Original Article

Surgical treatment of thoracic disc herniations using a modified transfacet approach

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Abstract

Background: Ideal surgical treatment for thoracic disc herniation (TDH) is controversial due to variations in patient presentation, pathology, and possible surgical approach. Althougth discectomy may lead to improvements in neurologic function, it can be complicated by approach related morbidity. Various posterior surgical approaches have been developed to treate TDH, but the gold standard remains transthoracic decompression. Certain patients have comorbidities and herniation that are not optimally treated with an anterior approach. A transfacet pedicle approach was first described in 1995, but outcomes and complications have not been well described. The aim of this work was to evaluate the clinical effect and complications in a consecutive series of patients with symptomatic thoracic disc herniations undergoing thoracic discectomy using a modified transfacet approach.

Materials and Methods: 33 patients with thoracic disc herniation were included in this study. Duration of the disease was from 12 days to 36 months, with less than 1 month in 13 patients. Of these, 15 patients were diagnosed with simple thoracic disc herniation, 6 were associated with ossified posterior longitudinal ligament, and 12 with ossified or hypertrophied yellow ligament. A total of 45 discs were involved. All the herniated discs and the ossified posterior longitudinal ligaments were excised using a modified transfacet approach. Laminectomy and replantation were performed for patients with ossified or hypertrophied yellow ligament. The screw–rod system was used on both sides in 14 patients and on one side in l9 patients.

Results: 29 patients were followed up for an average of 37 months (range 12-63 months) and 4 patients were lost to followup. Evaluation was based on Epstein and Schwall criteria.5 15 were classified as excellent and 10 as good, accounting for 86.21% (25/29); 2 patients were classified as improved and 2 as poor. All the patients recovered neurologically after surgery. A total of 25 patients had significantly improved motor function from 3 to 6 months after surgery and 10 patients had slow recovery 6 months after surgery.. Of the three patients with postoperative complications, two had exacerbated preexisting defects and one had implant failure. Postoperative computed tomography or magnetic resonance imaging showed that all patients had well fused replanted lamina and completely decompressed canal.

Conclusion: Thoracic discectomy using a modified transfacet approach can significantly improve the clinical outcomes.

Key words: Discectomy, intervertebral disc herniation, spinal stenosis, thoracic vertebrae, transfacet approach

Introduction

The incidence of thoracic disc herniations (TDHs) has been reported to be between 0.25% and 0.75% of all disc herniations[1] and symptomatic TDH is one patient per million population.[2] TDHs affect men more frequently than women, with a peak age of 40-50 years.[1,3] 75% symptomatic TDHs involve the lower segments (from T8-9 to T11-12) with the highest propensity for T11-12.[3] Onset and progression of symptoms can range from several hours to several years and as many as 25% of patients may experience complete absence of pain.[4] The vagueness of clinical history, chronic presentation, masquerading other pathological processes,[5-7] which delays in diagnosis and treatment. However, new techniques in computed tomography (CT) and magnetic resonance imaging (MRI) have resulted in earlier and more accurate diagnoses. Most TDHs are treated by surgery in view of cord compression.[8] Surgical removal of thoracic disc is relatively risky and is associated with ossified posterior longitudinal ligament and ossified or hypertrophied yellow ligament. Several approaches have been reported in literature to treat TDHs.[9] These approaches can be grouped into four categories, namely, anterior, true lateral, posterolateral, and posterior approaches. No gold standard exists and each

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technique has unique advantages and disadvantages.[9] In the current study, we modified the transfacet approach described initially by Stillerman *et al.*,[10] for safe discectomy and segmental reconstruction, in order to avoid recurrence or late deformity [Figure 1]. Our goal was to assess the outcomes and complications in patients undergoing transfacet discectomy and fusion.

Materials and Methods

A consecutive series of 33 TDH patients (27 males and 6 females), 18 to 72 years in age (average of 41.8 years) treated from October 1994 to August 2009 were included in this study. The duration of the disease was from 12 days to 36 months, with less than 1 month in 13 cases. 9 cases were due to trauma.

Inclusion criteria were (1) symptoms of numbness weakness, and difficulty in walking; or neuralgia of the back and intercostals; or loss of bladder control and constipation (2) Imaging showed Disc herniation (single-segment, double-segment, or triple-segment) of T2 to T12; MRI showed spinal cord compression (3) Complication like Ossified or hypertrophied yellow ligament. Exclusion criteria were Older age (>80 years), or patients with systemic disease (disease which influence the cardiopulmonary function) who could not tolerate surgery (anaesthesia).

All herniated discs were excised using a transfacet approach. Laminectomy and replantation of laminae were performed for the cases with ossified or hypertrophied yellow ligament. The pedicle screw system was used on both sides (n=14) or on one side (n=19).

Operative procedure

Under general anesthesia, patients were placed in prone position and the midline incision was made. The C-arm fluoroscopy somatosensory/motor evoked potential monitoring were used during surgery.

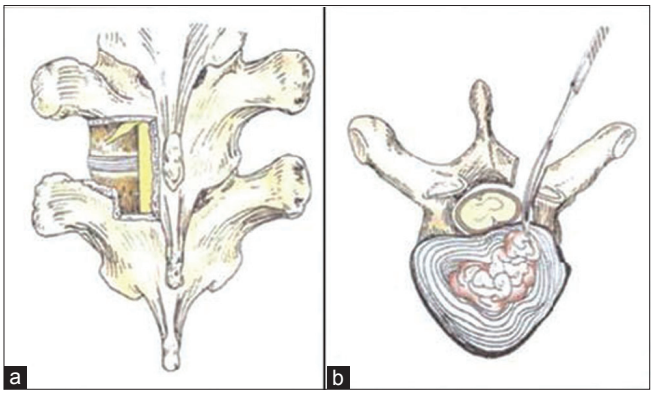

Figure 1: The schematic diagram showing (a) defect created in the zygapophysial joint and transverse process using a burr mill, (b) separating prominent intervertebral disc and spinal dura mater using a nerve dissector

The spinous process, lamina, and facet joint were exposed. Using a burr mill unilaterally or bilaterally facet joints were excised [Figure la]. When required, parts of the upper and lower ribs were excised to increase the exposure. The nerve roots and the prominent intervertebral disc was exposed. Disc material was removed using down angled curettes and pituitary rongeurs, working in a lateral to medial direction to create a central cavity. First, one third the prominent intervertebral disc, escaped from the middle and back of the lateral intervertebral space was removed. Next, the local nucleus pulposus and annulus fibrosus in the rear of the prominent intervertebral disc were removed to empty the anterior space of the prominent intervertebral disc. Finally, the remaining prominent intervertebral disc was carefully separated from the spinal dura mater using a nerve retractor and an "L"-type intervertebral disc processor; this was then pushed to the front and excised [Figure lb]. A posterior screw and rod system was used for internal fixation after intervertebral disc excision.

For patients with ossified ligamentum flavum, total laminotomy and autografting *in situ* was performed. The laminae were carefully cut in a trapezoid manner, just medial to the facet joints on both sides. Osteotomy was performed with a microsaw and a custom-made thin osteotome to minimize bone loss from the laminae. The inferior half of the spinous process of the superior adjacent vertebra, superior half of the spinous process of the inferior adjacent vertebra and ligamentum flavum were removed. The laminae and spinous processes were carefully elevated *en bloc* from the caudal to the cranial side to expose the dura. The herniated disc was treated using a similar method. After decompression, the laminae were reattached to their original sites and fixed by suturing the detached yellow ligament (or with sutures passed through the bony holes at each edge of the laminae). The spinous processes were also fixed to the residual or adjacent spinous processes with sutures through holes. Finally, the supraspinous ligaments were also sutured to help keep the spinous processes and laminae *in situ*. Gauge 10# silk or nylon sutures were used in all procedures for fixation of the laminae and spinous processes [Figure 2].

All patients were postoperatively treated with mannitol for 5-7 days and neurotrophic vitamin B1 and vitamin B12 for 1-2 months. The two patients who had somatosensory-evoked potential abnormalities and showed no significant recovery were treated intraoperatively

or postoperatively with methylprednisolone pulse therapy (30 mg/kg intravenous bolus within 15 min, followed by a 45 min intermission, and 3.4 mg/kg/h intravenous injection for 23 h). At the same time, intravenous injection of 500 ml of low-molecular-weight dextran daily for 2 weeks and 90 mg of nimodipine thrice a day for 2 weeks were given to improve microcirculation.

Results

29 patients were followed up for an average of 37 months (range 12-63 months) and 4 patients were lost to followup. Evaluation was based on Epstein and Schwall criteria.[5] 15 were classified as excellent and 10 as good, accounting for 86.21% (25/29); 2 patients were classified as improved and 2 as poor. The total efficiency was 93.10% (27/29). All the patients recovered neurologically after surgery. A total of 25 patients had significantly improved motor function from 3 to 6 months after surgery and rest had slow recovery 6 months after surgery. Frankel classification showed that the 29 patients who underwent followup, four patients were preoperatively graded as A, 11 as B, 7 as C, 6 as D, and 1 as E. At the final postoperative followup, 3 patients were graded as C, 15 as D, and 11 as E [Table 1].

12 patients who had total laminectomy and *in situ* replantation underwent followup and showed bone healing in all replanted spinous process and lamina [Figure 3]. However, symptoms worsened in two patients after surgery and the Frankel grade increased from preoperative D to postoperative B in one patient. Considering severe adhesion between the ossified posterior longitudinal ligament and the spinal dura mater, which can stimulate the spinal cord when separated, the patient classified as postoperative Frankel grade B was treated with dehydration drugs, neurotropic drugs and early hyperbaric oxygen therapy. His Frankel grade decreased to D 26 months later, but did not improve further. Meanwhile, the other patient had a large intervertebral disc herniation. His Frankel grade increased from preoperative E to postoperative A. This patient was treated with dehydration drugs, neurotropic drugs and early hyperbaric oxygen therapy, because the observed change may have been caused by spinal cord stimulation during separation of the adhered ligament and by injury during reperfusion after decompression. The patient's sensation began to recover 2 days after treatment and his muscle strength began to recover 4 days later. At day 7, muscle strength was graded as 3 (manual muscle test) and Frankel grade returned to C 6 months later. One patient had improved symptoms immediately after surgery. However, edema was found in his spinal cord 2 days later, because he was not given dehydration drugs; thus, his paraplegic symptoms worsened and his Frankel grade increased from C to B. After the patient was given dehydration drugs and high-pressure oxygen therapy, his Frankel grade returned to D 5 days later.

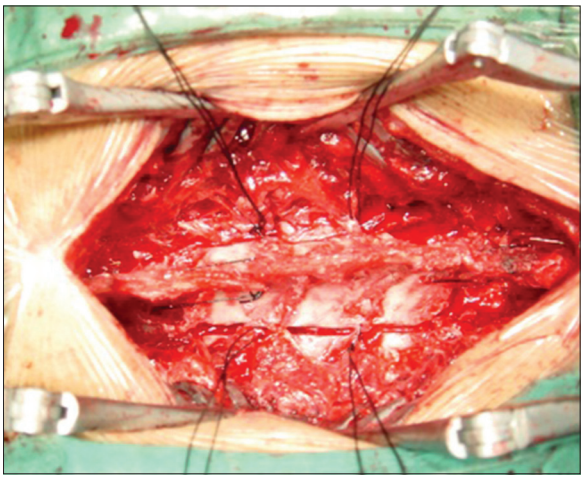

Figure 2: Intraoperative photograph showing the reattached laminae and spinous processes using 10# sutures

Discussion

The diagnosis of TDH can be quite challenging because of its complicated causes[11] and wide variety of symptoms. The etiological factors include weakness of the posterior longitudinal ligament and greater mobility of the lower thoracic spine.[8,12,13] Only 33-50% of patients with symptomatic disease report a history of trauma.[14,15] Patients with thoracic disc disease may present with varied symptoms, which can be classified into four broad categories, namely, back pain, sensory changes, motor deficits, and alterations in bowel or bladder habits. Patients usually present with a combination of these symptoms. In our study, 87.9% had numbness, weakness, and walking difficulty; 69.7% had back and intercostal neuralgia; and 48.5% had weak urination and constipation.

Surgical intervention alone is considered to be the treatment of choice for symptomatic TDH, especially for patients with myelopathy.[16-19] Theoretically, posterior laminectomy can reduce cord compression. However, Patterson and Arbit[20] reported that the effect of laminectomy is limited, because

Table 1: Frankel grading

Frankel grading before operation	Frankel grading at the last followup				
	A	B	C	D	E
A	0	0	2	2	0
B	0	0	0	5	6
C	0	0	0	7	0
D	0	0	0	1	5
E	0	0	1	0	0

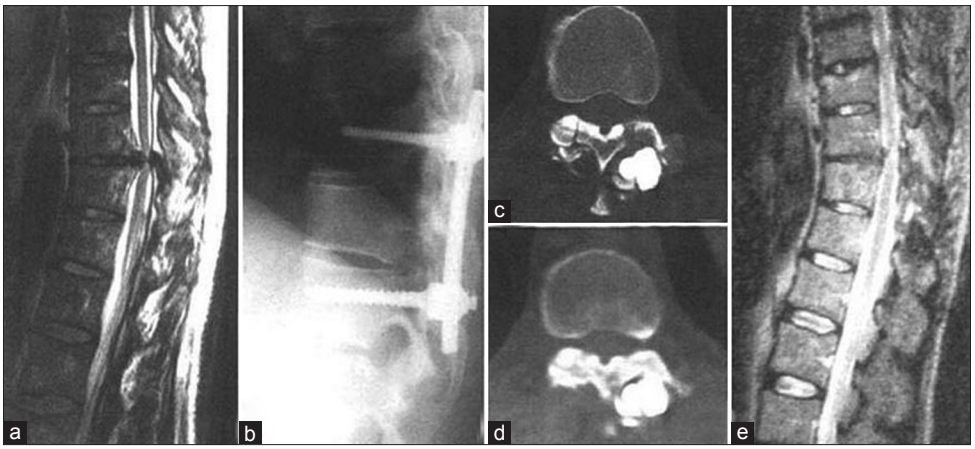

Figure 3: A 45-year-old male patient with T10-11 intervertebral disc prominence associated with ossification of yellow ligament. (a) Sagittal MRI T2-Weighted showing high signal at T_{10-11} level; (b) unilateral fixation using unilateral articular process approach and full lamina osteotomy plus in situ replantation (c) transverse CT scan at 1 month postoperation shows good location of the replanted lamina (d) transverse CT scan 5 years after surgery shows good healing of the replanted lamina, sagittal MRI shows full decompression; (e) sagittal MRI shows the spinal canal and sufficient decompression

the thoracic spine has a physiological tendency to develop kyphosis and the spinal cord tends to move forward. Thus, simple lamina excision cannot effectively relieve the compression of the spinal cord. Singounas *et al.*[21] improved this method and attempted to expose herniated disc by pulling aside the spinal cord and nerve roots after posteriorly excising the lamina; however, this method often leads to aggravated functional injuries to the spinal cord. In 1995, Stillerman *et al.*[10] improved discectomy using transfacet approach, in which the lateral articular process is excised to approach the intervertebral disc. This method[10] avoids the risk of neurological injury caused by intraoperative traction of dural sac. The interference to dural sac is minimal during exposure of the process and the herniated disc can be well exposed and completely excised. Compared with the anterior transthoracic procedures, this procedure can avoid the complication of atelectasis, pneumonia, and chest pain related with intrathoracic approaches to access through the chest. In addition, the operation is relatively simple. Preservation of the pedicle in the transfacet procedure reportedly leads to less postoperative localized axial back pain than is experienced by the patients treated with transpedicular discectomy.[10] However, compared with a transpedicular approach, the destabilization incurred by a facetectomy required for a transfacet approach makes segmental stabilization and arthrodesis necessary. In this study, all patients accepted discectomy using a transfacet approach and a posterior screw–rod system was used. The postoperative excellent and good rate was 86.21% and the total efficiency was 93.10% [Figure 4].

Total laminectomy and *in situ* replantation surgery are mainly used in lumbar disc herniation or lumbar spinal stenosis.[22] Zheng *et al.*[23] applied this method for TDH. Their method has the following advantages: (1) it restores the integrity of the spine and spinal canal; (2) it reduces bone loss using a thin homemade osteotome for osteotomy, thereby making the surface of the replanted lamina tidy and tightly connected, which is conducive to the healing of the lamina and avoids and reduces the lamina sinking as induced canal stenosis; (3) it rebuilds posterior soft tissue structure and further strengthens the stability of the spine by suturing the supraspinous and interspinous ligaments; (4) it prevents epidural adhesions; and (5) it restores the continuity of the posterior column. After conducting followup of 12 patients who underwent laminectomy and *in situ* replantation, we found that about 3 months after surgery, lamina was healed *in situ*. However, several considerations should be noted when performing total laminectomy and *in situ* replantation. (1) The chose osteotomy site should avoid spinal cord injury; the inner plate should be truncated in the bottom-up direction. (2) When performing total lamina replantation, ossified or hypertrophied ligamentum flavum in front of the lamina and inner plate of lamina should be excised prior to performing *in situ* replantation; in addition, the interlaminar ligamentum flavum should be sutured using No. 10 thread at both sides of the yellow ligament and then fixed to the spinous process to ensure connection between the resected surfaces.

There are also several issues that need attention during surgery. (1) Thoracic discectomy using transfacet joint approach can inevitably destroy the facet joint and affect spine stability; thus, thoracic interbody fusion and internal fixation screw and rod system should be applied. If one side is destroyed, unilateral fixation should be performed; if both sides are destroyed, bilateral fixation should be adopted. In our study,the screw–rod system was used on both sides in 14 patients and on one side in l9 patients. (2) Before excising the intervertebral disc, the

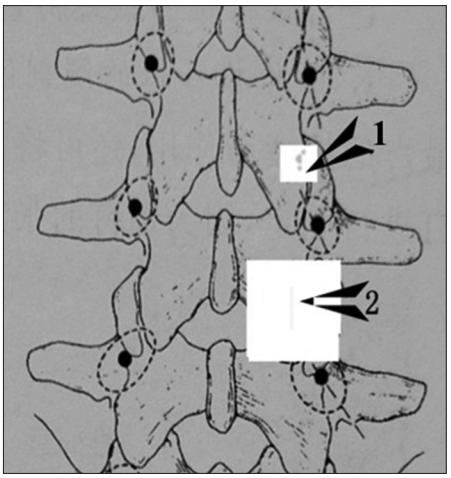

Figure 4: A schematic diagram 1 indicates the area of facet removal as described by Stillerman *et al.* (1995) in their transfacet pedical-sparing approach. 2 indicates the extent of bone removal for our approach

front of the herniated disc should be excised first. Then, the intervertebral disc prominent into the spinal canal should be carefully separated from the epidural and brought to the front to excise and avoid spinal cord injuries caused by repeated handling. (3) The anatomical structural characteristics of the thoracic spine result in spinal cord injury, which can worsen easily during surgical procedures. Thus, intraoperative somatosensory-evoked potential monitoring should be routinely applied to thoracic surgery if conditions allow.

The limitations to this study are the small series of patients from a single institution. Our experience shows that thoracic discectomy using a modified transfacet approach can significantly improve the clinical outcomes.

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