Surgical Treatment for Central Calcified Thoracic Disk Herniation: A Novel L-Shaped Osteotome

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abstract

Few reports are available on the posterior transfacet approach for the treatment of central calcified thoracic disk herniation (TDH). The objective of this study was to assess outcomes and complications in a consecutive series of patients with TDH who underwent posterior transfacet decompression and discectomy with segmental instrumentation and fusion. The data for 27 patients (16 males and 11 females) were retrospectively reviewed and analyzed, including clinical presentation, blood loss, operative time, pre- and postoperative complications, visual analog scale, Japanese Orthopedic Association (JOA) score, and Frankel grade. All patients underwent transfacet decompression and segmental instrumentation with interbody fusion. Mean patient age at surgery was 55.2 years (range, 21-81 years). Average follow-up was 30±19 months (range, 12-50 months). All patients were successfully treated with posterior decompression and segmental instrumentation with interbody fusion. Average operative time was 124±58 minutes (range, 87-180 minutes). Mean blood loss was 439±225 mL (range, 300-1500 mL). Average pre- and postoperative JOA scores were 4.12±0.87 and 8.01±0.97 points, respectively. Overall JOA scores showed a significant postoperative improvement. Overall recovery rates were excellent in 12 patients, good in 6, fair in 5, and unchanged in 1. No patient was classified as worse. The results suggest that the posterior approach using a special L-shaped osteotome is feasible. No major complications occurred while achieving adequate decompression for central calcified TDH. [Orthopedics. 2015; 38(9):e794-e798.]
Resection of calcified thoracic disk herniation (TDH) is often technically demanding. Several surgical techniques have been described to completely excise all disk material and reduce the rate of neurological morbidity. However, no universally accepted selection criteria exist to decide the best surgical approach for TDH. Generally, the selection of surgical approach depends on the location of the disk herniation (central vs lateral) and consistency (hard vs soft). The posterolateral or posterior approach may be used for soft central disks or calcified centrolateral disks. However, central calcified disks may be approached through an anterior or anterolateral approach because it allows direct visualization of the dissection plane between the dura and disk, which provides secure surgical management and helps in direct ventral decompression of the spinal canal. However, the anterior approach has significant approach-related morbidities, including pneumonia, pleural effusions, empyema, and intercostal neuralgia.

Little information can be found in the current literature regarding the posterior approach for the treatment of central calcified TDH because of poor visualization of ventral calcified disks. The objective of the current study was to report the outcomes of a transfacet approach in 27 patients with calcified massive TDH using a novel L-shaped osteotome (Figure 1) and to evaluate its efficacy and feasibility.

MATERIALS AND METHODS

Study Design

This study was reviewed and approved by the institutional review board of the authors’ hospital, and all patients provided written informed consent for the surgical procedures.

A retrospective analysis was performed. Data from 27 consecutive patients with central calcified TDH who underwent posterior transfacet thoracic disk excision between 2007 and 2012 using an L-shaped osteotome were included. Twenty-three (85%) patients presented with myelopathy, 16 (59%) presented with radiculopathy, and 21 (78%) presented with axial pain. Among patients with myelopathy, 12 had bladder and/or bowel dysfunction. Mean patient age at surgery was 47 years (range, 25-79 years). Herniation level was T7-8 in 7 patients, T6-7 in 1 patient, T9-10 in 3 patients, T10-11 in 5 patients, T11-12 in 9 patients, and T12-L1 in 2 patients. No obvious intradural penetration was found in this series, but 3 disks were adhered to dura mater. The size of disk protrusion ranged from 45% to 85% of the spinal canal (average, 69%). All herniated disks were partially or completely calcified, as evident on preoperative imaging.

Surgical Technique

The procedure was performed under general endotracheal anesthesia. The patient was placed in the prone position. The disk level of interest was identified using intraoperative radiography. A midline linear skin incision was made. The paraspinous muscles were reflected to expose the transverse processes and facet joints at these levels. A laminectomy was performed in a large central calcified disk with significant canal stenosis. Bilateral facet joints were removed using rongeurs and Kerrison devices (Jiangsu Jinlu Group Medical Device Co, Ltd, Jiangsu, China). The disk and part of the spinal cord were exposed from 2 sides of the intervertebral foramina. Once the lateral portion of the disk was removed and the anterior aspect of the thecal sac was carefully released from the posterior longitudinal ligament (PLL) and disk annulus, a down-biting flat curette was inserted under the thecal sac and used to push down the PLL and disk bulges anteriorly into the disk space. To resect the calcified herniated disks safely, superior or inferior of vertebral columns were resected using a special L-shaped osteotome. If residual calcified disks were still adhered to dura mater, down-biting curettes were inserted under the thecal sac and the disks/dural composites were gently pushed out and released carefully (Figure 2).

After the anterior aspect of the sac was sufficiently decompressed at both sides of the disk, the endplates were roughened using a ring curette. The disk space was impacted with autologous bone graft collected during the lateral facetectomy, and posterior fixation approaches were used in all patients. The osteotome allows disk resection through a limited midline incision, without the need for removal of pedicles, ribs, or transverse processes (Figure 3).

Assessment of Clinical Outcomes

The visual analog scale (VAS) was used to measure changes in pain from pre- to postoperative levels. Pre- and postoperative symptoms were assessed by Frankel neurological grade and Japanese Orthopedic Association (JOA) score for thoracic myelopathy. The JOA score recovery rate was calculated using the method of Hirabayashi et al. Recovery rate and final results were classified into 5 groups: excellent (75%-100%), good (50%-74%), fair (25%-49%), unchanged (0%-24%), and worse (<0%).

RESULTS

Clinical Outcomes

Average follow-up was 30±19 months (range, 12-50 months). Average operative
time was 124±58 minutes (range, 87-180 minutes). Mean blood loss was 439±225 mL (range, 300-1500 mL). In all patients, complete removal of the calcified disk was determined using postoperative computed tomography (CT) scan.

Functional Results

Mean preoperative VAS score was 8.01, which improved to a mean of 2.70 points at 6 months in 21 patients, 2.17 at 1 year in all patients, and 2.01 at final follow-up in 18 patients. Statistical analysis showed a significant improvement in pain at 6 months (P<.05) when compared with the preoperative status. There was no significant difference between the 6- and 12-month results (P<.05).

Postoperatively, total JOA score increased in all patients; average total JOA score increased from 4.12±0.87 (range, 3-6) preoperatively to 8.01±0.97 (range, 5-10) postoperatively. Mean recovery rates for lower limb motor, sensory, and bladder functions were 47.5%±27.1%, 48.3%±29.2%, and 54%±37.4%, respectively. Mean recovery rate for the total JOA score was 49.2%±25.4% (range, 14%-100%). Recovery rate=(JOA score at follow-up–preoperative JOA score)/(11–preoperative JOA score)×100 (%). Overall results were excellent in 12 patients, good in 6, fair in 5, and unchanged in 1. No patient was classified as worse.

The neurological status of patients was classified using the Frankel grading system. Four patients were Frankel grade B, 11 were grade C, and 12 were grade D. At final follow-up, Frankel grade improved either by 1 or 2 grades in 26 patients: 3 patients improved from grade B to C, 7 patients from grade C to E, 4 patients from grade C to D, and 12 patients from grade D to E. One patient had no change in grade; however, no further neurological deterioration had occurred. Patients were satisfied with the results of the surgery and experienced relief of their back pain.

Figure 2: Illustrations of the surgical procedure showing a normal thoracic transverse section (a), transverse section of the central calcified thoracic disk herniation (b), and laminectomy (c). The lateral portion of the disk was removed using a general osteotome and pituitary rongeur via transfacet decompression (d-f). The calcified disk was separated from the posterior longitudinal ligament or dura and completely cut using the L-shaped osteotome (g-j). The position and direction of osteotome bit placement (h) and autologous bone graft in the intervertebral space and posterior fixation in the adjacent vertebral body (k, l) are shown.

Figure 3: Radiograph showing hyperostosis and osteophyta at the posterior margin of the vertebral body in T12-L1 (a). Magnetic resonance image showing disk herniation and dura mater compression in T12-L1 (b). Computed tomography scan showing central calcified thoracic disk herniation in T12-L1 (c). Extent of the compression on sagittal reconstruction of computed tomography scan preoperatively (d). Lateral (e) and anteroposterior (f) radiographs showing excellent internal fixation and calcified disk removal. Transverse-view computed tomography scan showing complete decompression (g). Sagittal-view computed tomography scan showing complete decompression and excellent bone graft fusion (h).
Complications

No postoperative neurological deterioration was noted in any patient. No patient showed any signs of instrument migration or failure during regular follow-up. Postoperative kyphosis or recurrent disk herniation was not seen in any patient. One patient experienced a cerebrospinal fluid (CSF) leakage and underwent suture of the drainage tube 1 week postoperatively.

Discussion

Surgical management of TDH is technically challenging for various reasons. First, the thoracic canal is smaller, and the spinal cord-to-diameter ratio is higher in the thoracic spine than in the cervical and lumbar spines, leaving less space for the spinal cord during stenosis. The calcified or ossified lesions are often voluminous, which aggravates spinal canal stenosis and makes surgical resection difficult. Second, large calcified herniated disks make the spinal cord weak to any disturbance; hence, the surgeon should avoid overmanipulation to the dura mater, which may cause postoperative complications. In addition, the central disks are often adherent to the anterior dura or intradural, which makes dissection difficult. Finally, due to the rarity of these lesions and their chronic presentation, it can be difficult for spinal surgeons to gain experience, making management of the lesions challenging.

During the past decade, several attempts have been made to completely decompress the neural structures and restore the normal mechanical anatomy for TDH, including open transthoracic, retropleural thoracotomy, transpedicular, and transfacet approaches. Generally, a posterior approach (transfacet or transpedicular) may be used for soft central and calcified centrolateral disks, whereas anterior (transthoracic or thoracoscopic) and anterolateral (retropleural thoracotomy) approaches may be used for central calcified disks. However, these approaches have their own particular benefits and risks; therefore, surgeons should carefully select a treatment strategy based on each strategy’s features and on patient-related factors such as physical condition and respiratory function.

Anterior and anterolateral approaches may provide excellent exposure of ventral calcified disks without the need for manipulation of the spinal cord or dura; and the impaired dura is more easily, directly, and effectively closed with these approaches than with others, especially in intradural or transdural calcified TDH, which leads to dural tears or CSF leaks. Therefore, an anterior (anterolateral) transthoracic approach is the gold standard to treat TDH. However, the technique is associated with a number of significant morbidities in 50% of both adult and pediatric patients, including intercostal neuralgia, cardiopulmonary death, postoperative atelectasis, pneumothorax, pneumonia, substantial blood loss, and severe post-thoracotomy pain. Karmakar and Ho reported morbidities associated with thoracotomy in 50% of patients, which continued for 4 to 5 years postoperatively in 30% of patients.Mulier and Debois described a statistically greater pulmonary complication rate of 7% in patients who received treatment with transthoracic diskectomy vs 0% with the posterolateral approach (331 patients). These studies suggested that a posterolateral approach in patients with serious pulmonary comorbidities was a reasonable alternative.

In addition, there are many difficulties with the anterior approach. First, the surgeon works through a deep surgical management, which increases the difficulty, and thoracoscopy may not provide adequate exposure to the disk herniation–dura interface, even if the surgeon is skilled. Second, the approach necessitates a large surgical incision, soft tissue dissection, and resection of vertebral osseous structures, which may result in significant intraoperative blood loss, postoperative pain, and prolongation of postoperative hospitalization. Finally, less invasive thoracoscopic techniques have some disadvantages, including expensive equipment and a steep learning curve. Fewer incidences of TDH requires surgeons to seek additional training to acquire skills. In addition, poor experiences may result in prolonged operative times and occasional conversion to formal open thoracotomy.

For central and calcified TDH, posterior and posterolateral approaches hardly reach across the midline and remove central and calcified disk fragments, and poor visualization of calcified disks may carry the risk of spinal cord injury and dural tears. Therefore, the technique is seldom used in management of central calcified TDH. However, advances in surgical techniques made the posterior approach possible for TDH. Regev et al described a posterior transforaminal microscopic technique using tubular retractors for management of TDH, which enabled sufficient access to the midline of the spinal canal without extensive resection of the facet joint or the adjacent pedicle. However, application of transforaminal thoracic interbody fusion for patients with central TDH is limited. Yamasaki et al reported that posterior bilateral total facetectomies could provide an adequate working space and avoid excessive retraction of the neural elements.

The current study used a novel L-shaped osteotome to reduce the risk associated with thoracic disk removal. This technique could cut the central calcified thoracic disk without interfering with the spinal cord. The curved tool bit of the osteotome could extend the anterior spinal cord and remove the pressing materials in front of 2 sides of the spinal cord; thus, the drag could be avoided for the spinal cord. There was no patient with increased neurosis symptoms due to dragging the meninx fibrosa in the current study.

Use of the device has some advantages. First, the posterior approach resulted in few procedure-related complications. Second, the technique could separate the spinal cord and ligament for blunt dissection.
and reduce injury to the spinal cord. One patient developed CSF leakage. Third, the L-shaped osteotome reduced the surgical difficulty, which may decrease operative time and blood loss. In this study, average operative time was 124±58 minutes and mean blood loss was 439±225 mL.22 However, use of the device also has some disadvantages, including the inevitability of the rigid instrumentation to reconstruct the stability of the spinal column and to obtain fusion due to laminectomy and bilateral total facetectomies.

CONCLUSION

The results suggest that the posterior approach using a special L-shaped osteotome is feasible. No major complications occurred while achieving adequate decompression for central calcified TDH.

REFERENCES