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Posterior Minimally Invasive Transpedicular Approach for Giant Calcified Thoracic Disc Herniation

Daniel Shedid, MD[1], Zhi Wang, MD, MSc[1], Ahmad Najjar, MD[1], Sung-Joo Yuh, MD[1], Ghassan Boubez, MD[2], and Amer Sebaaly, MD, MSc[2,3]

Abstract

Study Design: Retrospective case series.

Objective: Posterior surgery for thoracic disc herniation was associated with increased morbidity and mortality and new minimally invasive approaches have been recommended for soft disc herniation but not for calcified central disc. The objective of this study is to describe a posterolateral microscopic transpedicular approach for central thoracic disc herniation.

Methods: This is a single center retrospective review of all the cases of giant thoracic calcified disc herniation as defined by Hott et al. Presence of myelopathy, percentage of canal compromise, T2 hypersignal, ASIA score, and ambulatory status were recorded. This posterolateral technique using a tubular retractor was thoroughly described.

Results: Eight patients were operated upon with a mean follow-up of 16 months. Mean canal compromise was 61%. Mean operative time was 228 minutes and mean operative bleeding was 250 mL. There were no cases of dural tear or neurologic degradation.

Conclusion: This is the first report of posterior minimally invasive transpedicular approach for giant calcified disc herniation. There were neither cases of neurological deterioration nor increased rate of dural tears. This technique is thus safe and could be recommended for treatment of this rare disease.

Keywords
calcified thoracic disc, giant disc herniation, minimally invasive, posterolateral approach, tubular retractor

Introduction

Thoracic disc herniation (TDH) is a less frequent disease compared with its lumbar and cervical counterparts (<1% of all disc herniations). Thoracic surgical discectomy accounts for all less than 2% for all surgical disc procedures.[1,2] Its incidence, in the general population, ranges between 1 in 1000 and 1 in 1 000 000, with middle-aged males and lower thoracic spine discs (below T8) being most affected.[1-3] Surgery is indicated when axial pain is present and not responsive to medical treatment, and in patients with progressive myelopathy.[2] Classically, posterior surgery for TDH was associated with high rates of morbidity and mortality with reports of 18% risk of paraplegia and 7% mortality with posterior laminectomy alone.[4,5] With the advent and the extensive use of anterior approaches to the thoracic spines (thoracotomy, mini-open retropleural thoracotomy, thoracoscopy), anterior approaches were used to treat central (and/or calcified) TDH and posterior approaches were reserved for posterolateral herniations.[6-8]

Calcified central TDH (CCTDH) is a subtype of TDH and accounts for 30% of symptomatic disc herniation.[2] The most

[1] Centre Hopitalier de l'Université de Montréal (CHUM), Montréal, Quebec, Canada
[2] Hotel Dieu de France Hospital, Beirut, Lebanon
[3] Saint Joseph University, Beirut, Lebanon

Corresponding Author:
Amer Sebaaly, Department of Orthopedic surgery, Spine Unit, Hotel Dieu de France Hospital, Alfred Naccache Street, Beirut, Lebanon.
Email: amersebaaly@hotmail.com

common cause for CCTDH is a history of thoracolumbar trauma (24%-30% of the cases).[3] There are some cases of spontaneous regression of this disease but the gold standard for treatment of symptomatic CCTDH is surgical resection.[9] CCTDH presents a surgical difficulty as intradural lesion are frequently encountered with high rate of adhesion to the dura,[10] generating unacceptable rates of cerebrospinal fluid leaks that are difficult to manage with minimally invasive techniques (thoracoscopy, mini-open thoracotomy).[10,11] Conversion to open procedures is thus required with increased morbidity of these approaches.

Minimally invasive posterior decompression of TDH was described by Cho et al[12] who reported the outcomes of 7 patients who underwent microscopic transpedicular discectomy using a tubular retractor. They recommended its use for posterolateral TDH, but this approach was not recommended for CCTDH.[12,13] To our knowledge, there are no reports minimally invasive posterior decompression for CCTDH. The objective of this article is to describe this approach while evaluating patients' outcomes and possible complications.

Materials and Methods

Surgical Technique for Minimally Invasive Calcified Disc Thoracic Spine

Similar to other posterior approaches, the patient is positioned in a prone position on a Jackson radiolucent table. Small incision (2 cm) is made after accurate localization of the affected level allowing the placement of the tubular retractor (METRx tubular retractor; Medtronic Sofamor Danek) against the bony elements.[14] After laminectomy is carried out, the lateral portion of the upper and lower facets are removed. Following the identification of the exiting root as well as the lateral margin of the spinal cord, removal of the upper and lower endplates is done using the high-speed burr while removing a part of the corresponding pedicle. When the anterior space to the cord is large, dissection between the cord and the anterior structures is carried at the least compressive region (at the rostral and the caudal end of the compression). Then, using a Brun (Hibbs-Spratt) curette, the calcified disc is progressively pushed into the created space. These last 2 steps are carefully repeated in order to separate the calcified disc form the adherent dura until all disc fragments are pushed into the anterior created space and removed using a Takahashi rongeur. Care should be taken to minimize cord retraction. Finally, hemostasis was achieved, the tubular retractor was withdrawn skin closure is carried out in a conventional manner. When the CCTDH is large, bilateral approach using 2 retractable tubes is the preferred method and is similar to the above described technique. Nonetheless, percutaneous fixation (one level above and below the removed pedicle) is done when bilateral facetectomy is done.

Methods

A retrospective review of all the cases operated, by a single surgeon (D.S.), with this technique from January 2006 to March 2019 was done. Inclusion criteria included (1) patients aged 18 years and older, (2) diagnosis of CCTDH on CT scanner of the thoracic spine, (3) indication for surgical treatment (axial pain, progressive myelopathy), (4) giant disc as defined by Hott et al: "occupying more than 40% of the spinal canal, on the basis of preoperative computed tomography (CT)–myelography, magnetic resonance imaging (MRI), or both."[15] Patients' demographics were recorded and included age, sex, and comorbidities. Preoperative variables included the presence of myelopathy, level of affected disc, percentage of canal compromise, the presence of hypersignal on T2-weighted images on the MRI, ASIA (American Spinal Injury Association) score, ambulatory status, hemoglobin level, preoperative visual analogue scale (VAS) axial pain.

Operative variables included used operative technique (unilateral vs bilateral), operative time, surgical bleeding, use of fixation, peroperative complications and total dose of radiation. No evoked potentials were used in these cases. Postoperative variables included hospital length of stay, postoperative complications (reoperation, infection, neurological deterioration, hemorrhage, conversion to anterior or anterolateral approaches), hemoglobin levels, ASIA score, ambulatory status, and VAS axial pain. Percent of disc resection was evaluated on the routine postoperative CT scanner. On the last follow-up, ASIA score, ambulatory status, and VAS axial pain were recorded.

SPSS 20.0 (IBM Corporation) was used for statistical analysis. Student t test was used to compare means. $P = .05$was chosen as a statistical significance level.

Results

Eight patients (Table 1) were operated upon in the inclusion period with a mean age of 54.4 years with a no sex predominance (4 females, 4 males). Myelopathy was the predominant symptom (87.5%) in all but one patient whose indication was back pain with dorsal radiculopathy. The affected disc level was between T7 and T12 in 6 patients and 1 patient had 2 adjacent level involvement (T7-T8 and T8-T9). Mean disc size at the highest compression zone was 7.65 mm (4-10 mm) with average canal compromise of 61% (50%-70%). All cases had giant calcified disc (canal compromise >40%) according to Hott et al. Only half of the patients had a hypersignal MRI on T2-weighted images. Preoperative ASIA was D in 50% and E in 50% with half of patients needing a walker to be able to ambulate. Mean preoperative VAS was 5.8 (0-8).

Unilateral approach was used in 6 patients and 2 patients required bilateral approach and fixation. Only 1 patient with unilateral approach required fixation (patient 6, Table 1) because of a history of an anterior hemangioma resection at the same level with a contralateral disc destabilization. Mean operative time (skin to skin) was 228 minutes (range 170-350 minutes) and

Table 1. Patients' Characteristics.

		Preoperative					Operative			Last follow-up	
ID	Sex/Age, y	Presenting symptom(s)	Disc level	Canal compromise, %	T2 hypersignal	ASIA score	Operative approach	Resection percentage	Complications	Mean follow-up, mo	ASIA score
1	Female/ 54.2	Conus medullaris myelopathy	T12-L1	80	No	E: Walks with walker	Bilateral: Intrumented fusion	40	Revision for incomplete resection	5.3	E: Walks freely
2	Male/54.0	Myelopathy	T11-12	60	Yes	D: Walks with walker	Unliateral: No fixation	100	0	42.3	E: Walks freely
3	Male/58.7	Dorsalgia and with radiculopathy	T3-4	60	No	E: Walks freely	Unilateral: No fixation	100	0	37.8	E: Walks freely
4	Male/34.9	Myelopathy	T7- 8, T8-9	50	No	D: Walks freely	Bilateral: Intrumented fusion	75	Epidural hematoma drained on D2	6.4	E: Walks freely
5	Male/40.2	Myelopathy	T7-T8	67	No	E: Walks freely	Unilateral: No fixation	80	0	24.8	E: Walks freely
6	Female/ 66.2	Myelopathy	T7-8	79	Yes	D: Walks with walker	Unilateral: Intrumented fusion	70	0	2.8	D: Walks with walker
7	Female/ 49.9	Myelopathy	T5-T6	70	Yes	E: Walks freely	Unilateral: No fixation	100	0	4.4	E: Walks freely
8	Female/ 76.9	Myelopathy	T10-T11	50	Yes	D: Walks with walker	Unilateral: No fixation	100	0	6.0	E: Walks freely

Abbreviations: ASIA, American Spinal Injury Association.

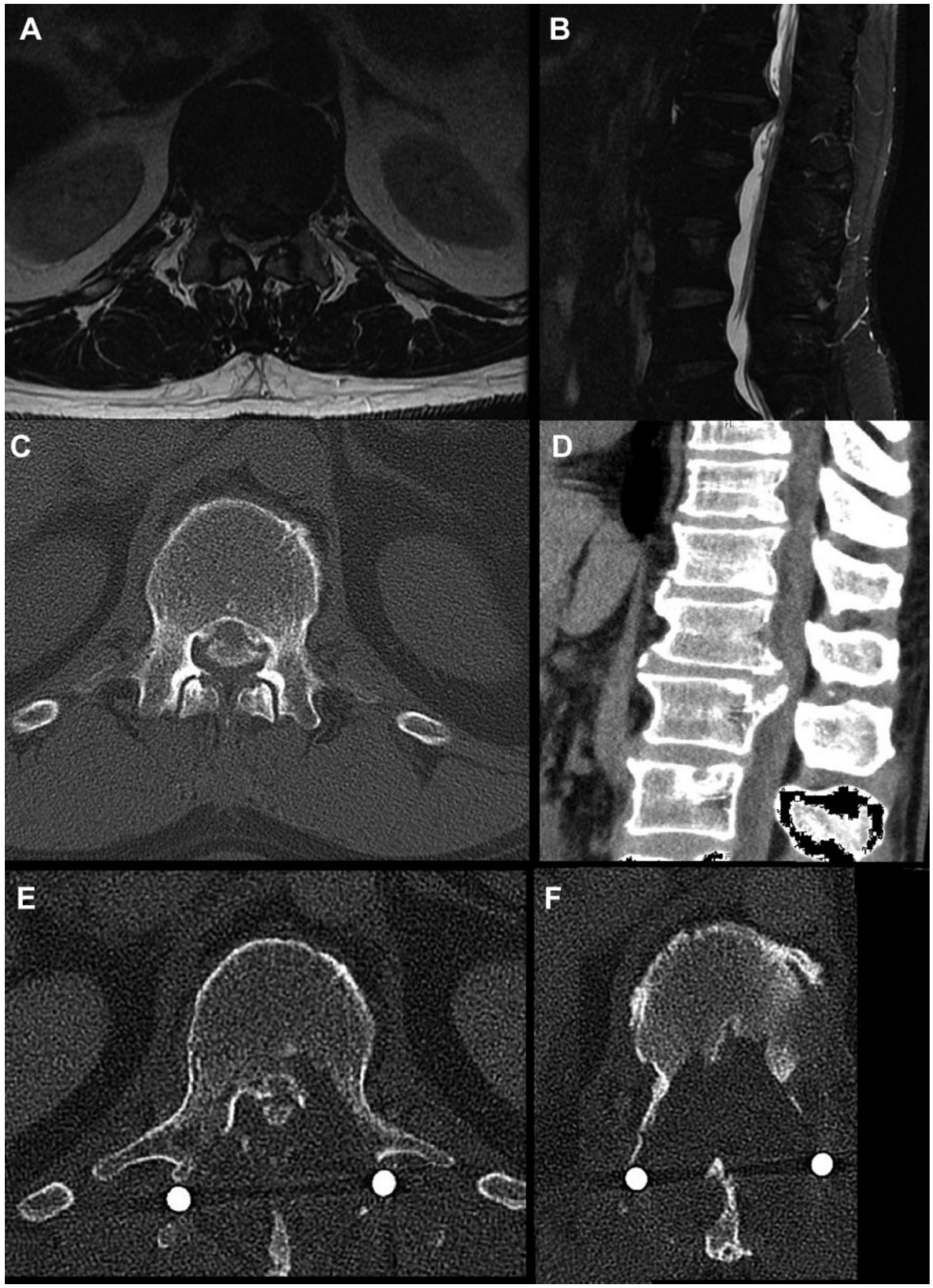

Figure 1. A 54-year-old woman (case 1, Table 1) presented with signs of progressive myelopathy with preserved walking ability (with help; ASIA E). Magnetic resonance imaging (MRI) and computed tomography (CT) scans showed a giant calcified thoracic disc herniation at the T12-L1 disc without T2 hypersignal (A-D). She was operated upon with the described minimally invasive technique. On the postoperative control CT scanner, a blind spot was discovered (E). She was operated upon with a contralateral approach and complete removal of the calcified disc was done. She had a complete recovery on the latest follow-up.

mean operative bleeding was 250 mL (range 50-500 mL). Preoperative hemoglobin levels were 13.8 g/dL (range 11.4-15.9 g/dL) and decreased to 11.33 g/dL (range 10.2-13.4 g/dL) on postoperative day 1 ($P = 0.001$). No patients required intraoperative or intrahospital transfusion. Total dose of radiation was 60 mSv (range 34.9-76.9 m Sv). One patient had a 1 class ASIA improvement in the immediate postoperative period. Mean postoperative day 1 VAS was 3.14 (range 0-6) and was significantly lower than its preoperative value ($P = .02$). Postoperative course saw 2 reoperations: one case of compressive epidural hematoma that was drained without any consequence and another case of incomplete resection

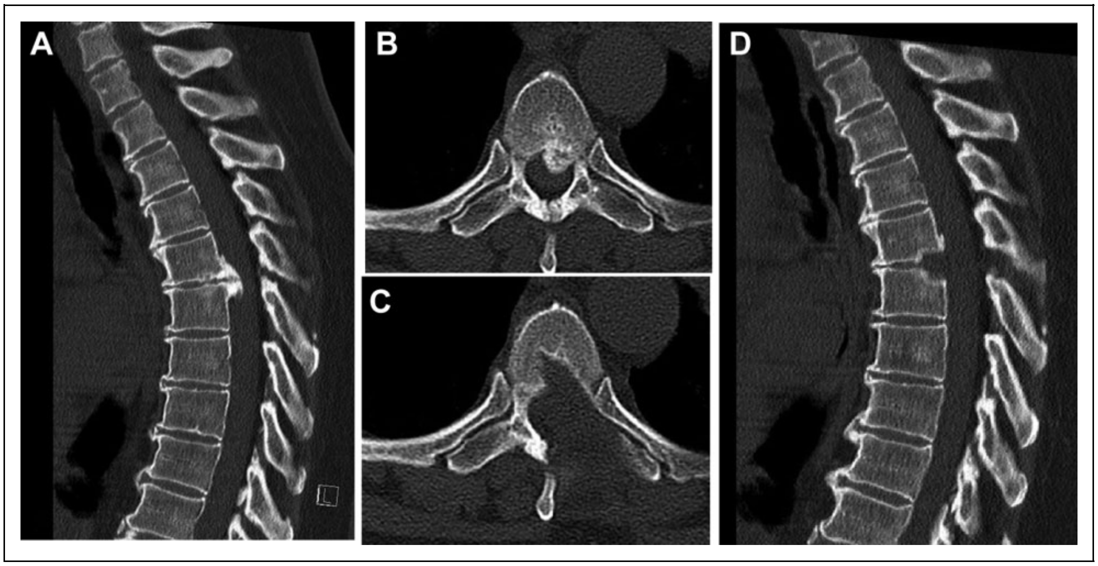

Figure 2. A 50-year old woman (case 7, Table 1) with signs of progressive myelopathy with preserved walking ability (ASIA E). Computed tomography (CT) scans showed a giant calcified thoracic disc herniation at the T4-T5 disc (A, B). She was operated upon with the described minimally invasive technique with unilateral approach. The postoperative control CT scanner shows complete removal of the disc. She had a complete regression of her myelopathy on the latest follow-up.

and resection was completed using a contralateral approach (Figure 1). There were no cases of dural tear. Mean length of stay was 14 days (decrease to 7 days when reoperated patients are removed from statistical analysis). Mean resection of the CCTDH was 83% (40%-100%) (and increases to 87% when case 1 was removed).

Mean follow-up was 16 months (range 3-42 months). All but one patient is ASIA E grade and are completely ambulatory with no help.

Discussion

Minimized exposure for surgical treatment of spinal disorders are becoming increasingly popular.[15] A minimally invasive oblique paraspinal approach using a tubular retractor for the treatment of TDH have been recently described[12] and was recommended for paramedian soft TDH. On the other hand, CCTDH is considered a contraindication for the use of this technique.[12] Anterior minimally invasive technique was also described for central herniation[16] but was associated with high rates conversion to open procedures caused by high rates of dural tears.[10] Paolini et al[17] reported on the use of the endoscope in calcified thoracic disc herniations. Nonetheless, this is the first description, to our knowledge, for the use of posterior minimally invasive decompression technique with a tubular retractor for the treatment of CCTDH. We found that this technique is safe with low dural tear and neurologic complications rates and is associated with good clinical outcomes. The main challenge of this technique is to create an unobstructed working channel to safely resect the calcified disc with minimal manipulation of the spinal cord (Figure 2).

CCTDH is a rare disease and poses therapeutic challenge even for the most experienced surgeons.[13] As a matter of fact, CCTDHs occupy frequently more than 40% of the canal (and considered giant TDH[18]) thus associated with greater neurological deficit and worse functional outcomes.[18] CCTDH tends to incorporate into the dura matter by eroding it[19] with as high as 70% of these cases being intradural. Using a standard posterior approach (laminectomy) for the treatment of this pathology was classically associated with high rates of neurologic deterioration as well as high mortality rates.[4] Thus, anterior approaches were recommended for the treatment of this pathology.[20] Anterior approaches were associated with good neurological outcomes and low neurological complications is some series with neurological recovery ranging from 85% to 100%.[21] Nonetheless, when compared with posterior decompression, anterior open approaches were associated with increased complications and lesser patients' satisfaction.[22] In fact, thoracotomy is associated with postthoracotomy pain in 50% of the patients and continues to 5 years postoperatively in one-third of the operated patients.[1] Even though minimally invasive anterior approaches are associated with less morbidity, repairing of dural tears is difficult with thoracoscopic approaches.[3,10,13]

Spine surgeons are more at ease when performing the more frequently used posterior approaches compared with anterior ones, with no need for an access surgeon.[23] Despite the more straightforward access of anterolateral approaches to CCTDH, there are still high complication rates using these approaches. Dural tears and revisions for incomplete removal or cerebrospinal fluid fistulas are frequently encountered with this disease caused by the intradural nature of this pathology.[10] Under those circumstances, some authors have recommended creating an anterior space to the spinal cord and leaving a thin shell of the CCTDH attached to the dura matter.[10] This recommendation was the driving hypothesis for the performance of this technique with posterior removal of CCTDH. By creating an anterior cavity between the 2 vertebral bodies and the affected disc and removing all the contact between the CCTDH and the dura being nonessential, posterior removal of most of the CCTDH is made possible by posterior minimally invasive technique. This is done by creating a "floating" calcified segment and by gradually separating the calcified disc from the dura. This was not associated with increased risk of dural tears or intraoperative complications. Moreover, this minimally invasive technique resulted to less blood loss compared to landmark study of Quraishi et al[13] (250 vs 1230 mL) with less average operative time (228 vs 344 minutes) but with the same hospital length of stay (14 vs 11 days) with comparable improvement of neurological status (83% vs 77%).

One of the main limitations of this technique is its inability, sometimes, by a unilateral approach to fully decompress the cord with possible blind spots. Bilateral approaches were described for open surgery and this creates a greater visualization access to the anterior cord, allowing separation of the neural membranes from the calcified disc and anterior communication to ensure complete decompression.[24] This bilateral approach used for CCTDH was associated with satisfactory outcomes in 11 patients albeit a 9% cerebrospial fluid leak rate with posterior fusion done for all patients.[24] Bilateral minimally invasive approach could be used with the same efficacy and safety profile. Similarly, a recent report has found that the use of neuronavigation allowed safe and effective removal of CCTDH with no postoperative neurological worsening or onset of new spinal instability.[25] Another reported tool for complete removal of the compressing calcification is the use of real-time intraoperative ultrasonography, which increases the accuracy of cord decompression.[5] Nonetheless, the probe should be small enough to go through the retractable tube.

One could argue that when posterior costotransversectomy as well as removal of a part of the pedicle is done, fusion is mandatory. Large and extensive bone removal are classical indication for instrumentation and fusion.[2] In like manner, instrumented fusion was recommended in giant TDH, calcified TDH, and transdural TDH when using anterior approaches and this is caused by the instability generated by excessive vertebral body bone removal.[2] On the contrary, we believe that the use of the described minimally invasive technique does not destabilize the thoracic spine. In fact, the discectomy per se is not destabilizing since postdiscectomy instability was found only in 1.8% of the operated patients.[26] Broc et al[27] found in a cadaveric model a small, biomechanically, insignificant increase in range of motion after discectomy. Other authors did not report any instability with posterolateral discectomy without fusion[28] or when transpedicular discectomy was done.[29] Healy et al[30] found that thoracic spinal stability is maintained immediately after unilateral facetectomy at the level of the true ribs with no increase of range of motion if the rib cage is intact.[30] Additionally, fusion procedures are associated with increased blood loss, longer hospital stays, increased blood transfusions, and higher complications rates.[2] For these reasons, we reserve posterior fixation when bilateral facetectomy is done[31] and discectomy at the thoracolumbar junction because of the increased lever of arm at this anatomical area and the absence of the stabilizing effect of the rib cage. The presence of a deformity (kyphosis, scoliosis, etc) is an indication for surgical stabilization to avoid deformity progression.[2]

Conclusion

This article reports the first description of posterior minimally invasive transpedicular approach for giant calcified thoracic disc herniation. This technique is safe with no increased risk of neurological deterioration and no increased rate of dural tears. It is associated with decreased blood loss as well as decreased operating times with no change in neurological status improvement. Minimally invasive transpedicular approach could be thus considered for treatment of this giant calcified thoracic disc herniation.

Declaration of Conflicting Interests

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ORCID iD

Amer Sebaaly, MD, MSc https://orcid.org/0000-0002-2785-7835

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