Original Article

Minimally invasive spinal fusion and decompression for thoracolumbar spondylodiscitis

ABSTRACT

Objective: The objective was to study the results of the treatment of thoracolumbar spondylodiscitis (SD) through minimally invasive fusion and decompression technique.

Materials and Methods: All the patients were evaluated clinically and radiologically (X-ray, magnetic resonance imaging, and computed tomography scan) along with necessary laboratory investigations. They underwent the minimally invasive spinal (MIS) decompression and fusion procedure using tubular retractor system and percutaneous transpedicular fixation done under fluoroscopy guidance. They were assessed using pre- and postoperative Visual Analog Scale (VAS), Oswestry Disability Index (ODI), and Kirkaldy-Willis functional outcome criteria. Postoperative radiological assessment of fusion was done. Operating time and fluoroscopy duration were also studied.

Results: There were a total of 12 patients, with an equal sex ratio of 1:1 with 8 and 4 patients having the involvement of the lumbar and dorsal spine, respectively. The fixation was done in the involved vertebrae in 8 patients and adjacent normal vertebrae in 4 patients. There was an improvement in VAS score from 7.8 to 2.1 and ODI from 64.3 to 16.4. 4 patients had excellent, 7 had good, and 1 had fair outcome in Kirkaldy-Willis functional outcome criteria. There was Grade 2 and 3 fusion in 4 cases each, and 2 patients had Grade 4 fusion. The laboratory studies were found positive for tuberculosis in 3 cases with 7 having necrotizing granulomatous inflammation, and 2 patients had negative results.

Conclusion: The MIS procedure is a safe and effective method of the management of SD in the thoracolumbar spine.

Keywords: Fusion, minimally invasive decompression, spondylodiscitis

INTRODUCTION

Spondylodiscitis (SD) is the infection of the spine affecting the various anatomical elements including intervertebral disc, vertebral body, or the posterior arch of the vertebra. The infection could be pyogenic, tubercular, and parasitic. In the Indian subcontinent, tubercular SD is more frequently seen compared to the other types of SD though exact incidence is not known.[1] On the other hand, the pyogenic SD is as well on rising trend owing to the increased longevity of life, a rise in the number of spinal procedures, and an increase in immunocompromised patients.[2-4] The annual incidence of pyogenic SD in the Western world ranges between 1:2000000 and 1:250,000.[5,6] SD causes considerable mortality and morbidity. Pyogenic SD has an estimated morbidity of 7% and mortality of 5%.[7]

There exist many challenges for the diagnosis of SD, including the type of SD, especially in our setup where the tuberculosis (TB) incidence is high. Equally challenging is the treatment of SD. The options include computed tomography (CT)-guided biopsy,

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followed by conservative treatment with antibiotics along with immobilization[8-10] and endoscopic decompression which could be effective in early stages of SD.[11,12]

Open procedures for SD have been the gold standard when surgery was chosen as the treatment option. However, the recent trends in spine surgery toward minimal invasiveness changed the SD management from open to minimally invasive spinal (MIS) procedures. The present article describes the authors' experience with treating various types of SD with MIS procedures using tubular retractor system and percutaneous instrumentation in the thoracolumbar spine.

MATERIALS AND METHODS

This was a retrospective review of all patients who underwent MIS decompression and fixation for SD from June 2018 operated by a team of three neurosurgeons.

The diagnosis of SD was provisionally made based on the symptomatology and the imaging. All the cases included in the study were evaluated with detailed history including history of prior surgery, history of infection elsewhere, and neurologcal examination, laboratory investigations (Erythrocyte sedimentation rate [ESR], C-reactive protein [CRP], total leukocyte count [TLC], and blood and tissue culture and histopathological examination (HPE) and TB GeneXpert) and radiological investigations (CT, MRI, PET-CT, (in selected cases) and X-ray). Other parameters which were taken into consideration were pre- and postoperative Visual Analog Scale (VAS), Oswestry Disability Index (ODI), Kirkaldy-Willis functional outcome criteria, number of segments involved and fused, operative time, and fluoroscopy time and intra- and postoperative complications.

Indications of surgery in SD include (1) neurological deficits, (2) spinal instability and deformity, (3) failed conservative management with worsening or unresolved pain, and (4) unknown organism.

Procedure

The patient was placed in prone position under general anesthesia on a fluoroscopy compatible operating table. After thorough preparation of the skin and draping, midline and percutaneous pedicle entry points are marked under fluoroscopic guidance and guidewires are placed through an incision of 3 cm on each side of the midline which generally corespond to 2 to 3 mm lateral to the lateral border of the pedicle visualised on the AP view of the spine on Flurosocope just lateral to the pedicle entry points [Figure 1]. If the pedicles of the involved bodies are healthy and the vertebral body is partially destroyed, guidewires were placed in the involved bodies. In cases of destruction of the pedicle and a significant portion of the body, adjacent uninvolved vertebra was chosen for the placement of the screws. Serial tubular dilators were placed on the side of pathology and tubular retractors docked on the facet. To access the disc space in lumbar spine pathology, facetectomy was done and pedicle drilling was done in the thoracic spine. Laminectomy and over-the-top decompression were done to decompress the canal. Pituitary rongeurs and curettes were used to debride necrotic disc material, the disk space was thoroughly irrigated, and antibiotic solution was instilled. A specimen was sent for HPE and culture and GeneXpert for TB. Pedicle screws were placed over the guidewires on both sides and connected with rods. The wound was closed in a standard fashion with vicryl sutures and staples. Illustrative cases are shown in Figures 2 and 3.

Postoperative management

All patients were ambulatory on day 1 and were discharged on day 3. All patients underwent postoperative X-ray and CT scan. In cases of suspected and proven TB, antituberculous treatment (ATT) was started on postoperative day 1 and the drugs were continued for 18 months. The 18-month treatment involves 6 months of rifampicin, isoniazid, pyrazinamide, and ethambutol and rest of the 12 months of isoniazid, rifampicin, and ethambutol.

RESULTS [TABLE 1]

A total of 12 patients underwent the procedure, and there were 6 female and 6 male patients, with an average age of 41.5 years. All the patients had axial backache and two patients had focal neurological deficit preoperatively. The average follow-up duration was 6.35 months.

Two patients among them had previous discectomy and one patient is a known case of hemolytic anemia.

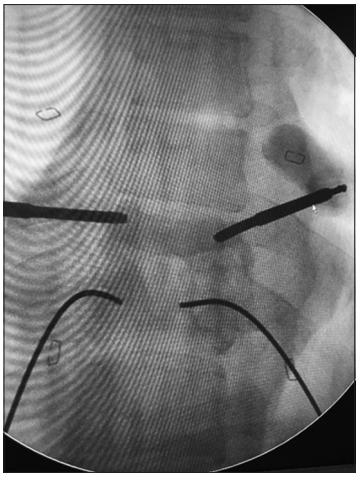

Figure 1: Accessing the pedicle with Jamshidi needle and guidewires

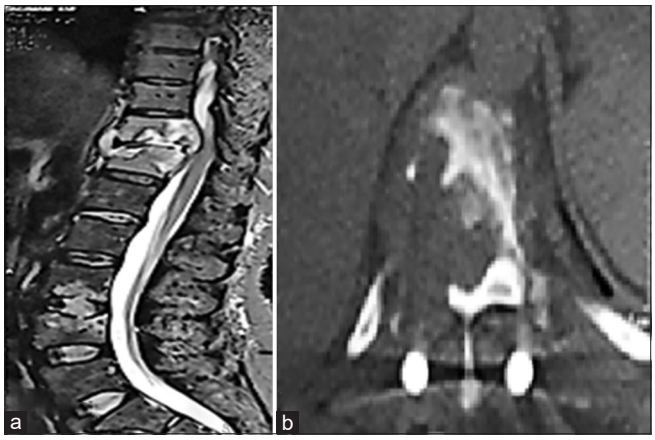

Figure 2: D11/12 spondylodiscitis. (a) Sagittal section of T2 magnetic resonance imaging showing end-plate destruction with epidural collection compressing the thecal sac. (b) Postoperative computed tomography scan showing adequate decompression of involved level with hemilaminectomy

Table 1: The patient demographics and post operative result

Patient characteristics	*n*
Male: female (total number: 12)	1:1
Mean age (range 13 years-64 years)	41.5
Presenting complaints	
Backache only	12
Associated radicular pain	4
Associated neurological deficits	2
Involved vertebral segments	
Dorsal spine	4
Lumbar spine	8
Operated vertebral segments	
Involved segments	8
Uninvolved adjacent segments	4
Average VAS score	
Preoperative	7.8
Postoperative	2.1
ODI (%)	
Preoperative	64.3
Postoperative	16.4
Kirkaldy-Willis functional outcome criteria	
Excellent	4
Good	7
Fair	1
Poor	0
Postoperative HPE/culture	
Tubercular	3
Necrotizing granulomatous inflammation	7
Negative	2
Average follow-up (months)	6.35
Average fluoroscopy time (s)	86.9
Average operative time (min)	131
Extent of bony fusion (Newton *et al.*) in 10/12 patients	
Grade 1	
Grade 2	4
Grade 3	4
Grade 4	2

VAS - Visual Analog Scale; HPE - Histopathological examination; ODI - Oswestry Disability Index

Figure 3: (a) Sagittal view of magnetic resonance imaging showing L4/5 spondylodiscitis. (b) Postoperative computed tomography axial section showing decompression of the involved level. (c) Lateral view of the postoperative X-ray showing the screw placement

Eight of 12 patients underwent fixation into the involved vertebra and four patients required fixation involving one normal adjacent vertebra in addition to the pathological vertebrae.

VAS scores for back pain improved from preoperative average of 7.8 to postoperative 2.1. The ODI score has shown a significant improvement from preoperative score of 64.3–16.4 in postoperative period. The Kirkaldy-Willis functional outcome criteria had excellent outcome in four, good outcome in seven, fair outcome in one, and poor in zero number of patients. Two patients who had thoracic SD with the ASIA Impairment Scale of Class C improved to Class D over a follow-up period of 2 months.

The HPE showed necrotizing granulomatous inflammation in 7 patients. GeneXpert was positive for tuberculous bacilli in 2 patients, and none of them had any resistance for isoniazid and rifampicin. One patient had tuberculous culture positive with sensitivity to all first-line antituberculous drugs. In 2 of 12 patients, the histopathology was not conclusive for either pyogenic or tubercular. In such cases of necrotizing inflammation or inconclusive status, empirical ATT or antibiotics or both were given based on symptomatology and imaging features.

Spinal fusion was assessed according to Newton *et al.*'s scoring system;[13] four patients had Grade 2 fusion [Figure 4] which is trabecular bone formation of more than 50% across the disc space, four patients had Grade 3 fusion which is <50% of bone formation, and two patients had Grade 4 fusion which is no bone formation, and none had Grade 1 fusion which is uniform bone formation across the disc space. The complications included an intraoperative lumbar pedicle breakage resulting in unilateral fixation, and another patient

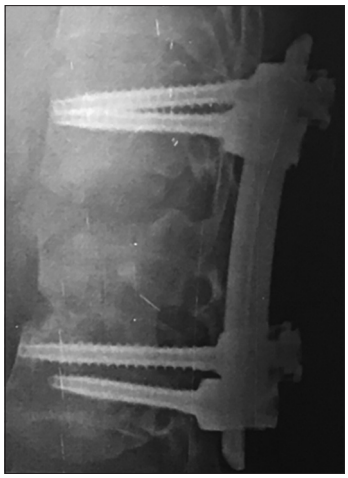

Figure 4: Postoperative X-ray of the L2–L4 fixation showing Newton Grade 2 fusion between L3 and L4 vertebrae

had a secondary bacterial infection of the wound which responded to culture-sensitive antibiotics. Two patients were lost to follow-up.

DISCUSSION

SD is a clinical challenge in terms of the diagnosis and the treatment. In the Indian subcontinent owing to the high incidence of TB, there remains a diagnostic dilemma as to the type of SD and the treatment strategies.[14] Musculoskeletal affection is observed in 4% of all cases with TB, 50% of which involve the spine.[15]

Although the exact prevalence is not known, tuberculous SD remains the most common SD seen in our practice contrary to the West, where pyogenic SD is the most common form of SD.[16,17] The incidence of acute nontuberculous vertebral osteomyelitis is estimated between 5 and 5.3 per million patients per year with a male predominance.[18]

Type of organism and yield

In bacterial SD, *Staphylococcus aureus* is the most commonly responsible organism, accounting for up to >75% of cases.[19,20] Other organisms that may cause bacterial SD include *Escherichia coli* in patients with concurrent urinary tract infections, *Pseudomonas aeruginosa* in patients with a history of intravenous drug abuse, *Streptococcus pneumoniae* in patients with diabetes, and *Salmonella* species in patients with sickle cell disease or asplenia.[21,22] The most common source of infection is hematogenous spread. In cases where the biopsy or culture is inconclusive and there is only a necrotizing granulomatous inflammation, there is a debate about which antibiotic regimen should be followed, and Güler *et al*. suggested that in countries where the incidence of TB is high, it is considered as the first differential diagnosis.[23] The cases in which the HPE demonstrated necrotizing granulomatous inflammation, we prescribed ATT for 18 months.

In our study, in cases with suspected TB, a quick confirmation of the pathology was done from the biopsy sample using GeneXpert test. In the study by Held *et al*., the sensitivity of the GeneXpert test was found to be 95.6%, the specificity 96.2%, the positive predictive value 97.7%, and negative predictive value 92.6% in cases of spinal TB.[24] We used GeneXPert test in four of our cases, and of the four patients, two were confirmed positive for TB on GeneXpert test. The remaining cases of suspected tuberculous SD were operated before the test was available to us. Two cases with negative biopsy could be because the patients received antibiotic treatment for the post lumbar dissectomy spondylodiscitis before presetnting to us. Both had chronic backache which was significantly impairing their quality of life.

Open versus minimally invasive spinal surgery

Lumbar pedicle screw fixation with transforaminal lumbar interbody fusion (TLIF) is an established, safe, and effective surgical technique in patients with infective SD.[25] Besides adequate surgical debridement, immediate stabilization when indicated could be achieved. Minimally invasive procedures help in that effect achieve the goal of decompression of the neural structures, giving the tissue to diagnose the type of organism and also faster pain relief as is evident in our series with a VAS score reduction from 7.8 to 2.1 in our series. Most of the patients who were not ambulatory because of pain started walking within 2 days of surgery. In most of the cases, we involved only pathological vertebra, giving the advantage of faster pain relief and minimizing the number of motion segments fused. Moreover, it possibly could offer the advantage of preventing the development of deformity. Tschugg *et al.* in their series of 69 patients found MIS procedures for SD having the advantage of overall less pain for the patient at the time of discharge and less duration of hospital stay.[26] All our lumbar SD patients had MIS TLIF with only bone graft placed into the disc space. The authors are of the opinion that adding fusion procedure, especially in cases of lumbar, prevents a chronic backache as opposed to the conservative management with antibiotics.

Another advantage of surgery is the higher yield of positivity of the sample obtained during the surgical procedure. Various studies have shown that the probability of the culture isolation of the bacterium is high, especially in cases of pyogenic SD compared to that obtained by CT-guided biopsy.[27,28]

In early stages of infection, there are several attempts of management for CT-guided biopsy and administration of culture-sensitive IV antibiotics, but the antibiotic treatment will be limited by the poor penetration of drugs to the disc space.[29] However, in the presence of focal collection with compression over neural elements, the decompression becomes necessary and selected cases of SD with focal abscess can be dealt with percutaneous endoscopic surgery. However, endoscopic approach has its own limitations in the form of limited access to the pathology, risk of injury to major vessels and viscera above L2 level, and need for separate incision for spinal stabilization. This problem is partially overcome by Chen *et al*.[30] by CT-assisted endoscopic surgery which enabled the surgeons to deal with upper lumbar and thoracic vertebrae. However, they are limited to cases where there is no motor weakness. In cases where there is extensive destruction with neurological deficits, proper debridement and irrigation with stabilization becomes imperative.

CONCLUSION

MIS procedures are feasible and effective in selected cases of SD. Quicker recovery, tissue diagnosis, and less pain at the time of discharge are some of the advantages of MIS procedures for SD.

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Conflicts of interest
There are no conflicts of interest.

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