Original Research Article

Evaluation of the effectiveness of single posterior only approach for circumferential decompression of thoraco-lumbar thecal sac and anterior column reconstruction with posterior stabilization

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Abstract

Background: The common indications for spinal decompression surgeries performed in India are infections, fractures and tumors. Our study objective is to evaluate the effectiveness of 360 degree circumferential decompression of thoracolumbar thecal sac through single midline posterior approach and anterior column reconstruction with posterior stabilization. **Materials & methods:** A prospective study of 31 patients with 24 patients having neurological deficit was conducted among the trauma, infection and tumor patients attending the outpatient and inpatient department of Orthopedics at Gitam Institute of Medical Sciences and Research from 2017 to 2020 with a minimum follow up of 6 months. They were followed up on monthly basis till satisfactory fusion was seen on X-ray and every 6 months thereafter till 2 years. Clinical evaluation is done using ASIA motor score, ASIA impairment scale and VAS score. Radiological union and correction of deformity will be assessed using anteroposterior and lateral radiographs using kyphotic angle, graft fusion and implant status. **Results:** Neurological recovery occurred in 91.7% patients and all the patients neurology was either stable or improved post operatively. The mean post operative ASIA motor score was 91.36±13.71 (p-value<0.001). The mean post operative kyphotic angle was 10.55±8.25 (p-value<0.001), there was no loss of kyphosis correction on follow up. The mean post operative VAS was 2.32±0.75 (p-value<0.001). No intra operative or post operative complications were encountered. There was no implant related complication seen during the study. **Conclusion:** The posterior transpedicular approach provides sufficient access for safe and effective circumferential decompression and three column stabilization. The technique achieved a high success rate for pain relief, neurological preservation and functional improvement. Less intra operative blood loss, complications, shorter operative time, better pulmonary function after operation and early rehabilitation are significant advantages of posterior alone surgery compared with combined anterior and posterior approaches.

Keywords: circumferential decompression, anterior column reconstruction, posterior transpedicular approach, posterior stabilization

Introduction

Numerous pathologic conditions of both traumatic and non traumatic etiologies can cause spinal cord compression. These patients often present with various manifestations including back pain, neurological deficits and spinal instability. Surgical decompression with or without stabilization is an effective remedy for most of these conditions.

Selection of the most appropriate surgical approach depends on several factors. The most importantly being the extent of disease, its location, patient's general health condition and associated comorbidities, and the expertise and experience of the surgeon. Anterior approaches offer good exposure to the vertebral body, allowing decompression of the anteriorly located pathology. However, they offer little or no access to the posterior elements and can involve significant morbidity especially if access is required across the thoracic cavity[1].

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Posterior approaches allow for posteriorly directed decompression and strong segmental instrumentation, but does not allow reconstruction of the load bearing anterior column. Combined approaches provide access to anterior and posterior elements but also suffer because of associated devastating intraoperative complications and the potential to cause, or exacerbate preexisting comorbidities, principally of the respiratory system[1]. They are associated with prolonged anaesthetic duration, increased intra- operative blood loss, increased wound infection rate, and myriad postoperative complications. The common indications for spinal decompression surgeries performed in India are for infections, fractures and tumors. Many of these conditions need adequate circumferential decompression and stabilization (as lesion involving both columns compromises stability). In widespread spinal tumor and thoracolumbar burst fractures also, it becomes essential to decompress the spinal cord circumferentially and stabilize it[2]. Morbidity and complications of combined approaches limit its use among surgeons for circumferential decompression. Recent literature have mentioned that adequate circumferential decompression is possible through posterior alone approach, thereby reducing the surgical time, blood loss, infection and overall morbidity of the patients[3].Transpedicular or posterolateral window access through the posterior alone approach not only allows the surgeon to decompress the anterior column, but also allows anterior column reconstruction and robust posterior stabilization with pedicular screw system. Hence, corpectomy and three- column reconstruction through single posterior alone approach is possible with reduced morbidity, thus allowing early

rehabilitation[4,5,6]. This prospective study was designed to evaluate the efficiency of a single posterior approach for thorough circumferential decompression of thoracic or/and lumbar neural tube for various disease pathologies.

Aims & objectives

1. To evaluate the effectiveness of posterior alone approach for all round decompression of the thecal sac in fractures, tumors and infective condition of thoracolumbar spine (from T1-L3).
2. To evaluate the intraoperative and post operative complications associated with the technique

Material and methods

A prospective study of 31 patients was conducted among the patients attending the outpatient and inpatient of department of Orthopedics at Gitam Institute of Medical Sciences and Research from 2017 to 2020. Among 31 patients 18were admitted with Denis burst unstable fractures, 9 patients were admitted with tuberculosis and 4 patients with tumor of which one had multiple myeloma and 3 had metastasis and totally 24 had neurological deficit at presentation. The patient selection criteria is given below.

Inclusion Criteria

1. Age more than 18 years.
2. Pathology affecting the spine between C7T1 disc to L3L4 disc.
3. Thecal Sac compression anteriorly or anterior with posterior compression with neurological compression needing surgical management.
4. Pathologies included: Trauma, infections, primary vertebral tumor and vertebral metastasis.

Exclusion Criteria

1. Age less than 18 years .
2. Other systemic comorbidities making the patients unfit for surgery.

Ethical justification

Ethical justification was followed according to guideline setup by ICMR (1994) and Helsinki declaration (modified 1989) and the guidelines were adhered to in all patients, volunteering to be involved in the study. These include all the possible treatment options will be given and none will be withheld; patients were enrolled in the study with their knowledge, and study will be done by utilizing known investigation modalities, regarding which proper information will be provided to the patients; patients were informed about all the major and minor risk factor and the remedies thereof; patients were given the option of quitting form the study during the protocol if she desires, no element of compulsion will be extorted; confidentiality of data due to contribution source or individual was ensured and maintained; written informed consent was obtained from all the patients included in the study; in the cases where patients were not eligible for giving consent due to poor neurological status, consent of the closest relative available was taken. This did not apply to any case in the present study. There was no difference in the management of the patients and all the patient were treated by standard protocol, maintaining the best interest of the patient.

Pre operative Preparation

Patients included in the study were evaluated and neurological charting was done as per **ASIA** neurological chart. Neurological grading was be done as per **ASIA** impairment scale and pain was assessed using **VAS**.

Routine investigations

Haemoglobin, Packed cell volume, bleeding time, clotting time, blood glucose, blood urea, creatinine, HIV, Hbs Ag, HCV, Blood grouping and typing, serum electrolytes, urine routine and microscopy, Electrocardiogram, Echocardiogram and chest roentgenogram posteroanterior view.mAnteroposterior and lateral radiographs of the concerned region of the spine was taken. MRI of the spine was done in all cases with special attention to the diseased area. CT was done only in needed cases.

Patients with spinal trauma with associated spinal cord injury received methyl prednisolone sodium succinate as per the NASCIS III protocol.

Operative technique

Instruments include general spinal instruments, Rib retractors**,** Cobb's elevator**,** Kirschner wire**,** Pedicle probe**,** Tap 5.5 mm and 6.5 mm, Pedicle sound, Rod contouring template, Rod cutter, Rod holder, rod pusher, Rod stabilizer, Distractor self holding, Hex screw driver.

Surgical technique

General anaesthesia will be utilized for all the cases. Patient will be positioned prone on bolsters over a radiolucent operation table. The involved level is marked under C-arm guidance. A posterior midline skin incision is made to expose three levels above and three levels below the affected levels.

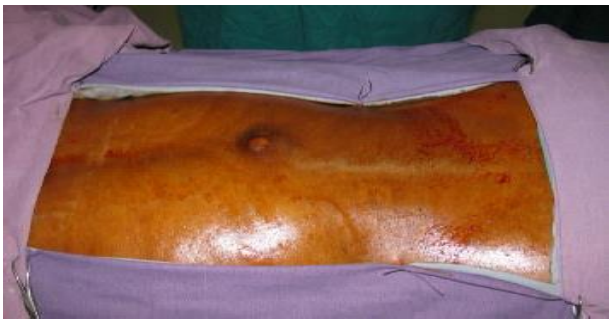

Fig 1: Patient in prone position

Lateral exposure is made upto the transverse process of each vertebra. In the thoracic regions, at the level of the diseased segment lateral dissection will be continued five cm lateral to the transverse process to expose the ribs for excision.

Pedicle screws are introduced two levels above and below the affected level. For D1 level pathology C6 lateral mass screw and C7 pedicle screws will be used. Pedicle screws will be used in the rest of the spine. In thoracic region, at the level of the lesion five cm of medial rib is excised along with the transverse process to develop the posterolateral approach.

Fig 2: Pedical screws two levels above and below the affected level

Depending on the compression side either unilateral or bilateral posterolateral approach is used. The segmental nerves will be protected in lumbar region at any cost. If needed one or two segmental nerves may be sacrificed in the thoracic region for safe cage placement. Malleable retractors will be placed anterior to vertebral body protecting the great vessels. Total laminectomy will be done at the diseased level.

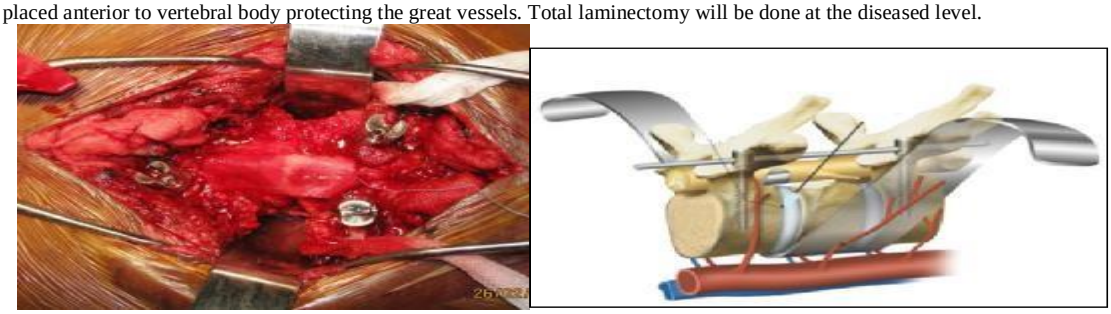

Fig 3(a,b): Malleable retractor to protect the great vessels

Temporary rod stabilization on one side to stabilize the spine temporarily will be done, then facetectomy and pediculectomy will proceed on the other side protecting the nerves and thecal sac. Hemicorpectomy and disectomy will be done on this side.

Fig 4: Temporary rod stabilization on one side

Then temporary rod stabilization will be shifted to the opposite side to effect thorough decompression from the opposite side if needed. Appropriate sized Harm's cage is measured and filled with bone graft harvested either locally or iliac crest. Cage will be inserted into anterior column through the posterolateral access.

Fig 5: Placing bone graft chips around the cage

Bone graft chips will be placed around the cage spanning the vertebral bodies. Valsalva maneuvre will be done to look for pleural rupture. If there is pleural rent attempted closure will be done and if not possible ICD will be inserted. Gel foam will be applied over the exposed pleura. Appropriately contoured rods will be applied on both sides and compression will be achieved across the decompressed segment.

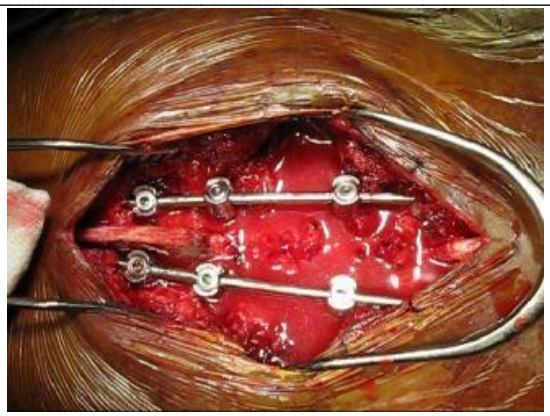

Fig 6: Valsalva maeneuvre

The stability of the cage will be assessed before closure of the wound over a drain. Image intensifier evaluation will be done to look for satisfactory positioning of cage, screws and the sagittal alignment of the spine.

Fig 7: Intra operative c-arm image after stabilization

Postoperative management and follow up

Postoperatively, all Patients were on IV antibiotics till 5th postoperative day. First dressing is done after 48 hours. Drain was removed once the drainage is less 30ml/day, preferably 2nd post operative day. Depending on the neurological status physiotherapy, rehabilitation and gait training with appropriate external orthoses was done accordingly. Suture removal done on the 10th post operative day. All patients received Deep vein thrombosis prophylaxis till they are adequately mobilized. Special attention will be given for back care and chest physiotherapy in the immediate postoperative phase. Postoperative radiographs will be taken on the 2nd day.

Follow up

Patients were followed up in the outpatient department on a monthly basis till satisfactory fusion is shown on X-ray and satisfactory recovery has been achieved. There after 6 monthly follow up for one and half year. During these visits the clinical and radiological improvement will be assessed. Clinical evaluation is done using ASIA motor score, ASIA impairment scale and VAS score. Radiological union and correction of deformity will be assessed using anteroposterior and lateral radiographs using kyphotic angle, graft fusion and implant status. In doubtful cases, fusion will be assessed using CT scan. All details and any complications during this period were entered in the proforma.

Results

A total of 31 patients were included in the study with mean age of 33.09 ± 15.22 years. Majority of the study population were in the range of age group 21 to 30 years (48.39%) followed by 18 to 20 years (16.13); 31 to 40 years (12.9%); 61 to years (9.68%); 41 to 50 years (6.45%) and 51 to 60 years (6.45%). In our study, majority were males (54.84%) compared to females (45.16%). In our study the mean time interval between admission and surgery was 1.90±1.3 days. In our study average duration of hospital stay was 15.29±4.68 days. Mean age of patients with fracture was 25.17 years, with infection was 38 years and tumor was 57.7 years. These were depicted in table 1. In our study majority of the patients had fracture (18, 58.06%) and the mode of injury in fracture group was fall from height in 9 patients and RTA in 9 patients. In our study the mean blood loss of all the groups(fracture, infection and tumor) together was 551.61±209.56 ml. In our study the average duration of surgery was 201.94±25.35 minutes. In our study the blood loss was more among tumor group with an average of 825ml, the duration of surgery was also more in tumor group with a mean of 230 minutes which were statistically significant with p-value (<0.05). But the duration of hospital stay almost same and insignificant. These were shown in table 1.

ASIA grading was used to assess neurological status in the pre operative and post operative period. In our study post operative neurological status remained unchanged in 2 patients with complete cord injury and in 7 patients with no neuro deficit pre operatively. Rest of the patients neurological status improved post operatively. These were shown in table 2. In our study among fracture group all the patients improved neurologically except 1 patient who was in ASIA- A in the pre operative period remained unchanged. Among the infection group except 4 patients who were in ASIA- E grade pre operatively all other patients improved by atleast one grade. In tumor group 1 patient remained unchanged post operatively in ASIA- A, 1patient remained in ASIA- E and 2 patients changed from ASIA- D to ASIA- E. Neurological improvement was observed in 91.7% patients.

In our study on comparing the pre and post operative ASIA motor score the improvement was statistically significant(t= 5.76, p<0.001).

The improvement in motor score was statistically significant among fracture and infection groups (p-value<0.05), but not significant among tumor group which can be attributed to total number of patients in tumor group were 4 and 2 patients neurological status remained unchanged at final follow up. This was shown in table 3. In our study the correction of kyphotic angle obtained was 18.09 degree, which is statistically significant. There was no loss of correction on final follow up. The average pre operative and post operative kyphotic angles were 28.64±9.02 and 10.55±8.25 (Mean±SD) respectively. The kyphotic angle correction obtained in fracture, infection and tumor groups were statistically significant. The difference between the three groups was not significant. This was shown in table 4. In our study the average pre-operative and post-operative VAS was 8.39 and 2.32 rspectively. The improvement was found statistically significant. This was shown in table 5.

There were no complications encountered in our study. In our study no patient developed pain, recurrence of deformity, worsening of neurological status, worsening of kyphosis angle, screw back out, screw breakage or rod breakage. No patient had implant failure at follow up in our study. Healing in terms of wound healing and graft fusion is achieved when there is clinical and radiological evidence of successful fusion. It can be defined as absence of local pain and tenderness over the site of fusion, maintaining the correction achieved and presence of trabecular bone bridging between the graft and vertebral body. There were no healing problems in our study. One of the illustrated case was shown in figure 8 to 11.

Table 1: Frequency and percentage wise cases according to their sex with diagnosis

Table 2: Frequency and percentage wise cases according to their neurologic status

Neurologic status	Pre –operative neurologic status		Post-operative neurologic status		Final –neurologic status	
	n	%	n	%	N	%
ASIA-A	6	19.35	2	6.45	2	6.45
ASIA-B	1	3.23	-	-	-	-
ASIA-C	9	29.03	2	6.45	1	3.23
ASIA-D	8	25.81	11	35.48	7	22.58
ASIA-E	7	22.58	16	51.61	21	67.74
TOTAL	31	100	31	100	31	100

Table 3: Motor Score pre, post operative and final

Variables	Fracture (n=18)	Infection (n=9)	Tumor (n=4)	Total (n=31)	F-value (pvalue)
	Mean ±SD	Mean ±SD	Mean ±SD	Mean ±SD	
Motor pre score	69.17±16.95	92.67±8.10	84.5±23.18	77.96±18.74	6.99(0.003)
Motor Post score	88.56±13.32	99.11±2.67	86.5±24.41	91.36±13.71	2.24(0.126)
t-value (p-value)	6.15(p<0.001)	2.86(p=0.021)	1.63(p=0.201)	5.76(p<0.001)	
Motor final score	92.22±12.65	99.55±1.33	87.5±25	93.74±13.05	1.52(0.234)
t-value (p-value)	6.26(p<0.001)	2.82(p=0.02)	1.69(p=0.19)	5.77(p<0.001)	

Table 4: Kyphotic pre, post operative and final

Variables	Fracture (n=18)	Infection (n=9)	Tumor (n=4)	Kyphotic angle	F-value (p- value)
	Mean ±SD	Mean ±SD	Mean ±SD	Mean ±SD	
kyphotic pre	28.11±10.04	28.22±8.57	32±5.42	28.64±9.02	0.30(p=0.741)
Kyphotic post	11.44±9.68	9.67±6.98	8.5±2.38	10.55±8.25	0.27(p=0.767)
Kyphotic final	11.44±9.68	9.67±6.98	8.5±2.38	10.55±8.25	0.27(p=0.767)
t-value (p-value)	5.46(p<0.001)	7.59(p<0.001)	10.42(p<0.001)	9.28(p<0.001)	

Variables		Fracture (n=18)	Infection (n=9)	Tumor (n=4)	Total (n=31)	F-value (p-value)
		Mean ±SD / n(%)	Mean ±SD / n(%)	Mean ±SD / n(%)	Mean ±SD / n(%)	
Age		25.17±5.17	38±18.07	57.75±5.79	33.09±15.22	16.71(p<0.0001)
Sex	Male	13 (76.4%)	2 (11.8%)	2 (11.8%)	17 (100%)	0.047
	Female	5 (35.7%)	7 (50%)	2 (14.3%)	14 (100%)	
Blood loss		550±207.22	433.33±119.89	825±125.83	551.61±209.56	6.67(p=0.004)
Duration of surgery		201.11±26.32	191.11±13.64	230±24.49	201.94±25.35	3.92(p=0.032)
Hospital stay		16.17±5.69	14±2.29	14.25±3.2	15.29±4.68	0.74(p=0.484)
Total		18 (58.06%)	9 (29.03%)	4 (12.9%)	31 (100%)	

Table 5: Mean and SD of VAS Score

VAS score	Mean±SD
Pre –operative	8.39±0.95
Post-operative	2.32±0.75
t-test(p-value)	49.66(p<0.001)

Fig. 8: Pre-operative radiograph (AP/LAT)

Fig. 9: Post-operative radiograph (AP/LAT)

Fig. 10: Post-operative radiograph (AP/LAT) (6 months)

Fig. 11 (a,b): Patient after treatment

Discussion

Numerous pathologic conditions of both traumatic and non traumatic etiologies can cause spinal cord compression. Surgical decompression with or without stabilization is an effective remedy for most of these conditions. The primary goals of the treatment for the patient with spine pathology are to provide stable pain free spinal column, restore spinal alignment and protect neurological function. The common causes of spinal decompression surgeries performed in India are infections, fractures and tumors. Many of these conditions need adequate circumferential decompression and stabilization (as lesion involving both columns compromises stability). In widespread spinal tumor and thoracolumbar burst fractures also, it becomes essential to decompress the spinal cord circumferentially and stabilize it[2]. Recent literature have mentioned that adequate circumferential decompression is possible through only posterior approach, thereby reducing the surgical time, blood loss, infection and overall morbidity of the patients[3]. Transpedicular or posterolateral window access through the posterior approach not only allows the surgeon to decompress the anterior column, but also allows anterior column reconstruction and robust posterior stabilization with pedicular screw system. Hence, corpectomy and three- column reconstruction through single posterior is possible with reduced morbidity, thus allowing early rehabilitation[4,5,6].

In our clinical study, 31 patients with (fracture, infection and tumor)

were treated with this surgical technique. The analysis of results were made in terms of – ASIA neurological grading, ASIA Motor score, kyphotic angle, VAS, blood loss, duration of surgery, complications, implant failure and duration of hospital stay. All the patients are followed up on monthly basis till satisfactory fusion is shown on X-ray and satisfactory recovery has been achieved. All the patients are followed up for a minimum of 6 months and there after 6 monthly follow up for 2 yrs. In our series majority of the patients were between the age of 18 and 30 years (48.39%) with maximum incidence being the productive age group 18 – 40 years (77.42%) with an average of 33.09 years. Sex distribution was like in fracture group 13 were male patients and 5 were female patients, among infection group 2 were male and 7 were female patients, in tumor group 2 male and 2 female patients. Majority of the patients were affected with fracture 18 (58.06%), next being infection 9 (29.03%) and tumor being 4 (12.9%).

Neurological recovery

In our study neurology was either improved or stable in all the patients with neurological improvement in 91.7% patients out of 24 patients who had neurological deficit, which is comparable with other studies i.e. Metcalfe S et al[6] (89.04%); Sahoo M et al[8] (94.4%); Wang JC et al[5] (96%). There was no case of neurological deterioration in our series. In our study on comparing the mean pre operative (77.96±18.74) and post operative (91.36±13.71) ASIA motor score the improvement was highly significant (t= 5.76, p<0.001).

Duration or surgery

In our study the average duration of surgery was 201.94±25.35 minutes which was comparable with other studies i.e Yang H et al[7] (157 minutes); Sasani M et al[2] (187.8 minutes); Metcalfe S et al[6] (260 minutes) and Wang JC et al[5] (300 minutes).

Kyphotic angle

The average pre operative and post operative kyphotic angles being 28.64±9.02 and 10.55±8.25 (Mean±SD) respectively, this was statistically significant there is no loss of correction at final follow up in fracture, infection and tumor groups. We observed that kyphotic angle correction obtained was at par with other studies i.e. Sasani M et al[2] (7.5º); Sahoo M et al[8](8.3º) and Yang H et al[7](21.26º).

Mean post operative VAS

The average VAS was 2.32 in the immediate post operative period which was compared with other studies i.e. Sahoo M[8](0.74); Yang H et al[7] (1.92); Sasani M et al[2] (2.66). The result was statistically significant in all the three groups (p-value <0.05).

Blood loss

In our study the average blood loss was 551.6±209.56 ml which is less compared to other studies i.e Sasni M et al[2] (596.4 ml); Yang H et al[7] (1086 ml); Wang JC et al[5] (1500 ml); Street J et al[1] (1514 ml) and tumor group had a mean blood loss of 825±125.83 ml.

Complications

No complications neither intra operative nor post operative were encountered in our study. similar results were observed in the studies done by Sundararaj G D et al[3] and Yang H et al[8]. Whereas in the studies done by Wang JC et al[5] and Sasani M et al[2] showed 11% and 14% complications respectively.

Hospital stay

The average duration of hospital stay was high (15.29 days) in our study attributed to rehabilitation, physiotherapy and associated injuries. Its was lower in studies done by Wang JC et al[7] (9 days) and Metcalfe S et al[6] (7.7 days). Four patients needed ventilator support due to associated injuries and rib fractures.

Conclusion

The most common cause of neurological deficit in our study was trauma followed by infection and tumor. The study has preponderance to males in the trauma group while infection group had a female preponderance. While lesions in trauma group involved mainly thoracolumbar junction (D11- L2), lesions in the infection group involved (D3-L3). The improvement seen in the trauma group was better the than improvement in infection group. In fracture group patients with incomplete neurologic deficit exhibited a better prognosis compared to those with complete neurologic deficit. 93.5% patients showed improvement in the neurology which was comparable with other studies, only 2 patients with complete neurologic deficit did not recover. The overall outcome was poorer among tumor group compared to other groups. The correction of kyphosis improvement in VAS in our series is comparable with other studies. Intraoperative blood loss was less compared to other studies. No complications were encountered in our study. Single stage posterior approach for acute thoracolumbar fractures offers advantages over the classic combined anterior-posterior approach. Kyphosis correction is better maintained with posterior instrumentation.

Posterior transpedicular approach allows circumferential epidural tumor decompression and placement of anterior and posterior spinal column instrumentation.

On conclusion we say that this approach provides sufficient access safe and effective circumferential decompression and three column stabilization and achieved a high success rate for pain relief, neurological preservation and functional improvement, while avoiding the morbidity associated with combined approach. Less intra operative blood loss, complications, shorter operative time, better pulmonary function after operation and early rehabilitation are significant advantages of posterior surgery.

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