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IDEAS AND TECHNICAL INNOVATIONS

Endoscope-assisted resection of calcified thoracic disc herniations

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Abstract
Purpose Resection of calcified thoracic disc herniations carries significant risks of neurological worsening, particularly in case of concomitant central location. Transthoracic approaches are a first-choice option to avoid spinal cord manipulation but entail drawbacks such as postoperative pain and the risk of bronchopulmonary complications. The purpose of this report is to describe a novel approach to resect calcified herniations, even centrally located, from a posterior perspective.
Methods Unilateral lamino-arthrectomy is performed, uncovering few millimeters of the disc space beside the dura. Following discectomy and drilling of the vertebral endplates, an angled endoscope is introduced allowing resection of the calcified herniation through an anterior perspective. The spinal cord can now be decompressed with a no-touch technique. Each maneuver aimed at resecting the calcified mass up to the contralateral side can be done under visual control.
Results The technique was used in two patients. The first was a 38-year-old man with a calcified mediolateral T9–T10 disc herniation and mild myelopathic symptoms. The second patient was a 73-year-old obese woman, with a T6–T7 central, calcified disc herniation and severe compression myelopathy. In both cases, complete decompression of the spinal cord could be achieved and rapid neurological recovery was observed postoperatively. No surgery-related complications were observed.
Conclusions The endoscope-assisted posterior approach afforded safe and complete resection of calcified discs. The technique is particularly useful for central disc herniations, where transthoracic approaches are normally deemed mandatory.

Keywords Disc herniation · Endoscope · Myelopathy · Thoracic disc · Transfacet approach

Introduction

Symptomatic herniations of the thoracic disc are uncommon [1, 2]. Surgery carries risks of neurological worsening because of the unique susceptibility of the thoracic cord to retraction injury. A number of approaches have been developed aimed at resecting the disc with minimal or no manipulation of the dural sac. As a rule, the choice of the approach rests on two factors: location in the axial plane and consistency of the herniated disc. Midline location or hard consistency usually makes an anterior perspective advisable. When both features are present, namely in calcified central disc herniations (CCDHs), the transthoracic approach is deemed essential [3–8]. However, postoperative pain and the risk of life-threatening bronchopulmonary complications must be taken into account [7]. The need for a multidisciplinary team is also a limitation. Thoracoscopy has been used with good results to overcome some drawbacks [9, 10]. Yet, the technique requires a steep

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learning curve and does not eliminate the risk of pulmonary complications.

Posterior or postero-lateral approaches, including lateral extracavitary, transfacet, transpedicular and transforaminal approaches have been refined to fit most cases of lateral or soft disc herniations but they have not been able to replace anterior surgery, particularly in pure CCDHs [2, 3, 5, 11–16] (Fig. 1). Accordingly, in the literature, we could not find illustration of a CCDH removed from posterior.

We describe here the principles and application of a novel technique providing safe resection of calcified discs, even CCDHs, from a simple posterior approach.

Technique and case description

The procedure is conducted under general anesthesia. The patient is positioned prone with chest rolls on the Jackson table. Intraoperative monitoring of motor-evoked potentials and somatosensory-evoked potential is performed. The spinal level is localized with fluoroscopy or pre-operative CT marking. A midline skin incision is performed. Paraspinal muscles are detached on the side of the herniation or, in case of central location, according to the surgeon's preference. The first phase of the procedure is done under microsurgical view. Following hemilaminectomy, the facet joint is resected enough to uncover a few millimeters of the disc space beside the dura. The pedicle, the head of the costa and the transverse process are left intact. Microdiscectomy is performed, entering the disc space laterally. The vertebral endplates are marginally resected, along with the disc, pointing anteriorly and towards the contralateral side (Fig. 2). Using either the high-speed drill or the ultrasonic bone curette, the most lateral part of the calcified disc is undermined, leaving a posterior shell and avoiding any effort to manipulate the interface between the shell and the ventral dura. Once the microscope perspective becomes insufficient to visualize the tip of the instruments, a rigid endoscope with a 45-degree lens is introduced in the cavity under microsurgical view and oriented so that the posterior "blind spot" is visualized (Fig. 2, upper box, Fig. 3). Less frequently, a 30-degree lens turns out to be useful. Attention is now shifted to the endoscopic monitor. Using the endoscope with the non-dominant hand and a high-speed drill or the ultrasonic bone curette with the dominant hand, the posterior shell is thinned as much as possible with a no-touch technique (Fig. 2, middle box, Fig. 3). Every time the endoscope is withdrawn, for cleaning or changing the

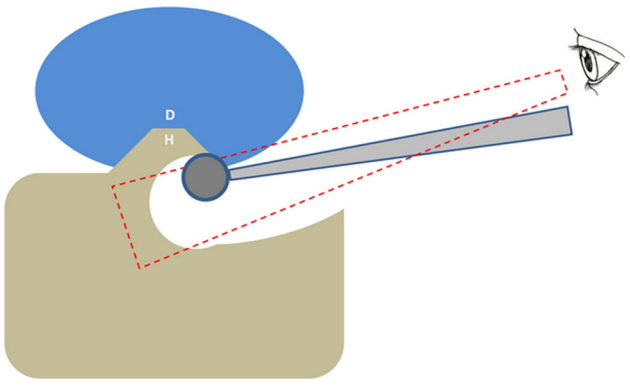

Fig. 1 Schematic representation of a simple postero-lateral perspective in a case of CCDH. The interface between the dura (D) and the apex of the herniation (H) cannot be visualized (*blind spot*)

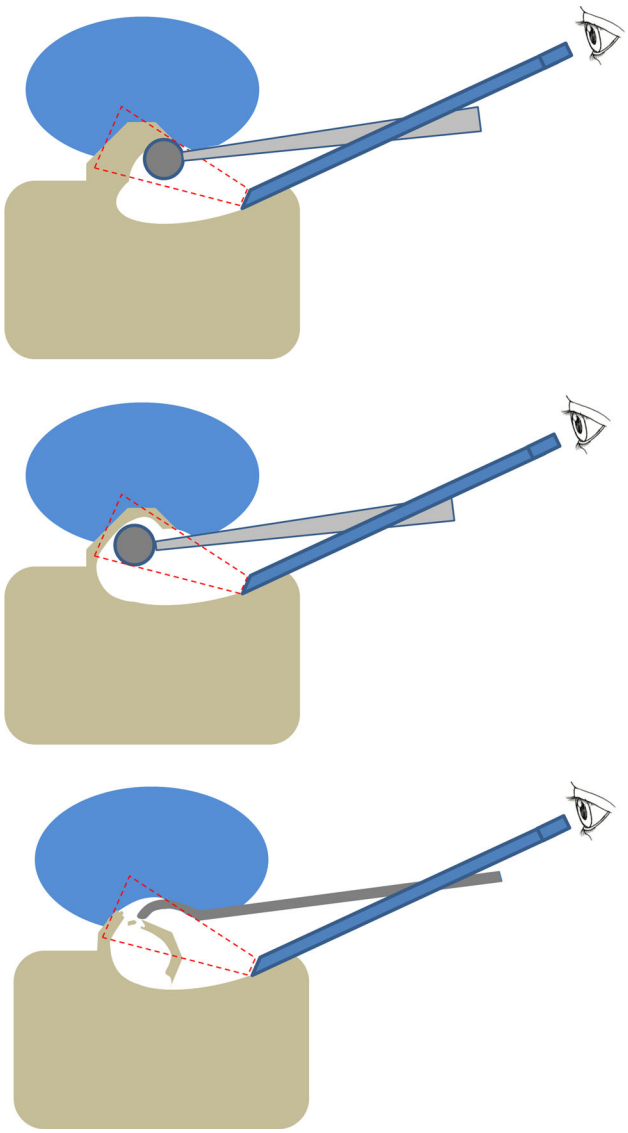

Fig. 2 Schematic representation of the endoscope-assisted technique. *Upper*: a working room is created underneath the apex of the herniation *middle*: the posterior shell is drilled with endoscope assistance *lower*: Using a curved dissector, the shell is detached from the dura and fractured within the working room, under constant visual control

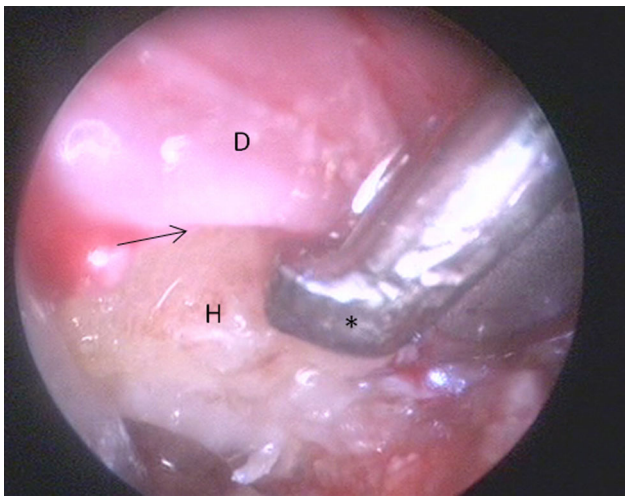

Fig. 3 Intraoperative endoscopic view (Case 2 of this paper). The interface (*arrow*) between the ventral dura (D) and the calcified herniation (H) is under control. An ultrasonic bone curette (*asterisk*) is used to resect the herniation while leaving the dural sac untouched

lens, reinsertion is better done under microsurgical view. Once the bone becomes flexible, a curved dissector is used to dissect it from the dura. Eventually, the shell is fractured within the cavity (Fig. 2, lower box).

Case 1

A 38-year-old man presented with leg paresthesia and mild gait disturbance. The patient was moderately obese. MRI showed a T9–T10 right paramedian disc herniation with compression of the spinal cord (Fig. 4). Heavy calcification was seen on CT scan (Fig. 5). Motor-evoked potentials (MEPs) and somatosensory-evoked potentials (SSEPs) from lower limbs were both depressed. The case was managed using the endoscope-assisted posterior approach, coupled with intraoperative neurophysiological monitoring. The disc could be easily resected up to the midline. Postoperatively, no complications were observed. A CT scan confirmed complete removal of the calcification (Fig. 6). The patient's symptoms resolved within 1 month after surgery. At the latest follow-up, 2 years after surgery, the patient was free of symptoms, including back pain. No signs of segmental instability were visible on follow-up MRI.

Case 2

A 73-year-old obese woman developed paraparesis over a 4-month period. Hypertension and chronic obstructive bronchopulmonary disease were also present. MRI (Fig. 7) and CT (Fig. 8) showed a central disc herniation at T6–T7, with severe spinal cord compression. The lesion was densely calcified and enveloped by the dura. On admission, the patient was unable to walk. Neurological examination showed a motor deficit of both legs (muscle strength: 2/5 left limb, 1/5 right limb) and impaired superficial and deep sensation below the T8 dermatome. The patient underwent an endoscope-assisted posterior approach. Intraoperatively, MEPs and SSEPs were recorded to monitor the residual spinal cord function. The calcified herniation could be removed up to the contralateral side. Throughout the whole procedure, the instruments touched the dural sac but never retracted it. After the left half of the shell had been fractured, a curved dissector was used to keep the sac in the original position, allowing to complete the resection towards the right side.

Postoperatively, the patient made a striking recovery. One week after surgery, she was able to walk with assistance. A CT scan confirmed complete resection of the mass (Fig. 9). No complications related to surgery were

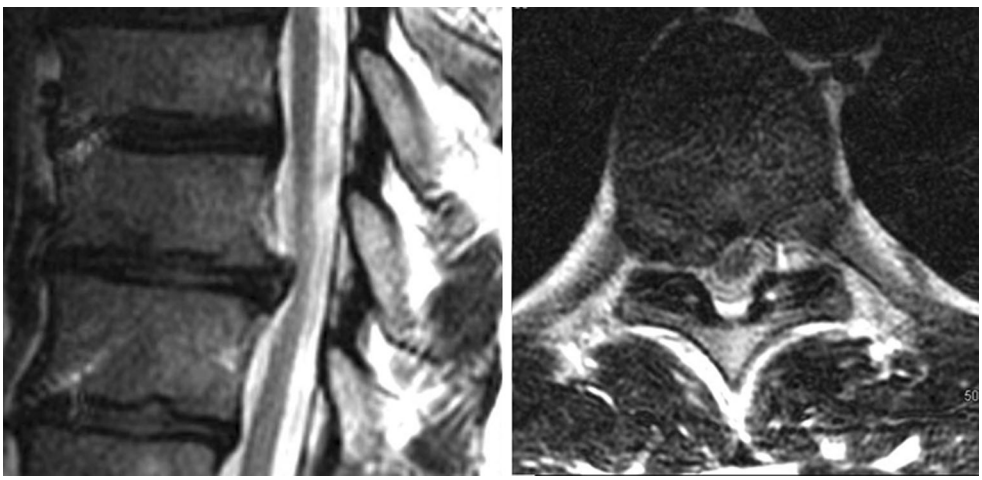

Fig. 4 Case 1 MRI scan showing T9–T10 right paramedian disc herniation with mild spinal cord compression

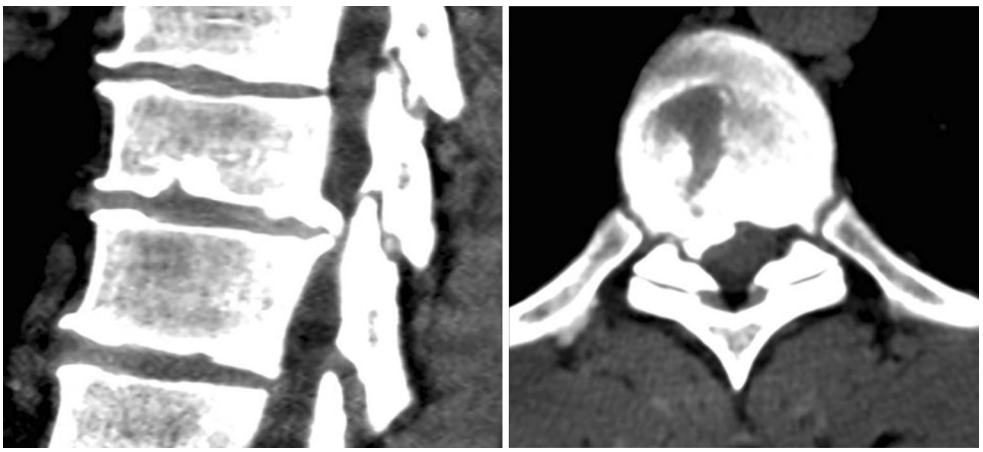

Fig. 5 Case 1 CT shows the herniation as densely calcified

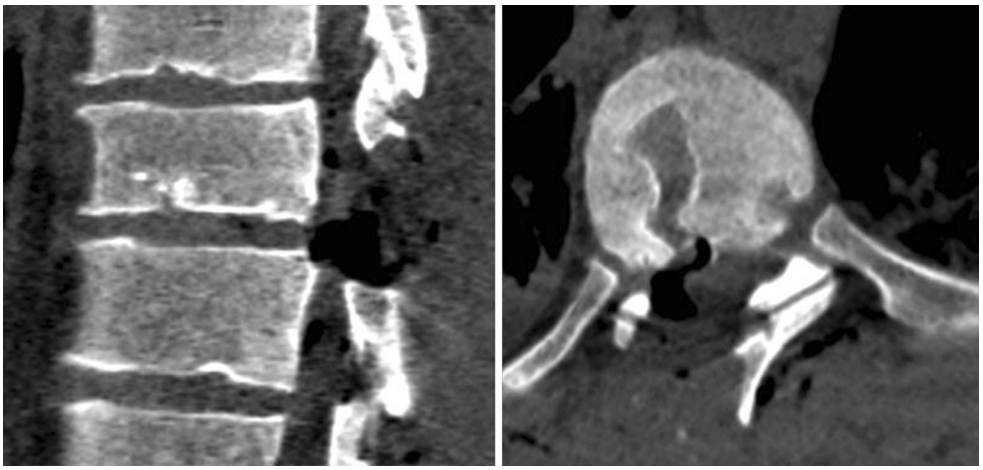

Fig. 6 Case 1 postoperative CT scan showing removal of the disc herniation

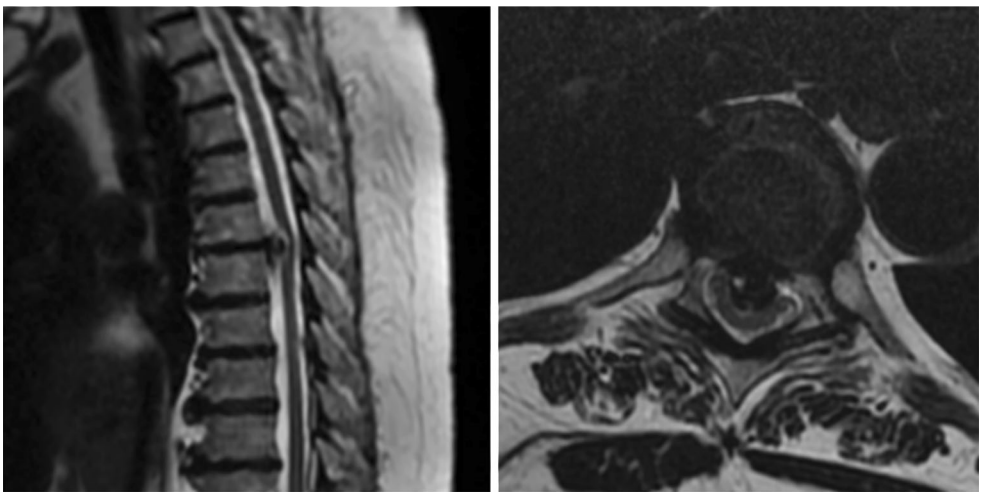

Fig. 7 Case 2 MRI scan showing T6–T7 disc herniation with severe compression myelopathy

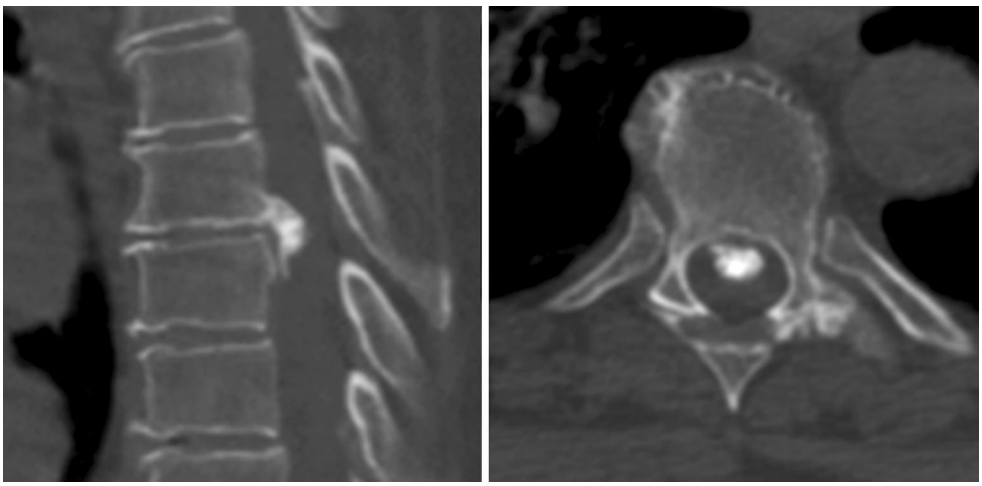

Fig. 8 Case 2 CT scan showing the herniation as centrally located and densely calcified (CCDH)

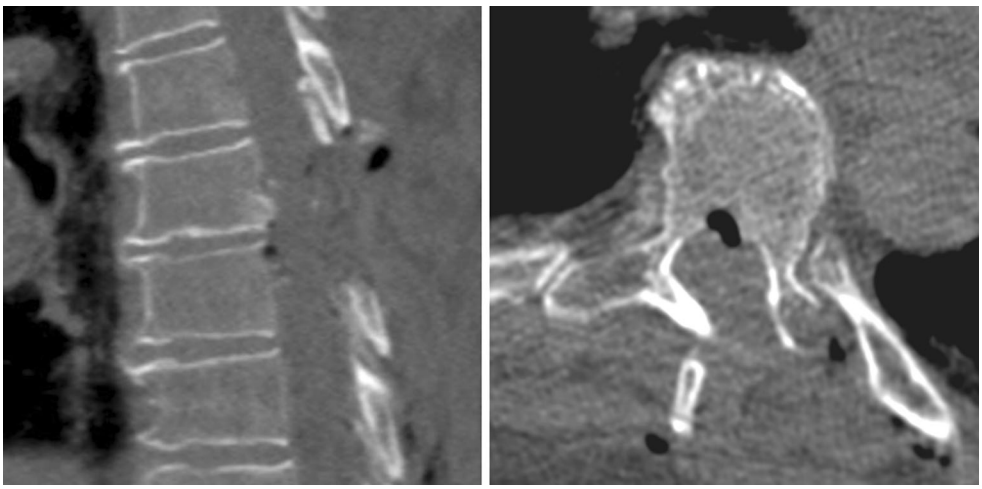

Fig. 9 Case 2 postoperative CT scan showing complete resection of the disc herniation

observed. During the rehabilitation program, she sustained a fracture of the proximal femur which was treated surgically. So far, 6 months after surgery, she is doing well.

Discussion

Uniform agreement exists on managing central and calcified herniations of the thoracic disc through thoracotomic anterior approaches [2, 3, 5, 11–16]. We developed the endoscope-assisted technique in an effort to avoid the impact of chest surgery, particularly on patients with risk factors or unfavorable comorbidities such as obesity or bronchopulmonary obstructive disease. Avoiding thoracotomy would also simplify surgery, with no need for a multidisciplinary approach, would reduce intraoperative blood loss and shorten hospitalization time. However, standard posterolateral approaches do not represent a safe alternative to anterior surgery for most calcified herniations [2, 3, 7, 8]. The main problem is adequate visualization of the ventral surface of the dura. A pure microsurgical view as that afforded by postero-lateral approaches does not provide full view of the ventral dura; the most critical phase of decompression, at the interface between the midline dura and the calcification, must often be performed blindly (Fig. 1). Recently, transforaminal approaches have shown to provide tangential exposure of the ventral dura, partially uncovering the aforementioned blind spot. Yet, the surgical corridor is still considered inadequate or unsafe for CCDHs [5, 14]. Also, the narrow line of sight makes it difficult to manage herniations extending beyond the disc space [17].

We found that coupling a basic posterior approach with the use of an angled endoscope overcomes most of these drawbacks, allowing to manage calcified herniations irrespective of their location in the axial plane. The key step is bringing the endoscope into the bottom of the cavity. This

step, as shown in Fig. 2, virtually converts the original approach into an anterior one and decompression can reach the opposite side with direct, magnified vision of the plane of dissection. In this way, the posterior blind spot is under complete control, which is a significant advantage over a postero-lateral non-endoscopic perspective (Fig. 1). A second advantage is that herniations extending superiorly or inferiorly, beyond the disc space, can be managed effectively. Unlike transforaminal approaches, this technique allows to widen the operative window longitudinally as much as necessary to guarantee proper range of motion for the instruments.

Recently, Nishimura et al. [18] reported an ultrasound-assisted technique which basically shares our philosophy, namely the attempt to monitor the blind spot while resecting central herniations from posterior. Yet, there are significant differences with our technique. First, the guidance was sonographic rather than visual. Hence, the technique was able to reveal deformation of the spinal cord but direct control of the dural interface was not available. Second, complete bilateral laminectomy, with facet resection, was required to visualize the spinal cord. Instrumented fusion was performed in all cases at the end of the procedure. In general, spinal stability is an issue of bilateral approaches to the thoracic disc and fusion is performed, as a rule [12–18]. The technique we described does not include spinal fusion because of the low risk of spinal stability associated with unilateral approaches.

Accordingly, Gu et al. [19] showed preservation of the spinal stability, on a 2-year follow-up, in all 28 patients undergoing unilateral cervical facetectomy for tumor removal. The risk is even lower for those cases located in the mid-thoracic segment which is known to be inherently stable, particularly if the costovertebral joint is preserved [5, 11, 15] as it happens in our approach (Fig. 10).

As for other approaches, a possible limitation of this technique is the presence of tight adhesions or transdural extension of the herniated disc which increases the risk of cerebrospinal fluid fistula and neural injury. In such cases, where safe dissection appears unfeasible, we have supposed to convert the residual disc into an "empty shell", disconnect it from the adjacent boundaries and leave it in place. In this way, spinal cord decompression would be achieved as well. A minor limitation is also the lack of dedicated curved instruments which would simplify surgical maneuvers around the tip of the herniation.

Conclusions

This experience shows how complete resection of central and calcified herniations can be achieved, with rapid clinical improvement, from a posterior route. Compared with anterior approaches, this technique simplifies surgery with no risk of bronchopulmonary complications, no need for a multidisciplinary approach (single surgical specialist), short operating time, reduced blood loss and hospitalization time. The advantage over postero-lateral non-endoscopic approaches is that the blind spot which normally prevents dissection of the ventral dura is brought to the surgeon's view, allowing a safer procedure, without compromising the spinal stability. Further experience and the use of dedicated tools will seemingly refine the technique.

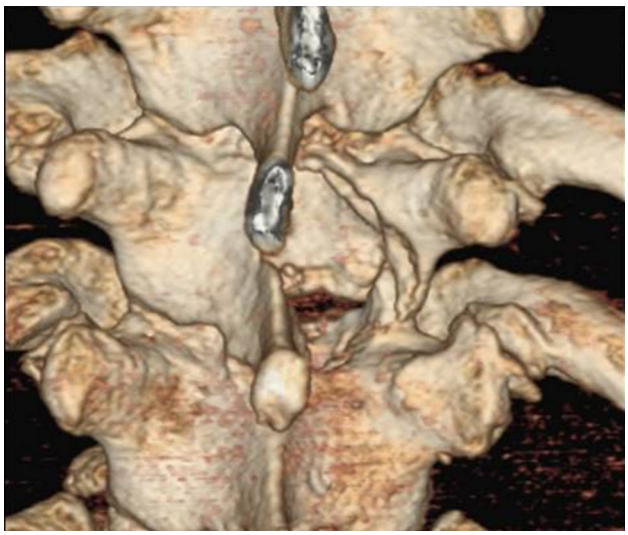

Fig. 10 Three-dimensional rendering of postoperative CT scan (Case 1) gives better evidence of the limited amount of bone resection. The bone window is unilateral, the consto-transverse joint is intact

Conflict of interest None.

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