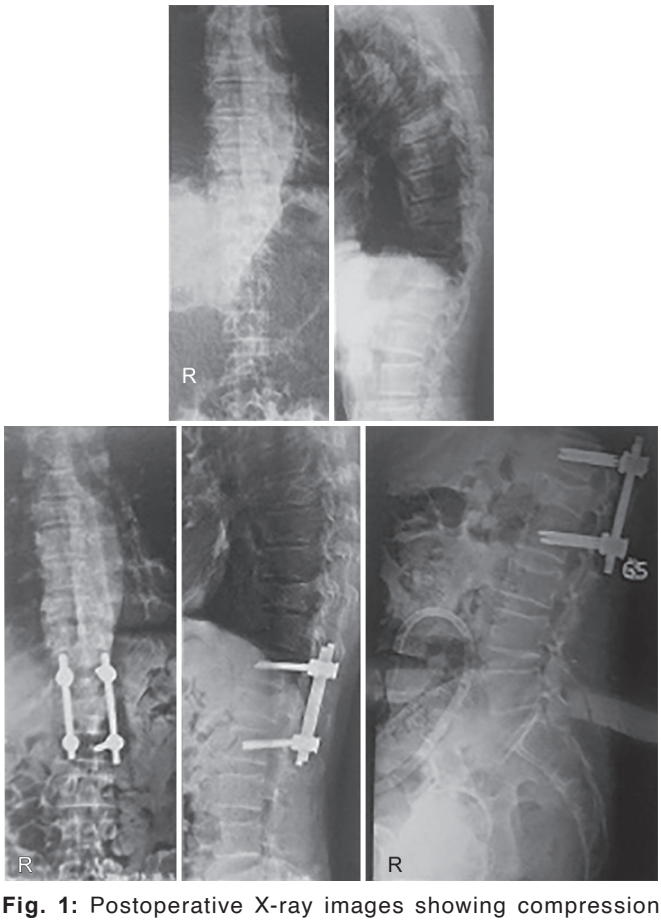

Fig. 1: Postoperative X-ray images showing compression fracture of L2 vertebra and L1 vertebra in two different male patients, respectively

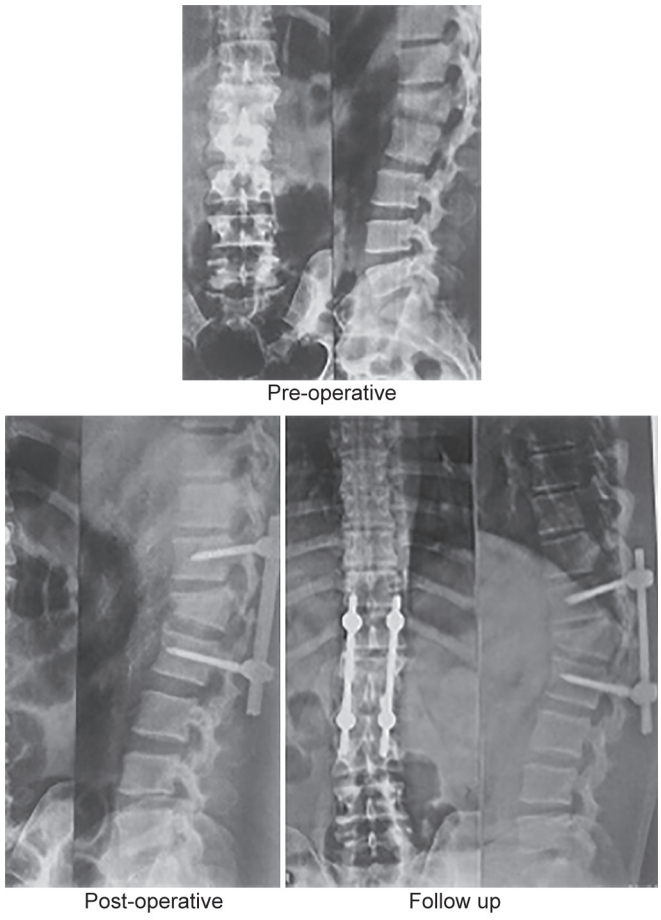

Fig. 2: Preoperative , post operative and follow up X-ray images in a 36 year old female with L1 compression fracture

OBSERVATIONS AND RESULTS

A total of 20 patients were studied out of which 18 were male and 2 were female (Tables 2 and 3). The mean age of the patients was 38 years with standard deviation (SD) of 9.93 years and range of 17–55 years. The mean period of following was 18.6 months (13–37 months). Twelve patients were classified as Denis Burst type fractures with 9 patients as Denis type A and 1 each as type B, C and E. Eight patients were classified as Denis compression type fractures with 4 patients as Denis type A and 2 patients classified as type B and D each (Table 4). Mode of injury fell from height in 12 patients, roadside accident in 5 patients, falling of construction material on back in 1 patient, fall after seizure attack in 1 patient and train accident in 1 patient.

The mean improvement in Cobb's angle postoperatively was 10.8°. The mean loss of correction of Cobb's angle at follow-up compared to postoperatively was 7.1 degrees with an SD of 5.7° (Tables 5 and 6).

The mean improvement in anterior wedge compression angle postoperatively was 7.1 degrees. The mean loss of correction of anterior wedge compression angle at follow up compared to postoperatively was 2.05° with an SD of 2.3° (Tables 7 and 8).

The correlation between loss of correction of Cobb's angle with loss of correction anterior wedge compression angle at follow-up compared to postoperatively was found to be statistically significant (r = 0.684, p = 0.001) (Table 9).

The patients were evaluated for pain at follow up using Denis evaluation scale. Ten patients had no pain (P1–50%), 8 patients had mild pain (P2–40%), and 2 patients had moderate pain (P3–10%). The mean period postoperative after which sitting was initiated was 1.5 months and standing with support initiated after 3.12 months. The mean period postoperatively for which braces were used by the patients was 8.6 months (Table 10). One patient was re-operated for implant removal.

DISCUSSION

Pedicle screw fixation is an effective modality for treatment of dorsal/dorsolumbar/lumbar spine injuries. Pedicle screw instrumentation makes it possible to reduce thoracolumbar burst fractures over a short segment. Shin et al. retrospectively reviewed 19 patients managed surgically for thoracolumbar fractures by the short-segment pedicle screw fixation technique. They concluded that the short term follow-up results suggest a favorable outcome

Table 1: Distribution of patients according to Frankel grade

Number of patients	*Frankel grade pre-op*	*Frankel grade post-op*	*Percentage (%)*
3	A	B	15
3	A	A	15
1	B	C	5
1	C	C	5
4	D	E	20
8	E	E	40

Table 2: Distribution of patients on the basis of sex

Sex	*Number*	*Percent*
Female	2	10.0
Male	18	90.0
Total	20	100.0

Table 3: Distribution of patients the on basis of age

Age (Years)	*Number*	*Percent*
15-25	2	10.0
26-35	6	30.0
36-45	8	40.0
46-55	4	20.0
Total	20	100.0
Mean	38	
SD	9.93	

Table 4: Distribution of patients the on basis of level of fracture

Level of fracture	*Number*	*Percentage (%)*
#D8	1	5.0
#D11	2	10.0
#D12	3	15.0
#L1	11	55.0
#L2	1	5.0
#L3	2	10.0
Total	20	100.0

Table 5: Cobb's angle measurement (in degrees)

COBB's angle	*N*	*Minimum*	*Maximum*	*Mean*	*Std. deviation*
Pre Op	20	10	42	20.95	9.790
Post OP	20	3	28	10.10	6.943
Follow-up	20	6	50	17.70	12.872

Table 6: Change in Cobb's angle at follow-up compared to postoperatively

	Post-op		*Follow-up*		
	Mean	*SD*	*Mean*	*SD*	*p value*
COBBS angle	10.10	6.943	17.70	12.872	0.0001

Table 7: Anterior wedge compression angle measurements (°)

Anterior wedge compression angle	*N*	*Minimum*	*Maximum*	*Mean*	*Std. deviation*
Pre-op	20	5	40	18.45	8.882
Post-op	20	3	42	11.95	9.747
Follow-up	20	3	46	14.00	11.328

Table 8: Anterior wedge compression angle at follow-up compared to postoperatively

	Post OP		*Follow-up*		
	Mean	*SD*	*Mean*	*SD*	*p value*
Anterior Wedge Compression Angle	11.95	9.747	14.00	11.328	0.001

Table 9: Correlation analysis: oss of correction of Cobb's angle with loss of correction of anterior wedge compression angle

	Loss of Correction of Cobb's Angle	
	r	*p value*
Loss of Correction of Anterior Wedge Compression Angle	0.684	0.001

for short-segment instrumentation.[13] When applied to patients with isolated spinal fractures who were cooperative with 3–4 months of spinal bracing, short-segment pedicle screw fixation using the posterior approach seems to provide a satisfactory result. Khare et al. carried out a prospective study of 25 patients in the age group of 15–65 years with thoracolumbar fractures with the associated neurological deficit or compression fractures. The average preoperative kyphotic angle as measured by the Cobbs method was 20° which improved to 7.8° following instrumentation. The average preoperative vertebral height was 58.65% which improved to 78.55% postoperatively. They concluded that short segment trans-pedicle posterior fixation is helpful for not only stabilization of the fractures and restoration of anatomy, but also maintaining the same over a period with good functional outcome.[14]

However, the results of a short-segment posterior stabilization are not always good. Recurrent kyphosis has been reported in various studies. In our study, the mean Cobb's angle improved from 20.95° preoperatively to 10.1 degrees postoperatively. The loss of correction in Cobb's angle at follow up was 7.1° which were statistically significant. So, there was long term significant progression of kyphotic deformity in spinal injuries postoperatively with posterior pedicle screw system. Similar results were seen in various studies in which there loss in the correction of the kyphotic deformity. Xu et al. in their study had an average correction loss of 12.0°, leaving a final average reduction of 5.8°.[10] Speth et al. in their study had a mean loss in the correction of 10° and 11° in two groups.[15]

The patients with Cobb's angle of >15 degrees postoperatively had more increase in Cobb's angle at follow up. So, it is important to achieve good intraoperative alignment and reduction. Also in our study, there was a loss in the reduction of a fractured vertebra with mean anterior wedge compression angle of 14.0° at follow-up and 11.95° postoperatively and mean the loss of reduction of 2.05° which was statistically significant. The loss in the correction of Cobb's angle was more than a loss in the reduction of anterior wedge compression angle.

There was also the progressive collapse of upper and lower intervertebral disc spaces adjacent to the fractured vertebra at follow up compared to postoperatively. This was statistically significant anteriorly, at the middle and posteriorly for both upper and lower intervertebral disc spaces. The collapse of intervertebral disc spaces was also found in studies by Xu et al., Speth et al., and Huang et al.[10,15,16]

Table 10: Oswestry disability index

Patient	*Frankel grade at 5 years*	*ODI at minimum 5 years from date of injury %*
1	Lost to follow-up	–
2	C	54
3	C	60
4	E	18
5	D	24
6	E	12
7	D	18
8	E	14
9	E	20
10	E	22
11	B	78
12	E	8
13	D	12
14	C	28
15	C	18
16	Lost to follow-up	–
17	E	12
18	E	18
19	Lost to follow-up	–
20	A	86
Mean		*27.88*

The correlation between loss in the correction of Cobb's angle and loss in the reduction of anterior wedge compression angle and collapse of intervertebral disc spaces was also studied. There was a statistically significant correlation found between loss in the correction of Cobb's angle and loss in the reduction of anterior wedge compression angle ($p = 0.001$). Similar results were obtained by Lakshmanan et al. in their study where the loss in the reduction of vertebral body correlated with loss of correction of deformity as a decrease in fractured vertebral body heights correlated with an increase in Cobb's angle. They concluded that there is a progressive loss of correction of the angle of kyphosis after posterior stabilization with instrumentation even without implant removal that mainly corresponds to the decrease in the anterior segment height of the fractured vertebral body.[9]

Also, the back pain was well tolerated at the follow up by the patients.50% patients had no pain (Denis grade P1), 40% of patients had mild pain (Denis grade P2), and 10% of patients had moderate pain (Denis grade P3). Significant pain (P3 and above) at follow up was seen in just two patients who had postoperative Cobb's angle more than 15°. So it is important to achieve adequate intraoperative alignment or reduction.

Wang et al. had 11 (40.7%) of the 27 patients were rated P1 (no pain), 14 (51.9%) rated P2 (occasional pain), 1 (3.7%) rated P3 (moderate pain) and 1 (3.7%) rated P4 (moderate to severe pain).[17]

SUMMARY AND CONCLUSION

Pedicle screw fixation for dorsal/dorsolumbar/lumbar spine injuries has satisfactory outcomes. Postoperative reduction or alignment is an important predictor for the progression of deformity. So it is important to achieve adequate intraoperative alignment or reduction. There was long term progression of kyphotic deformity after pedicle screw fixation which was positively correlated with loss in the reduction of anterior wedge compression angle and the collapse of intervertebral disc height anteriorly. Significant pain (P3 and above) at follow up was seen in just two patients who had postoperative Cobb's angle more than 15°. So, even as the deformity progresses but the pain is well tolerated by the patients. Significant pain was present in patients who had inadequate postoperative alignment or reduction.

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