

Posterior Spinal Fixation with Pedicle Screws and Rods System in Thoracolumbar Spinal Fractures

Kashif Mahmood Khan¹, Anisuddin Bhatti¹ and Muhammad Arif Khan²

ABSTRACT

Objective: To determine the effectiveness of posterior spinal fixation in maintaining the stability of spine and to determine mortality in 6 months after posterior spinal fixation.

Study Design: Quasi experimental study.

Place and Duration of Study: Department of Orthopaedics, Jinnah Postgraduate Medical Centre, Karachi and Department of Orthopaedics, Postgraduate Medical Institute, Hayatabad Medical Complex, Peshawar, from April 2006 to April 2009.

Methodology: Fifty patients with unstable thoracolumbar spinal fractures from T7 - L4 were included. All the patients were operated by posterior approach using pedicle screws and rods. Effectiveness of the fixation was measured at 6 months postoperatively in terms of relief of pain and improvement in mobility using Oswestry disability index, range of motion of spine using Schober Test/sign, reduction in deformity by measuring Cobb angle, local kyphosis angle (LKA), thoracolumbar angle, anterior and posterior vertebral heights (AVH and PVH respectively), evidence of union was made using plain radiographs and by computer assisted measurement using " OSIRIS " software. The data was then analyzed using SPSS software version 13 and presented in the form of tables and charts.

Results: Twenty-eight patients were operated within first week. In 38 patients, 4 screws were used and in 12 patients, 8 screws were used with 2 rods. Pain and disability showed improvement, with mean 71.98% score pre-operatively to 44.96% mean at last visit ($p = 0.001$). Mean range of motion increased 0.5 – 2 cms postoperatively in all directions ($p = 0.001$). Mean kyphosis angle, Cobb angle and thoracolumbar angle improved postoperatively. Anterior and posterior vertebral body heights increased postoperatively with resultant decrease in anterior vertebral body compression. Ninety six percent patients showed signs of postoperative union on last visit and only 3 people died of unrelated causes till last visit.

Conclusion: Posterior spinal fixation with pedicle screws and rods is an effective surgical technique in maintaining stability of spine by improvement in pain and mobility, range of motion of spine, correction of deformity and bone union.

Key words: Posterior spinal fixation. Cobb angle. Local kyphosis angle. Anterior vertebral height. Posterior vertebral height.

INTRODUCTION

Spinal instability is the loss of the ability of the spine under physiological loads to maintain relationships between vertebrae in such a way that there is neither damage nor subsequent irritation to the spinal cord or its nerve roots. In addition, there is no development of incapacitating deformity or pain. Traumatic spinal cord injury is estimated to be 29 – 50 cases per million populations per year worldwide.¹ In Pakistan, a higher number of people suffer from spinal injuries every year.² Prevalence of vertebral fractures increases with age due to osteoporosis³ and decreasing bone density.³

Different treatment options are applied to patients with thoracolumbar spinal fractures.⁴ Non-operative treat-

ment can be employed in patients with less vertebral body compression < 40% and kyphotic angulation < 25%. Thoracolumbar orthosis is used with restriction of activities.⁵

Surgery is indicated to minimize pain, stabilize spine, correcting and preventing subsequent spinal deformity, early mobilization, reduction of morbidity and improvement in neurological function.⁶ Anterior corpectomy allows direct decompression through thoracic and abdominal approach. Posterior internal fixation with titanium and stainless steel made pedicle screws and rods is becoming increasingly popular, which are longitudinally anchored to the spine.⁷ In posterior intertransverse fusion, bone grafts are placed. Generally used in conjunction with anterior and posterior fixation. In posterior interbody fusion technique, decompression is done through a standard posterior laminectomy.⁸

The outcome and prognosis of patients with thoracolumbar fractures depend on patient's neurological condition, age, co-morbid condition, associated injuries, general medical complications and time of fixation.

The purpose of conducting this study was to find out the effectiveness of posterior internal spinal fixation in maintaining the stability of spine.

¹ Department of Orthopaedics and Trauma Surgery, Jinnah Postgraduate Medical Centre (JPMC), Karachi.

² Department of Orthopaedics and Trauma Surgery, Hayatabad Medical Complex, Peshawar.

Correspondence: Dr. Kashif Mahmood Khan, Ward - 17, Department of Orthopaedics, Jinnah Postgraduate Medical Centre (JPMC), Karachi.

E-mail: kashif2511@hotmail.com

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METHODOLOGY

This quasi experimental study was conducted at Department of Orthopaedics, Jinnah Postgraduate Medical Centre, Karachi and Department of Orthopaedics, Postgraduate Medical Institute, Hayatabad Medical Complex, Peshawar, from April 2006 to April 2009. Patients with mechanically unstable traumatic thoracolumbar spinal fractures from T7 - L4 were selected. Patients with bed sores, unfit for anaesthesia and comorbid conditions were excluded. Patients were admitted and were counselled for the procedure and its implications. Data was collected pre-operatively and informed consent was taken.

All patients were operated by using posterior spinal fixation method using pedicle screws and Moss Miami rods within one week after injury. In most of the patients 4 pedicle screws were used and in some 8 screws depending on the number of vertebrae involved. Surgery was performed under general anaesthesia using standard posterior exposure. After dissecting the fascia and muscles with diathermy, fractured and normal above and below were exposed completely sufficient for fixation and upto the tips of transverse processes. Holes were made in the pedicles of the adjacent normal vertebrae into the vertebral bodies with awl and tap. Direction of the holes was verified with path finders. Pedicle screws were introduced through the holes. Their position was verified by the image intensifier. Four screws were used for one fractured vertebra and 8 screws for two fractured vertebrae for stable fixation. Appropriate length Moss Miami titanium rods were then curved and put in the pedicle screws. Innie and outie was placed on each pedicle screw over the rods, the curvature of the rod adjusted according to the curve of spine. The pedicle screws were distracted on the rods, to disimpact the fracture and straighten the curve. At the same time, innies and outies were tightened on the pedicle screws to fix the screws and rods assembly. Fractured vertebrae were then decompressed posteriorly. The bone grafts obtained were then put across the pedicles. Wound was closed air tight over redivac drain for 48 – 72 hours.

With the assistance of trained physiotherapist, patient was advised log-roll in the bed next day. Log-roll, static and range of motion exercises were continued for lower limbs over the next 2 weeks. At 2 weeks, patient was allowed to sit in the bed and/or assisted walking. After one month, patients were allowed to do normal light work at home.

The clinical and radiological follow-up was mandatory at one, three and six months. Pre-operative data was already collected on proforma and data of every follow-up visit was collected to measure different variable/pain and disability was recorded on Oswestry disability index questionnaire. Deformity was assessed by measuring

range of motion of spine using Schober test/sign, on radiographs for deformity and correction of deformity by measuring Cobb angle, local kyphosis angle (LKA), thoracolumbar angle, anterior and posterior vertebral heights (AVH and PVH) and evidence of union and by computer assisted measurement using "OSIRIS" software.

Oswestry disability index questionnaire contains six statements (denoted by the letters A to F) in each of 10 sections.^{9,10} The sections concern impairments like pain, and abilities like personal care, lifting, reading, driving, and recreation. For each section, subjects choose the statement that best describes their status. The chosen statements receive scores: statement A = 0; statement B = 1; C = 2; D = 3; E = 4; F = 5. Total scores can range from 0 (highest level of function) to 50 (lowest level of function). To accommodate patients who do not respond to every sections, clinicians can calculate a "percentage of disability" on the basis of the total possible points. Interpretation of "percentage of disability" scores is: 0 – 20% - minimal disability, 20 – 40% - moderate disability, 40 – 60% - severe disability, 60 – 80% - crippled and 80 – 100% - bed bound (or exaggerating symptoms).

Postoperatively on every visit, patients range of motion of spine was measured by using Schober test/sign.¹¹ The technique is that patient stands erect with normal posture. Identify the level of posterior superior iliac spine. Mark midline at 5 cm below the iliac spine. Mark midline at 10 cm above the iliac spine. Patient bends at waist to full forward flexion. Measure distance between 2 lines (started 15 cm apart). Normally, the distance between the two lines should increase to more than 20 cm. Distance less than 20 cm suggests decreased spinal range of motion.

Pre-operative and on every follow-up visit, we measured Cobb and kyphosis angle, and anterior and posterior vertebral body heights on the radiographs. "OSIRIS" software was also used to assist in correct measurements. All the individual measurements were recorded on proforma. On radiographs, we also looked for signs of union and noted on proforma.

Data from the questionnaire was analyzed using Statistical Package for Social Sciences (SPSS) version 13, and results were presented as frequencies and mean values \pm standard deviation in the form of graphs and tables. Descriptive method was used to present qualitative data and was given in the form of frequency distribution. Quantitative analysis was made to test the significance of a number of factors to various variables. Differences in pre- and post-intervention scores, and other outcomes were assessed using t-test for paired sample. P-value of 0.05 or less was considered to be significant.

RESULTS

Fifty patients aged 15 – 70 years, who had thoracolumbar spinal fracture from T7-4 level were operated by posterior spinal fixation using pedicle screws and rods. Thirty-two patients (64%) were males and 18 patients (32%) were females. Twenty-one patients (42%) were between the age of 21 – 30 years age group, 11 patients (22%) between 31 – 40 years, 5 patients (10%) between 41 – 50 years, 5 patients (10%) between 51 – 60 years, 6 patients (12%) between 15 – 20 and 2 patients (4%) more than 60 years age. Thirty-three patients (66%) had a fall and 17 patients (34%) had suffered RTA. Twelve patients (24%) had fracture at T12 level, 17 patients (34%) had fracture at L1, 8 patients (16 %) at L2, 5 patients (10%) at L3, the other 8 patients (16%) had fractures at different thoracic and lumbar levels. Twenty-eight patients were operated within 6 days, 10 within 9 days, 7 in 3 days and 5 took more than 9 days for operation. Thirty-three patients were discharged in 5 days, 14 in 10 days and 3 took more than 10 days to discharge. Four screws with 2 rods were used in 38 patients (76%) and 8 screws were used in 12 patients (24%). According to Oswestry disability index for pain and mobility, the mean pre-operative score was $71.98 \pm 14.35\%$ which changed to $44.96 \pm 24.61\%$ at 6 months postoperative follow-up. The difference from pre-operative to 6 months was found statistically significant with $t = 6.67$ and $p = 0.001$. Schober test is used for ROM. Movements were not elicited in pre-operative period. Postoperatively in flexion, the mean range of motion was 4.00 ± 0.78 cms at 6th month follow-up visit. The difference from pre-operative to 6 months was found statistically significant (Table I). The mean range of motion in extension was 3.00 ± 1.08 cms at 6 months postoperative follow-up. The difference from pre-operative to 6 months was found statistically significant (Table I). The mean range of motion on either right or left side was 3.995 ± 0.80 cms at 6 months visit. The difference from pre-operative to 6 months was found statistically significant (Table I). The range of motion in rotation was 2.935 ± 1.12 cms at 6 months postoperative visit. The difference from pre-operative to 6 months was found statistically significant (Table I). The mean correction in Kyphosis angle was from 29.36 ± 4.15 degrees pre-operatively to 19.18 ± 3.91 degrees at 6th month postoperatively. The difference was found statistically significant from pre-operative to 6 months duration (Table II). Mean correction in Cobb angle was from 6.54 ± 6.81 degrees pre-operatively to 1.8 ± 1.53 degrees at 6 months follow-up. The difference was significant from pre-operative to 6 months follow-up (Table II). Correction of thoracolumbar angle was from 28.14 ± 2.76 degrees pre-operatively to 19.88 ± 2.69 degrees at 6th month visits which was significant change from pre-operative to 6 months duration as shown in Table II. The mean anterior vertebral body height pre-operatively was 2.008

± 0.28 cms, which increased to 2.902 ± 0.43 cms at 6 month visit. Overall change was significant from pre-operative to 6 months follow-up (Table III). The posterior vertebral body height was 3.534 ± 0.34 cms before surgery which increased to 3.738 ± 0.25 cms at 6 months postoperative visit changing from 3.53 to 3.78 which was significant (Table III). The mean percent of anterior vertebral body compression was $43.36 \pm 2.83\%$ before surgery and $20.64 \pm 3.47\%$ at 6th month postoperatively, resulting from 56.64% to 79.36% correction in anterior vertebral body height with $p = 0.001$ which was significant as shown in Table III. At 1 month visit, 5 patients (10%) showed postoperative evidence of radiological union, at 3rd month postoperative visit, 35 patients (70%) showed evidence of union while at 6th month visit, 48 patients (96%) showed postoperative evidence of union whereas 2 patients (4%) did not show union. Out of 50 patients, only 3 patients (6%) died of unrelated causes during the follow-up duration.

Table I: Pre-operative and 6 months post intervention range of motion in flexion, extension, bending, rotation.

Duration	Flexion (mean±SD)	Extension (mean±SD)	Bending (mean±SD)	Rotation (mean±SD)
Pre-operative	0 ± 0	0 ± 0	0 ± 0	0 ± 0
Six months	4.000 ± 0.78	2.997 ± 1.08	3.9956 ± 0.80	2.935 ± 1.12
Paired test values	t = -11.65 p < 0.001	t = -11.17 p < 0.001	t = -12.13 p < 0.001	t = 5.62 p < 0.001

Table II: Pre-operative and 6 months post intervention correction of deformity by measuring Local Kyphosis angle, Cobb angle and Thoracolumbar angle.

Duration	Local Kyphosis angle in degree	Cobb angle in degree	Thoracolumbar angle in degree
Pre-operative	29.36 ± 4.15	6.54 ± 6.81	28.14 ± 2.76
Six months	19.18 ± 3.19	1.80 ± 1.53	19.88 ± 2.69
Paired test	t = 12.06 p < 0.001	t = 5.50 p < 0.001	t = 16.40 p < 0.001

Table III: Pre-operative and 6 months post intervention improvement in anterior vertebral body height, posterior vertebral body height, and improvement in anterior vertebral body height relative to posterior vertebral body height.

Duration	Anterior vertebral height (AVH) in cm	Posterior vertebral height (PVH) in cm	AVH relative to PVH in mm
Pre-operative	2.008 ± 0.28	3.534 ± 0.34	43.36 ± 2.83
Paired test values	t = 12.10 p < 0.001	t = -3.52 p < 0.001	t = 45.60 p < 0.001

DISCUSSION

Significant number of patients suffers traumatic spinal fractures around the world every day. Out of them, quite a high percentage experience fractures in thoracolumbar region. Of these fractures, a high number of traumatic fractures are unstable fractures that need surgical stabilization.

Different surgical modalities are used in treating thoracolumbar spinal fractures. Of these, the most

common being used is posterior spinal fixation with different instruments. The most modern and commonly used, these days, are pedicle screws and rods system. Other methods are anterior spinal fixation with cage, kyphoplasty, vertebroplasty, posterior interbody fusion and posterior intertransverse fusion. Of the posterior spinal fixation, the various instruments used are pedicle screws and rods system, Harrington rods and fixateur interne.

Pedicle screws and Moss Miami rods system was used in this series for stabilization of spine. The neurological aspect of the treatment of spinal fracture by this system were not considered sole with concentration on stability. This neurological recovery is dependent on the degree of stability provided by fixation, and on initial trauma and neurological loss. So, if stability is provided to spine then neurological status of some patients can be improved.

Stabilization was assessed in the form of pain and mobility, range of motion, and correction of deformity. Oswestry disability index was used to measure pain and mobility. Pre-operatively, majority of patients were in the 80 – 100% and 60 – 80% grade showing that most patients were bed bound and crippled before surgery. Postoperatively, with each follow-up grades started improving and in final postoperative visit majority of the patients were in 40 – 60% and 20 – 40% grades and few even in 0 – 20% grade. This study showed that all the patients mean score on Oswestry disability index which was 71.98% before surgery, improved to 44.96% in final postoperative visit. This showed that by operating the patients by posterior spinal fixation with pedicle screws and rods improved the pain and disability of the patients, hence, functional status of the patient improved, though some patients remained in 80 – 100% and 60 – 80% groups due to permanent disability at the time of injury and admission. Kaya and colleague in their study found increase in number of ambulatory patients to be 71.4% 6 months after fixation with pedicle screws and rods.¹² Karlstrom and colleagues found increase in the degree of mobilization, shortening of the period of disability and improvement in comfort of the patient.¹³

Schober test used for this study showed that the range of motion was lower than normal but increased with time postoperatively, if fixation was done with pedicle screws and rods. Post and colleague found that range of motion is decreased than normal but still improved.¹⁴

This study showed mean correction in Cobb angle, thoracolumbar angle, kyphosis angle, anterior and posterior vertebral body heights and improvement in anterior vertebral body height compression. Verlaan and colleagues in their study found significant improvement in Cobb angle after surgery with pedicle screws and rods.¹⁵ Korovessis and colleagues found in their study that there was improvement in kyphosis angle from 16 degrees pre-operatively to 1 degree at final follow-up

visit. The anterior vertebral height ratio improved from 0.6 to 0.9 and posterior vertebral height ratio improved from 0.95 before surgery to 1 after surgery.¹⁶ Afzal and colleagues noted that there was restoration of 72 – 82% vertebral body height postoperatively as compared to pre-operatively.¹⁷ Payer found that the mean regional Kyphosis was 23 degrees pre-operatively, 17 degrees postoperatively and 18 degrees at follow-up. The mean anterior vertebral height compression was 8 mm pre-operatively, 1 mm postoperatively and 1 mm at follow-up.¹⁸ Yue and colleagues found in their study about improvement in kyphosis angle from 15.9 degrees pre-operatively to 10.6 degrees postoperatively and the mean anterior vertebral body height compression percentage improved from 35.4 pre-operatively to 24.4 mm postoperatively.¹⁹ Lu and colleagues found reduction in loss of vertebral body height after operation.²⁰

Khan and colleagues found that pedicle screw fixation is a useful choice for thoracolumbar junction injuries for achieving reduction and stability.²¹ So this study and others showed comparable improvement in deformity by use of pedicle screws and rods in fixation of spine.

Before operation, posterior column injury was found in majority of the patients along with other columns injury on radiographs. Most of the patients had evidence of postoperative union which showed improvement in fusion and union by posterior spinal fixation with pedicle screws and rods in this study.

Acosta and colleagues found improvement in bone fusion.²² Dickman and colleagues found 96% fusion rate with pedicle screws and rods system in their study.²³ So if this study is compared to others regarding postoperative fusion and union, it found increased percentage of union as shown by others with 96% union rate.

Out of 50 patients, only 3 patients died of unrelated causes during the follow-up duration. Lin and colleagues in their study found no deaths postoperatively in any of their subjects.²⁴

CONCLUSION

Posterior spinal fixation with pedicle screws and rods system is an effective and safe method in maintaining the stability of spine, by improvement in all the scores and parameters including the pain and mobility, range of motion of spine, and deformity.

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