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## Technical note

## Anterior transcorporeal tunnel approach for cervical myelopathy guided by CT-based intraoperative spinal navigation: Technical note

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## ABSTRACT

Cervical spondylotic myelopathy (CSM) is the most common degenerative disease of the spine in elderly patients. Although there are several surgical options for the treatment of this disease, minimally invasive techniques for localized decompression of the true clinical generator of the patient's disease has revolutionized spinal surgery recently. This article presents an alternate application of the anterior transcorporeal tunnel approach in combination with computed tomography (CT)-based intraoperative navigation in the treatment of patients with cervical myelopathy secondary to spondylosis. Three clinical cases are used as examples to demonstrate how this procedure can be used to decompress a localized target in cervical spondylotic myelopathy. Clinical images of each case are shown. Cervical decompression was successfully achieved in all three patients, with the improvement of preoperative symptoms. The anterior transcorporeal tunnel approach combined with the use of CT-based intraoperative spinal navigation may be a feasible minimally invasive procedure for the treatment of cervical spondylotic myelopathy in selected cases.

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## 1. Introduction

Cervical spondylotic myelopathy (CSM) is the most common degenerative disease of the spine in elderly patients [1]. The incidence and prevalence of this disease are estimated to be 41 and 605 per million in the United States of America, respectively [2]. A systematic review published in 2013 reported that between 20 and 60% of patients with symptoms and radiographic findings of CSM will worsen over time if they are not surgically treated [3]. Surgical treatment is recommended for patients diagnosed with mild symptoms of CSM [4]. There are several surgical options, all of which aim to alleviate the compression from the spinal cord or nerve root. Conventional techniques include anterior cervical discectomy and fusion (ACDF), anterior cervical corpectomy and fusion (ACCF), posterior laminectomy with/without fusion, and laminoplasty [5]. Some authors suggest that anterior procedures appear to be more suitable when the compression is ventral and involves a multilevel disease. On the other hand, if the compression

is dorsal, posterior approaches or a combination of both anterior/posterior approaches can be utilized [5–7].

Surgical techniques of the spine have evolved, and minimally invasive procedures can be used to decompress the spinal cord accurately. Examples of these procedures are posterior microforaminotomy, laminoforaminotomy, minimally-invasive laminectomy, and cervical anterior/posterior endoscopic approaches [8]. These techniques can be considered when there has been a careful patient selection [9].

The present work describes a novel application of the anterior transcorporeal tunnel approach in combination with computed tomography (CT)-based intraoperative spinal navigation for the treatment of CSM. We provide three case examples where good results were achieved.

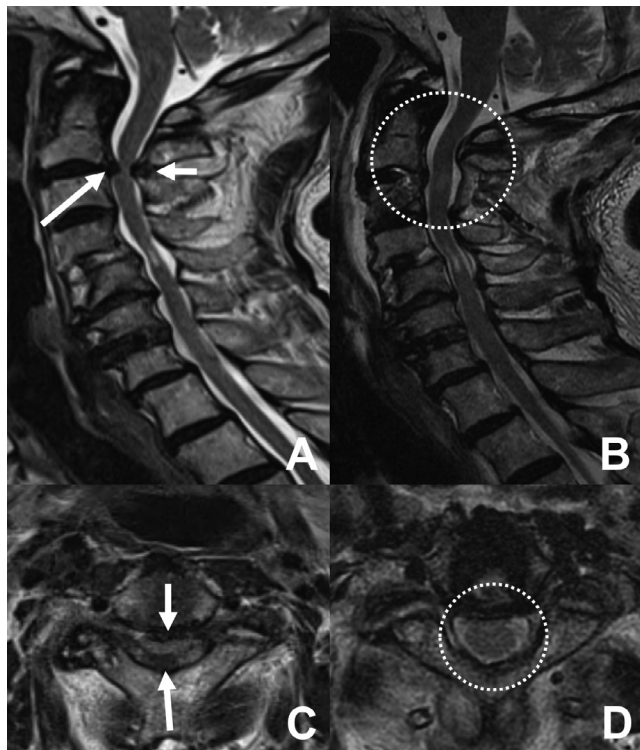
## 2. Clinical cases

## 2.1. Case 1

A 75-year-old man presented with progressive quadriplegia that had developed over 3 months. He had received ACDF at C4–C5 and C6–C7 10 years previously. His physical examination demonstrated decreased strength in the upper and lower limbs with a global score of grade 3. The patient presented voiding difficulty and impaired anal tone associated with bilateral paresthesia

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**Fig. 1.** Preoperative images. A: T2-weighted sagittal view on MRI with circumferential stenosis at C2–C3 (arrows). C: T2-weighted axial view of C2–C3 showing anterior and posterior spinal cord compression (arrows). Postoperative images. B and D: sagittal and axial views on T2-weighted MRI showing the free spinal cord at C2–C3 level after decompression (dotted white circles).

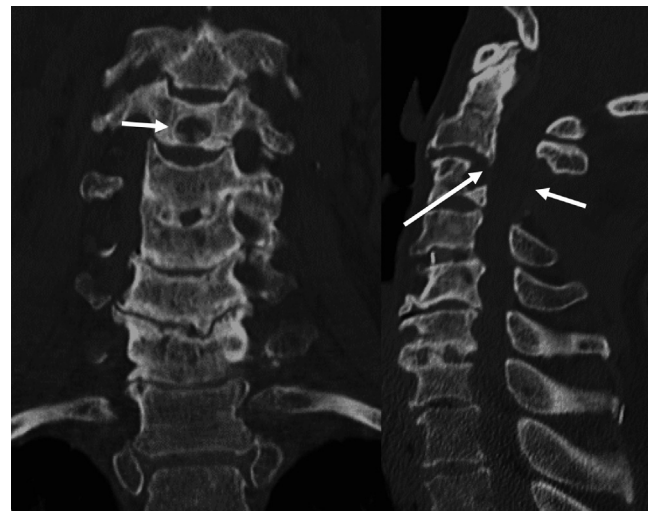
and hyperesthesia below the C5 dermatome. Magnetic resonance imaging (MRI) revealed a circumferential stenosis at the C2–C3 level caused by a posterior spondylotic osteophytes and hypertrophy of the ligamentum flavum (Fig. 1A and C). We decided to perform two-step decompressive surgery. The first step consisted of an anterior transcorporeal tunnel upward approach guided by CT-based intraoperative spinal navigation. The C3 vertebral body was approached for treating the C2–C3 anterior compression. The second surgery was a spinous process-sparing undercutting partial laminectomy of C2 along with a C3 decompressive total laminectomy. Postoperatively, strength and sensitive disturbances improved. Postoperative radiological scans showed proper decompression (Fig. 1B and D). The 11-month postoperative CT scan revealed filling of the inside of the tunnel made in the C3 vertebral body with an ingrowing bone mass, suggesting fusion (Fig. 2).

## 2.2. Case 2

A 71-year-old woman presented with progressive arm and leg weakness that had developed over 2 months. MRI and CT myelogram demonstrated an anterior cord compression at C3–C4 (Fig. 3). The target was reached with an anterior transcorporeal tunnel approach guided by CT-based intraoperative spinal navigation performed in the C4 vertebral body. Postoperatively, symptoms improved significantly, and the postoperative MRI demonstrated that the C4 tunnel approach resulted in a complete decompression (Fig. 4).

## 2.3. Case 3

A 49-year-old woman was diagnosed with a downward migrated disc herniation at C5–C6. MRI showed a central compression on the spinal cord (Fig. 5). The tunnel was created in the cen-



**Fig. 2.** Left: CT view showing the tunnel approach (white arrow) at C3. Right: Sagittal CT view; the upward vector of the tunnel approach on C3 to reach the anterior compressive target at C2–C3 level (large white arrow) with posterior decompression (short white arrow) are shown.

ter of the C6 vertebral body towards the target. After decompression, the patient's myelopathy symptoms improved. Postoperative MRI revealed the central tunnel approach (Fig. 6).

## 3. Indications and contraindications

Patients with cervical myelopathy secondary to spondylosis are suitable candidates for this procedure. The stenosis can be central, paracentral, or foraminal affecting only one level.

However, it is not recommended to perform this approach on patients with multilevel cervical stenosis, kyphotic deformity, axial pain as the primary symptom, or cervical instability. We encourage the use of CT-based intraoperative spinal navigation to provide the greatest security along with surgical target exactitude (Fig. 7).

## 4. Surgical technique

The patient is placed in a supine position under general anesthesia, and intraoperative nerve monitoring is done. The position at which the tunnel approach will be carried out depends on the site of the pathology: central, paracentral, or foraminal. In upper levels, such as C2–C3 and C3–C4, a 2.5 cm transverse skin incision is made over C3 and C4, 1 cm away from the midline. Once the prevertebral fascia is opened, finger dissection is performed, and the Caspar retractor is subsequently positioned to expose the C3 or C4 vertebral body, with minimal disturbance of the longus colli muscle. In the low-cervical region (C6–C7 and C7–T1), the tunnel approach is done with a downward trajectory. In the mid-cervical region (C4–C5 and C5–C6) the anterior transcorporeal tunnel approach can be made with an upward, central or downward trajectory depending on the site of the pathology at these levels. In all cases, intraoperative navigation is essential to the planning and performing of the bone drill. Our surgical center employs the O-arm system (Medtronic Sofamor Danek, Memphis, TN, USA). After the surgical procedures are finished, the surgeon can recheck the navigation system images to see whether decompression procedures are sufficient and whether the surgical trajectory is correct.

## 5. Discussion

In the first case, the approach was decided because the primary site of pathology was at a higher cervical level (C2–C3), which

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