The transdural approach for thoracic disc herniations: a technical note

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Abstract Surgery for thoracic disc herniations is still challenging, and the disc excision via a posterior laminectomy is considered risky. A variety of dorsolateral and ventral approaches have been developed. However, the lateral extracavitary and transthoracic approach require extensive surgical exposure. Therefore, we adopted a posterior transdural approach for direct visualization without entry into the thoracic cavity. Three cases that illustrate this procedure are reported here with the preoperative findings, radiological findings and surgical techniques used. After the laminectomy, at the involved level, the dorsal dura was opened with a longitudinal paramedian incision. The cerebrospinal fluid was drained to gain more operating space. After sectioning of the dentate ligaments, gentle retraction was applied to the spinal cord. Between the rootlets above and below, the ventral dural bulging was clearly observed. A small paramedian dural incision was made over the disc space and the protruded disc fragment was removed. Neurological symptoms were improved, and no surgery-related complication was encountered. The posterior transdural approach may offer an alternative surgical option for selected patients with thoracic

paracentral soft discs, while limiting the morbidity associated with the exposure.

Keywords Disc herniation · Transdural approach · Thoracic

Introduction

Symptomatic thoracic disc herniations account for less than 1% of patients requiring disc surgery [3]. The most common locations of thoracic herniations are central or centrolateral, with a minority of herniations in the truly lateral position [3, 20]. The calcification rate has been reported to be 30–70% in patients with thoracic disc herniations. The treatment of thoracic disc via a posterior laminectomy has been associated with poor results; most surgeons have abandoned the laminectomy procedure over the past few decades. Some surgeons advocated simple decompression without disc removal to avoid the spinal cord manipulation required to reach a ventrally located disc herniation. In an attempt to extend the surgical exposure to a ventral view of the spinal cord, the surgical approach has changed from the standard laminectomy to a variety of dorsolateral and ventral approaches [2, 7, 12, 14, 15, 17, 18, 20]. However, (many of these approaches) the lateral extracavitary and transthoracic approach require extensive destruction of normal structures. Although the thoracoscopic approach provides direct ventral access with less morbidity, it requires entry into the chest and is technically demanding with a steep learning curve.

By contrast, the other extreme was to attempt disc removal via a dural opening after laminectomy [11]. We adopted a transdural approach for the treatment of

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paracentral thoracic disc herniations to reduce the risk of spinal cord injury. Three cases that illustrate this procedure are reported here with the preoperative findings, radiological findings and surgical techniques used.

Surgical technique

With the patient prone, the conventional posterior approach was performed. After (the clean) exposure of bilateral posterior elements, a total laminectomy was performed with the preservation of bilateral facet joints. With the aid of a microscope, the dura was opened with a longitudinal paramedian incision. The incised dura mater was tacked to the muscle margins over the bone edges. The arachnoid membrane was punctured and cerebrospinal fluid (CSF) was drained for the creation of more operative space. After transection of the dentate ligament, the spinal cord was gently retracted away from the surgical site. Great care was taken to avoid harm to the spinal cord while the spinal cord was retracted. A thin suction cannula, at low power, was applied to prevent mechanical injury of the spinal cord.

Between the rootlets above and below, bulging of the ventral dura came into view. A blunt hook was used to palpate the ventral dura over the disc space. A small vertical dural incision was made over the ventral dura in the paramedian location. The disc fragments were removed using a micropunch and milked through the dural hole with a hook (Fig. 1). No efforts were made to explore the disc space. After successful decompression, the dorsal dura was closed watertight, and fibrin glue was applied over the suture. However, the ventral dura was not repaired, because of the tight adhesion of ventral dura to the posterior longitudinal ligament and annulus fibrosus. The anatomical layers of the wound were closed. All patients were mobilized on the third day after the surgery.

Illustrative cases

Case 1

A 59-year-old man presented with a year history of interscapular axial pain. The symptom worsened progressively and he developed numbness and tingling sensation involving left leg for a month. He was diagnosed as having a left paracentral soft-disc protrusion with upward migration at T2–3 on magnetic resonance (MR) images of the thoracic spine (Fig. 2a, b), and conservative treatment was recommended. When his symptoms became disabling, he was referred to us for a second opinion. Neurological examination revealed hypoesthesia below the L1 sensory dermatome without motor weakness. After laminectomy at

Fig. 1 Intraoperative photographs. **a** Photograph after laminectomy and dural opening demonstrating central bulging of the ventral dura. **b** Photographs after ventral durotomy showing the extruded disc through the dural hole

T2–3, the free disc fragments were removed with transdural approach. The postoperative course was uneventful with immediate improvement of the sensory numbness. The postoperative MR images demonstrated complete decompression of the ventral spinal cord (Fig. 2c). The patient remains asymptomatic after 18 months follow-up.

Case 2

A 72-year-old woman presented with progressive paraparesis and numbness of both legs 1 month before admission. Neurological examination revealed that she had spastic weakness (grade 4/5) in both legs and diminished sensation below the L1 sensory dermatome. MR images revealed a marked left paracentral T11–12 soft-disc herniation with severe spinal cord deformation (Fig. 3a, b). The surgery consisted of laminectomy at T11–12, dural opening, a paramedian ventral dural incision over the bulging lesion, and removal of free disc fragments. The patient

Fig. 2 Case 1. The sagittal (a) and axial (b) T2-weighted magnetic resonance (MR) images reveal a large extruded disc at the T2–3 level with an evidence of the spinal cord compression. c The postoperative T2-weighted MR images showing complete decompression of the spinal cord after total laminectomy with transdural discectomy

demonstrated improvement of motor functions and returned to normal activity 2 months after surgery. The postoperative MR images demonstrated adequate decompression of the spinal cord (Fig. 3c). The patient remains asymptomatic after 18 months follow-up.

Case 3

A 41-year-old man presented with a 3-week history of numbness in the left hand and left shoulder pain, which subsequently developed into weakness of left hand with particular weakness of grasping (grade 4/5). The patient presented diminished sensation to pain and temperature on the left C8 and T1 sensory dermatome. MRI of the cervical spine showed space-occupying lesion at left anterior epidural space of C7–T1 with associated compressive myelopathy, suggesting sequestered disc material (Fig. 4a, b). After hemilaminectomy of C7 and T1, longitudinal dorsal and paramedian ventral durotomy were performed. Several

free fragments of disc material including cartilaginous endplate fragment were removed. The grasping power of left hand was improved immediately after the operation. The postoperative MR images demonstrated adequate decompression of the spinal cord (Fig. 4c). No intracanalicular disc material is present, and only normal postoperative changes are seen. The patient remains asymptomatic after 12 months follow-up.

Discussion

The surgical treatment for thoracic disc herniations remains challenging for the spinal surgeon. The operative results of disc excision via thoracic laminectomy were disappointing. There was a 35% rate of postoperative neurological deterioration [16]. The manipulation of the spinal cord, during the removal of the disc ventral to the spinal cord, may produce mechanical injury. In addition,

Fig. 3 Case 2. The sagittal (a) and axial (b) T2-weighted MR images of a herniated thoracic disc with central spinal stenosis at T11–12. Postoperative axial T2-weighted MR images (c) demonstrating adequate decompression of the ventral thoracic spinal cord

this approach can potentially interfere with the spinal cord blood supply [18].

Although the transpedicular and transfacet pedicle-sparing approaches are less extensive procedures, the exposure of the ventral view of the spinal cord is very limited. The transpedicular approach, with the aid of a 70°-angled endoscope, might be a solution for the limited visual field. However, it is difficult and disorienting to become familiar with a reversed surgical field [14].

Transdural approaches have been successfully adopted for multilevel cervical spondylotic myelopathy with central or paracentral disc herniation or lumbar disc herniation [4, 5, 8, 9, 11, 16]. For the thoracic disc herniation, the posterior laminectomy has been abandoned because of the limited visualization of the surgical field and the unavoidable manipulation of the spinal cord. Horwitz et al. [11] reported good outcomes for the ruptured thoracic discs after laminectomy with a dural opening, which facilitates the expression of the disc fragments without trauma to the spinal cord. Since then, the transdural approach has been evaluated in several case reports of thoracic intradural disc herniations during the past decade [1, 10, 13, 19]. With the sectioning of the dentate ligament and CSF drainage, the transdural approach allows for an adequate exposure without spinal cord retraction. The thoracic spinal cord is approximately 6.5 mm deep and 8.0 mm wide, whereas the thoracic spinal canal is approximately 16.8 mm deep and 17.2 mm wide; the canal widens distally. Therefore, there is a minimal clearance space of 9.2 mm laterally, whereas

there is a 10.3 mm of clearance in the AP direction [6]. With the aid of a microscope and the microsurgical technique, the transdural approach provides direct access to the lesion, permitting reduced trauma while removing the soft disc fragments without excessive cord retraction.

The advantages of the transdural approach are the use of familiar surgical techniques and a short learning curve. This approach can be readily adopted by spine surgeons who are comfortable with the laminectomy approach and requires no special instruments. The posterior transdural approach allows entry into the disc space without significant disruption of the integrity of the facet–pedicle complex. The limited bone removal and soft tissue destruction minimizes the perioperative pain with potential for improvement related to axial pain. The posterior transdural approach might reduce the morbidity associated with entry into the chest; it is optimal especially for the high-risk patient. Especially in the upper thoracic disc, such as illustrative case 1, this approach could be very reasonable given that an anterior approach to the T2–T3 level would likely require splitting the sternum. The potential complications associated with this procedure are CSF leakage and the development of a pseudomeningocele. For case number 3 at the cervicothoracic junction an alternative would have been an anterior approach to the cervical spine and anterior corpectomy and fusion. The advantage of the transdural was to obviate the need of a fusion.

A total six cases of thoracic disc herniation were operated from January 2006 to June 2008. Two cases with

Fig. 4 Case 3. The sagittal (a) and axial (b) T2-weighted MR images demonstrating a large ventral lesion with dorsal displacement of the spinal cord at C7–T1. Postoperative axial (c) and T2-weighted MR images demonstrating no intracanalicular disc material. The spinal cord has returned to its normal location and configuration

posterolateral type of thoracic disc herniation were performed through posterior convenient approach, because the spaces for disc removal were easily exposed via only unilateral laminectomy and medial facetectomy without dural incision. In case with severe calcified central disc, transthoracic approach was used for disc removal due to the possibility of damage caused by too much retraction of spinal cord during the surgery. Three cases in this paper were performed via transdural approach.

In the cases presented, no attempt was made to close the ventral dural defect. The ventral dura densely adheres to the posterior longitudinal ligament and annulus fibrosus, which explains why a small incision less than 1 cm is not problematic. Regarding the neurological complications, no patient demonstrated worsening of spinal cord function postoperatively. Intraoperative neurophysiological monitoring, including somatosensory evoked potential (SSEP), motor evoked potential (MEP), and electromyography (EMG), have been used to monitor the spinal cord during spine and spinal cord surgeries. Combined intraoperative

monitoring is helpful for predicting and possibly preventing neurological injury. Therefore, intraoperative monitoring can be adopted in posterior transdural approach for thoracic disc herniation. We did not encounter any neurological complications despite the fact that no intraoperative monitoring was used in these cases. We certainly recommend intraoperative neuromonitoring when this technology is available.

The posterior transdural approach for the thoracic disc allows a more direct approach to the paracentral discs. In addition, ample operating space can be secured without excessive retraction of the spinal cord. Although the follow-up period and the number of patients were limited for a definitive conclusion, the posterior transdural approach could be applied for lateral and paracentral soft-disc herniations. However, calcified central disc herniations might not be appropriate for this procedure. The removal of hard discs risks the occurrence of inadvertent mechanical injury to the spinal cord. Therefore, computed tomography (CT) scan should be performed prior to selecting the surgical approach and to avoid this technique in those with calcified discs. We emphasize that this approach offers an alternative approach in those with soft discs documented by CT and in those that may not be good candidates for an anterior approach.

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