Transpedicular Approach to Thoracic Disc Herniaton Guided by 3D Navigation System

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Abstract

Background

The choice of surgical approach for thoracic disc herniation should consider the location on the axial plane and the consistency of the herniated disc. Calcified midline disc herniations are difficult to remove with a transpedicular approach because of limitations due to blind spots; so they are usually treated via a transthoracic approach, although this entails a high risk of thoracopulmonary injuries.

Methods

In this work we present two cases of calcified midline thoracic disc herniations treated with a transpedicular approach, improved by using a three-dimensional (3D) neuronavigation system to verify the extent of removal on the blind side.

Results

Postoperative computed tomography (CT) scans demonstrated that this original technical innovation, in the two present cases, allowed us to reach the side opposite the disc herniation and to assess the extent of resection at the end of the procedure.

Conclusions

The employment of a neuronavigation system in the transpedicular approach allowed safe and effective removal of calcified midline thoracic disc herniations. We did not observe any postoperative neurological worsening, onset of spinal instability, or other adverse events.

Keywords Thoracic disc herniation • Thoracic transpedicular approach • Spinal neuronavigation

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Introduction

Surgical treatment of calcified thoracic disc herniations is challenging because of the probability of spinal cord damage. Many approaches have been developed to obtain satisfactory decompression and to overcome the significant rate of neurological damage associated with a strictly posterior laminectomy. These approaches are categorized as anterior (transthoracic [17], transsternal, and thoracoscopic [8, 12]), lateral (lateral extracavitary and costotransversectomy [10, 20]), and posterolateral (transpedicular [5] and transfacet pedicle-sparing [22]).

The approach should be selected individually in each case, considering the location on the axial plane and the consistency of the herniated disc. In our experience, the transpedicular approach, first described by Patterson and Arbit in 1978 [16], is a convincing technique with a lower rate of morbidity than that of the anterior and lateral approaches, although these approaches could be more effective in cases of calcified midline disc herniations. Here we describe an original technical innovation that allowed us to check the resection of a calcified median disc done by a posterolateral thoracic approach, guided by a three-dimensional (3D) navigation system.

Materials and Methods

Patient Population

The posterolateral thoracic approach was used in two patients. The herniated discs were located, respectively, at the T8–T9 and T7–T8 levels.

Case 1 was a 53-year-old woman with dorsal pain not responsive to medical care, initial gait disturbance, and leg paresthesia. Magnetic resonance imaging (MRI) showed a

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left paramedian T8–T9 disc herniation compressing the spinal cord, with a T2 hyperintense signal at that level (Fig. 1a and b). A computed tomography (CT) scan showed a calcified disc herniation (Fig. 1c and d). Motor evoked potentials (MEPs) and somatosensory evoked potentials (SSEPs) before surgery were slightly altered.

Case 2 was a 62-year old woman with severe paraparesis mainly in the right leg with impairment of standing and walking, sensory loss at a low thoracic level, and urinary retention. MRI showed a median disc herniation with compression of the spinal cord and T2 hyperintensity at the T7–T8 level. A CT scan showed calcific consistency of the disc. Preoperative MEPs and SSEPs showed only slight activity in the left leg.

Preoperative Preparation

Before surgery, a CT scan is performed to acquire the images that will be matched with the intraoperative field to create a 3D image base for navigation. The procedure is performed under total intravenous anesthesia. Inhalational anesthetic agents are not used in conjunction with electrophysiological monitoring because they interfere with electrical conduction.

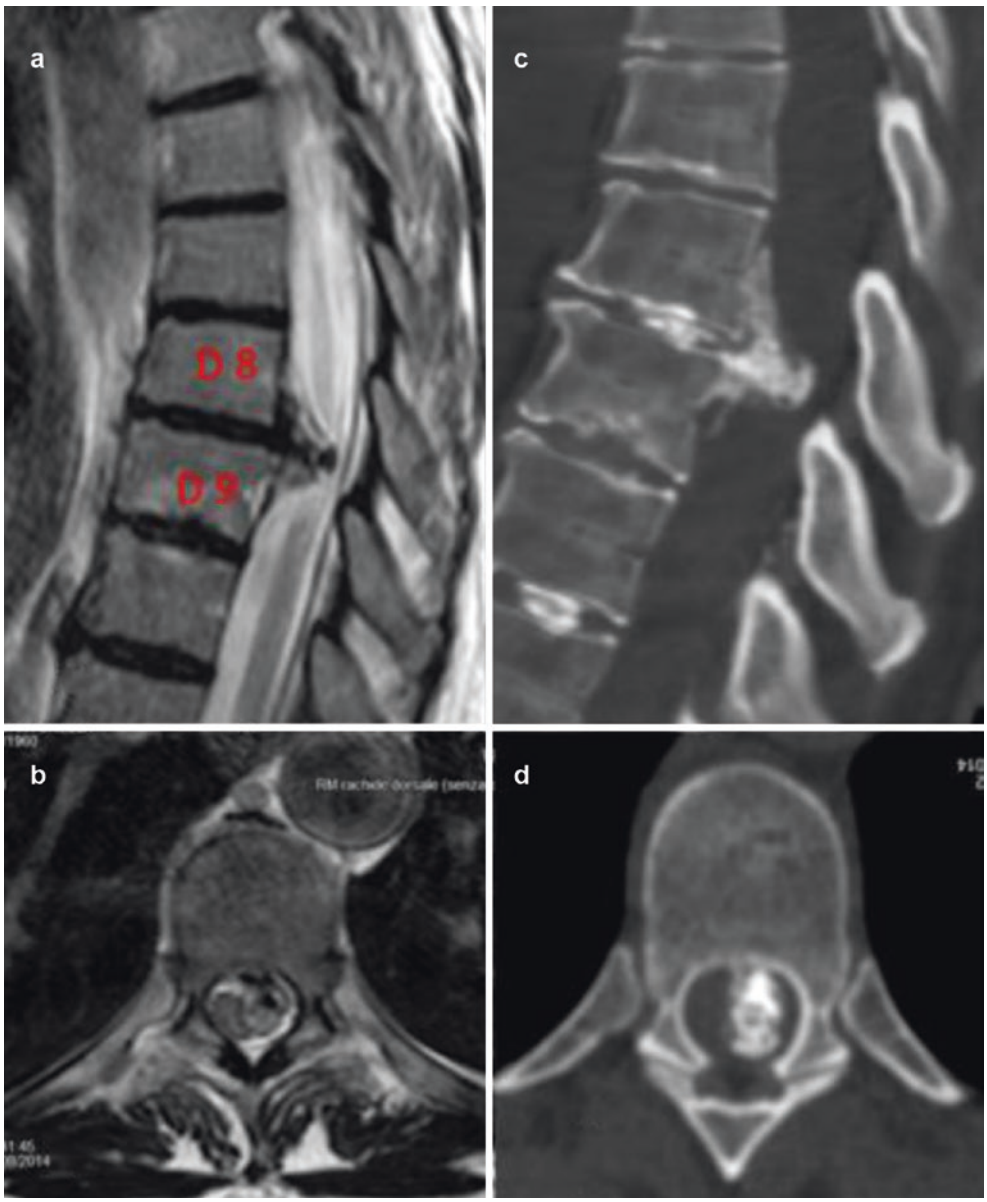

Fig. 1 Case 1: preoperative magnetic resonance imaging (MRI) in sagittal (**a**) and axial (**b**) planes. Computed tomography (CT) scans in sagittal (**c**) and axial (**d**) planes show calcified midline disc herniation

We used a modified park-bench position, with the side of the surgical approach facing upwards. Localization of the correct level was obtained by anteroposterior and lateral fluoroscopy after the positioning of the patient on the operation table.

Electrophysiological Monitoring

Electrodes were applied to the patient's limbs and scalp for continuous intraoperative spinal cord monitoring of SSEPs and transcranial MEPs.

Surgical Procedure

A midline linear skin incision was made, extended approximately 4 cm over the spinous processes at the level adjacent to the disc herniation. The paraspinous muscles were reflected to expose the medial portion of the transverse processes and facet joints at that level. The reference system for navigation (BrainLab Munich, Germany) was inserted on the spinous process below the level of surgery. Then we proceeded to match the selected vertebra with the preoperative images. In case 1, we removed—alternating drilling and the use of a Kerrison punch—the hemilamina of D8 and D9, the medial facet of D8, and the lateral facet of D9, and we did a partial pediculectomy of D9. The depth of the pedicle resection was established by the transition from the cancellous bone of the pedicle to the posterior cortical bone of the vertebral body. The rib was kept untouched. In case 2 we performed the same procedure at the upper level (D7–D8). Under microscopic view, we started removing osteophytes from the endplates and then we progressively reduced and debulked the compression, using an ultrasonic bone curette with a 30-degree angled tip (Misonix Farmingdale, NY). The disc space was incised and a large cavity was created using curettes, the Kerrison punch, and the ultrasonic bone curette, working in a lateral-to-medial direction. During the resection, we sometimes checked the extent of the removal by placing the navigation system pointer, in an oblique way, on the contralateral side of the surgical field, which was covered by the spinal cord. The residual thin layer of calcification on the contralateral side, not adherent to the dura, was dislodged with Penfield dissectors. The shell strictly attached to the dural plane was left. At the end of the procedure we checked the extent of removal by moving the pointer as described above, and by further assessment with endoscopy (Fig. 2 and 3).

Results

Case 1 During the surgical procedure we observed the depression of MEPs and SSEPs after moving the shell of the calcified disc herniation that was attached to the dura, so we decided to fracture the shell and leave it in situ. At the end of the procedure an improvement in the monitoring parameters was observed. In the early postoperative period this patient did not present with any neurological worsening. The postoperative CT scan showed the removal of the herniated disc and the dislocation of the shell attached to the spinal cord (Fig. 3).

Case 2 During surgery no alterations of the monitoring parameters were observed. After 9 months of rehabilitation therapy the patient was able to maintain a standing position and to walk with support and she had achieved urinary control. Postoperative MRI and CT scans showed the removal of the herniated disc.

Discussion

Incidental thoracic disc herniations are common, but symptomatic ones are rare [20]. Surgery is usually not recommended for asymptomatic patients, because the great majority of thoracic disc herniations remain stable or decrease in size, without the onset of neurological symptoms [6, 24]. However, no predictors currently exist to suggest which patients will develop symptoms [4]. In a review of ten surgical series, Bilsky [4] found that indications for surgery were myelopathy in 70 %, intractable radiculopathy in 24 %, and back pain in 6 % of cases.

The choice of the surgical approach for thoracic disc herniation depends on the location on the axial plane and on the consistency of the herniated disc.

There is general agreement in the literature about the preference for anterior transthoracic approaches to treat calcified midline thoracic disc herniations [2, 3, 7, 9, 13, 14, 19–21]. Transthoracic approaches have a high risk of bronchopulmonary complications [25], which has not been completely overcome by the introduction of thoracoscopy [1, 23]. However, posterolateral approaches do not provide adequate exposure of the ventral surface of the spinal cord without manipulation, with a blind angle between the midline dura and the calcified disc herniation, representing a critical phase of the surgical procedure [13, 18, 19]. This problem has been partially overcome by the use of a transforaminal approach, which provides tangential exposure of the ventral dura, albeit through a narrow passageway. In our experience, these drawbacks could be bypassed applying neuronavigation and endoscopic systems in

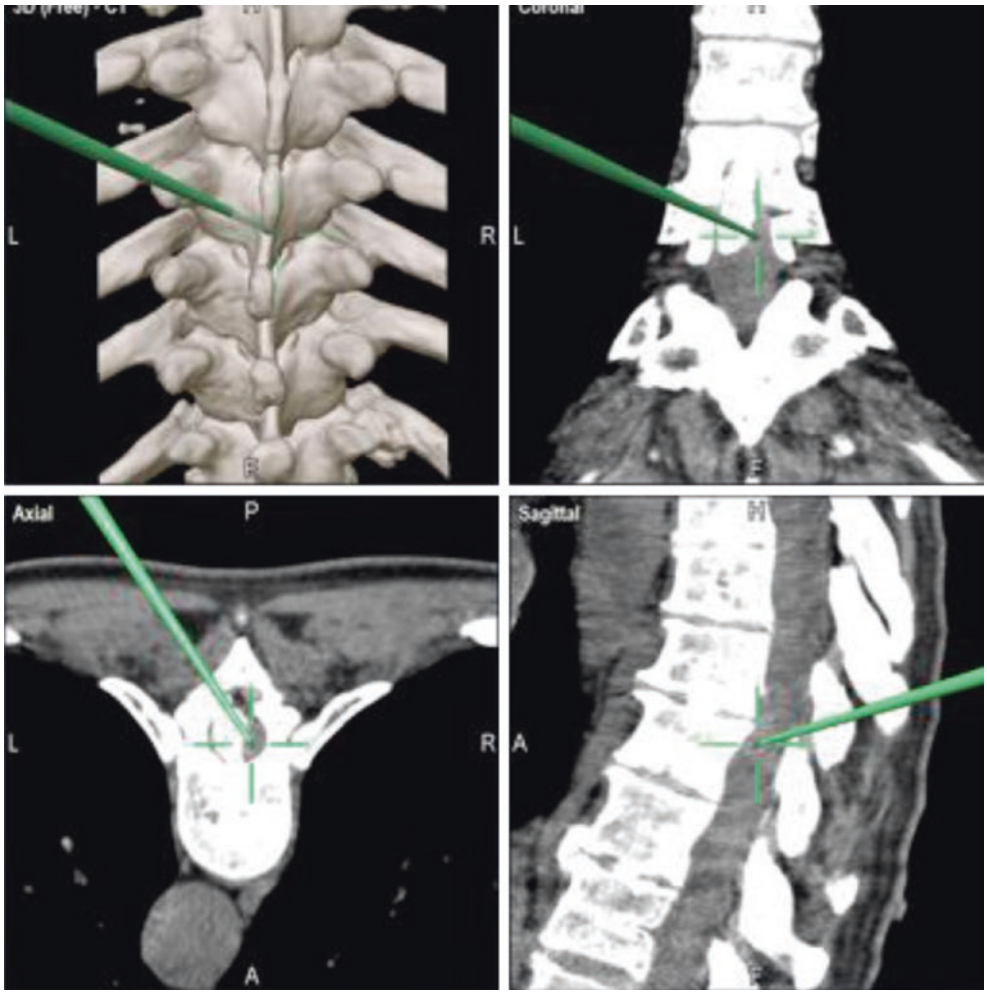

Fig. 2 Case 1: removal of calcified thoracic disc herniation guided by navigation system

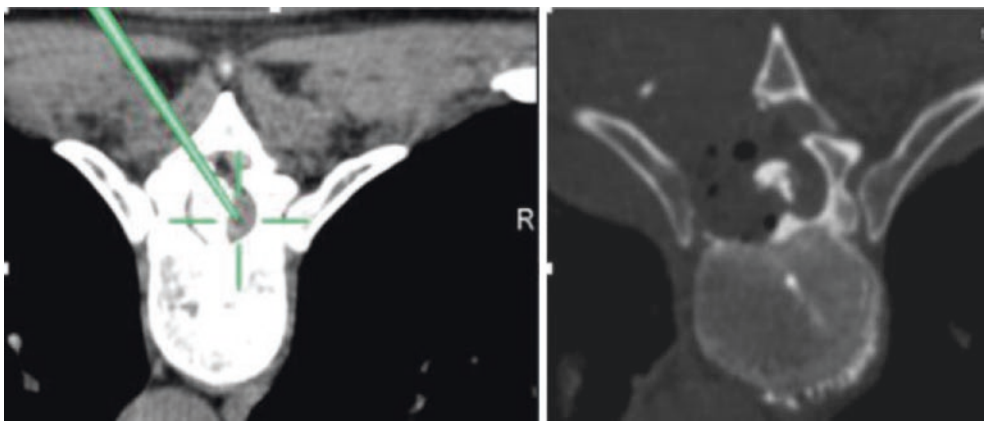

Fig. 3 Case 1: comparison between the position of the pointer on the blind side during surgery and postoperative CT scan

standard posterior approaches. These simple and easily available tools allow the quick verification of the intraoperative position, in order to obtain complete removal of the midline calcified disc herniation, even beyond the standard surgical corridor. The application of angled endoscopy in surgery for thoracic disc herniation has already been described, and it is currently a standard procedure in our department [15]. Neuronavigation systems, however, have been reported only in the thoracoscopic approach [11]; to our knowledge, the present study reports the first employment of such a system in the posterior approach to the thoracic spine to be described in the literature. However, even when these systems are used, the

complete removal of calcified disc herniations can be difficult because of the presence of tight adhesions between the calcification and the dura. In some cases a transdural extent of the herniated disc is also possible. Such conditions increase the risk of cerebrospinal fluid (CSF) fistula and neural injuries. In such conditions a safe and feasible surgical target could be considered to be the emptying of the disc herniation, leaving an external shell, still obtaining satisfactory decompression [15].

Conclusions

The preliminary clinical experience reported here suggests that the employment of tools such as a neuronavigation system in the transpedicular approach to thoracic disc herniations allows us to compensate for the lack of visualization and to overcome the limitations of this surgical corridor in midline calcified disc herniations. With neurophysiological monitoring, the dural sac and spinal cord were never retracted and the modality provided added safety . We did not observe any postoperative neurological worsening, onset of spinal instability, or other adverse events. On the basis of this experience, we consider that we will continue to employ this technique.

Conflict of Interest Statement The authors declare that they have no conflicts of interest.

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