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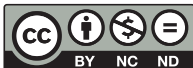

Navigation-assisted interlaminar endoscopic technique for C7-T1 disc herniation: a minimally invasive approach to the cervicothoracic junction. Case report

Técnica endoscópica interlaminar asistida por navegación para hernia discal C7-T1: abordaje mínimamente invasivo de la unión cervicotorácica. Reporte de caso

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ABSTRACT

Introduction: C7-T1 disc herniation is an uncommon pathology presenting unique surgical challenges due to limited fluoroscopic visualization "shoulder overlap" and inherent risks associated with anterior approaches (ACDF, sternotomy). Intraoperative navigation during the full endoscopic posterior approach is key to minimizing invasiveness, preserving motion, and providing a viable, crucial alternative. **Case description:** a 48-year-old female with six-month C8 radiculopathy (confirmed by MRI/EMG) underwent navigation-assisted full endoscopic posterior foraminotomy and sequestrectomy at C7-T1. The surgical strategy prioritized minimal invasiveness and joint preservation. Operative time was 95 minutes, estimated blood loss (EBL) was 20 ml, and the hospital stay was just one day. **Results:** the patient achieved complete pain resolution (pre-operative VAS: 9/10, post-operative: 0/10) at 24 hours, which was sustained throughout six months of follow-up, with no complications recorded. NDI scores showed remarkable improvement, moving from 48 to 6%. **Conclusions:** navigation-assisted full endoscopic posterior foraminotomy at the cervicothoracic junction may represent a feasible and safe alternative in carefully selected C8 radiculopathy cases. The technique offers favorable outcomes, a low morbidity profile, and enables rapid recovery.

RESUMEN

Introducción: *la hernia discal C7-T1 es una patología infrecuente con desafíos únicos de visualización fluoroscópica (superposición de hombros) y riesgos de abordajes anteriores (ACDF, esternotomía). La navegación intraoperatoria en el abordaje endoscópico posterior minimiza la invasividad, preserva el movimiento y ofrece una alternativa viable.* ***Descripción del caso:*** *femenino de 48 años con radiculopatía C8 (seis meses de evolución, confirmada por RMN/EMG), fue sometido a*

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foraminotomía y secuestrectomía endoscópica posterior C7-T1 asistida por navegación. La estrategia quirúrgica se centró en la mínima invasión y preservación articular. El tiempo operatorio fue de 95 minutos, el sangrado estimado de 20 ml y la estancia hospitalaria de un día. ***Resultados:*** *el paciente reportó resolución completa del dolor (VAS pre: 9/10, post: 0/10) a las 24 horas, sostenida a 6 meses, sin complicaciones. Sus puntuaciones NDI mejoraron de 48 a 6%.* ***Conclusiones:*** *el abordaje endoscópico posterior C7-T1 asistido por navegación puede ser una alternativa factible y segura en casos seleccionados de radiculopatía a este nivel, ofreciendo un perfil de mínima morbilidad y rápida recuperación.*

Abbreviation:

ACDF = Anterior Cervical Discectomy and Fusion
ASD = Adjacent Segment Disease
DRF = Dynamic Reference Frame
EBL = Estimated Blood Loss
EMG = Electromyography
MRI = Magnetic Resonance Imaging
NDI = Neck Disability Index
VAS = Visual Analog Scale

INTRODUCTION

Cervical disc herniation at the C7-T1 level, specifically causing C8 radiculopathy, is regarded as a rare pathology, constituting approximately 4-10% of all cervical disc herniations.[1,2] This infrequency, paired with its potential for profound functional impact, presents considerable diagnostic and therapeutic hurdles, frequently necessitating highly specialized surgical expertise.

While traditional anterior surgical approaches, such as **ACDF (Anterior Cervical Discectomy and Fusion)**, remain established effective treatments, their necessary application at the C7-T1 junction involves specific risks and potential complications. ACDF itself carries intrinsic long-term disadvantages, including reduced range of motion, potential adjacent segment disease, and implant-related concerns.[3,4] Furthermore, achieving anterior access to the C7-T1 level may mandate procedures like partial sternotomy or manubrial resection, significantly prolonging operative time and introducing risks to adjacent mediastinal structures and the esophagus.[2,5,6]

The **cervicothoracic junction (C7-T1)** is inherently a challenging anatomical segment for accessing the posterior column. Critical neurovascular structures lie in close proximity, and more significantly, the interposition of the patient's shoulders severely compromises crucial fluoroscopic visualization.[7] This "shoulder overlap" phenomenon frequently occludes the operative field, rendering accurate and safe targeting of the C7-T1 level unreliable when relying solely on standard fluoroscopy.[7-9]

Minimally invasive surgical techniques, particularly full endoscopic posterior cervical foraminotomy and discectomy, have quickly become preferred alternatives, largely due to their proven benefits in reducing tissue trauma, minimizing postoperative pain, and accelerating recovery compared to traditional open methods.[10] Nonetheless, deploying this advanced approach at the C7-T1 level demands exceptional precision due to the segment's distinct anatomical constraints.[1]

Recent advancements in **Image-Guided Surgery (Navigation)** technology have successfully mitigated this key safety challenge. Navigation delivers real-time, precise, three-dimensional anatomical guidance, substantially enhancing surgical accuracy and safety, especially within complex anatomical regions.[7,11] The seamless integration of navigation is particularly transformative at the C7-T1 level, directly solving the visualization risks inherent to fluoroscopy limitations.[7]

While promising case reports and small patient series supporting endoscopic management for C7-T1 radiculopathy exist,[1,12,13] there is a notable scarcity of dedicated studies detailing the specific implementation and derived benefit of neuronavigation-assistance when performing the posterior interlaminar endoscopic approach at this particularly complex level.[7,9] This report, therefore, highlights the successful and precise application of a navigation-assisted full endoscopic posterior interlaminar technique for the management of C7-T1 disc herniation, demonstrating its feasibility and efficacy as a state-of-the-art, minimally invasive approach in the challenging cervicothoracic junction and offering a valuable contribution to the current surgical literature.

CASE PRESENTATION

A 48-year-old male, with no history of previous spinal surgery, presented to the clinic having endured six months of **progressive left cervical pain** radiating into the arm and hand, consistent with C8 radiculopathy. His symptoms included paresthesia in the fourth and fifth digits, accompanied by motor weakness affecting the triceps and wrist flexors. The patient reported a

substantial negative impact on his quality of life and daily activities, quantifying his functional limitation with a **Neck Disability Index (NDI) of 48%** and pain intensity using a **Visual Analog Scale (VAS)** of **9/10** (neck) and **9/10** (arm).

Having already completed a three-month course of conservative treatment (analgesics and physical therapy) without significant relief, the patient met the **surgical indication criteria** due to the failure of conservative management and the presence of a progressive neurological deficit.

Physical examination demonstrated diminished sensation in the left C8 dermatome and **4/5** motor strength in the triceps muscle, alongside a positive Spurling's sign on the left side. Deep tendon reflexes were noted as diminished in the triceps.

The diagnosis was confirmed by Cervical Spine Magnetic Resonance Imaging (MRI) and electromyography (EMG) *(Figure 1)*. The cervical MRI revealed a **left paracentral disc extrusion** at the C7-T1 level, resulting in severe compression of the C8 nerve root. This imagery confirmed a **soft** (non-calcified) herniation of left laterality. The EMG findings were consistent with C8 radiculopathy.

The C7-T1 location represented the primary therapeutic challenge. Shoulder interposition severely impedes fluoroscopic visualization *(*shoulder overlap*)*, rendering traditional posterior approaches without image guidance technically demanding, while anterior surgery (ACDF) carries inherent risks at the cervicothoracic junction. The definitive surgical decision favored a **minimally invasive, motion-preserving approach** assisted by real-time navigation.

Surgical intervention, metrics, and outcome

The patient underwent a **navigation-assisted posterior interlaminar endoscopic foraminotomy and sequestrectomy** at the C7-T1 level. The procedure was performed under general anesthesia while the patient was in the prone position. A **Medtronic O-Arm** navigation system was employed and meticulously registered with a biportal mechanic arm by Medtronic as Dynamic Reference Frame (DRF) to ensure continuous and precise three-dimensional guidance *(Figures 2-4)*.[11]

Using a single 1 cm portal, the navigation facilitated precise localization of the entry point and a safe surgical trajectory. This dramatically minimized the

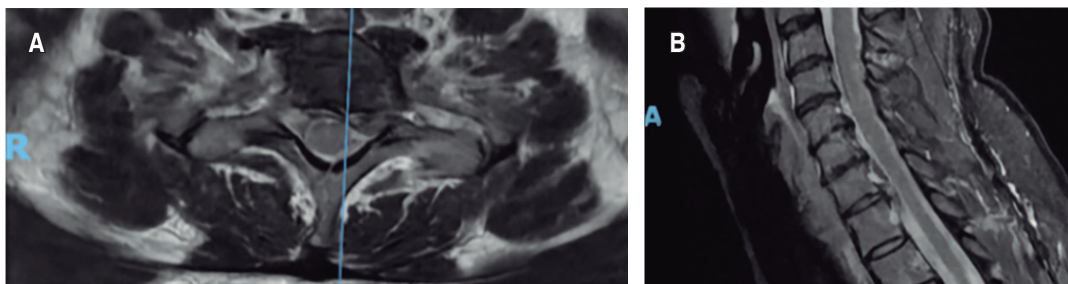

Figure 1: A) Showing an MRI T2 axial cut at the C7-T1 level, revealing severe left paracentral extrusion with radicular compression. **B)** Showing sagittal cut with T2 STIR sequence, revealing foraminal stenosis from C3 to C7 with particular compression at C7.
MRI = Magnetic Resonance Imaging. STIR = Short TI Inversion Recovery.

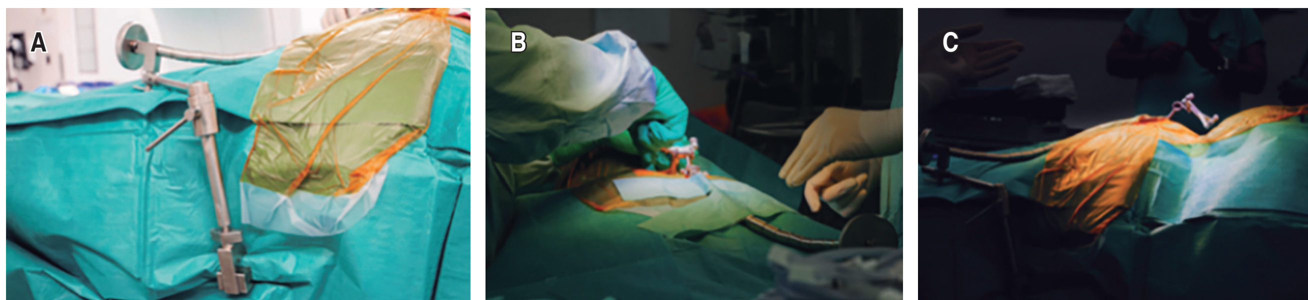

Figure 2: Use of Medtronic mechanical arm used in tubular surgery, as an alternative for frame placement for navigation.

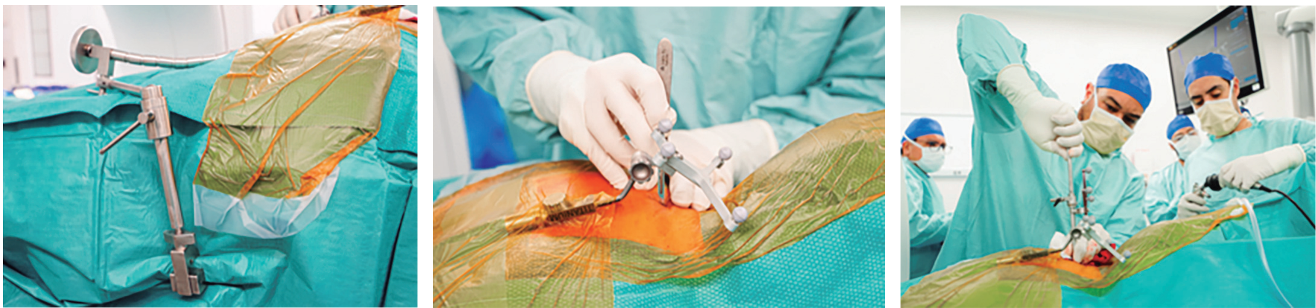

Figure 3: A paramedial approach was performed, and an endoscopic cannula was inserted using neuronavigation guidance.

need for repetitive fluoroscopy, limiting its use solely to the initial level verification.[7] A meticulous foraminotomy was carried out, requiring minimal resection of the inferomedial C7 lamina and the superior T1 lamina, thus preserving facet stability. The extruded disc fragment was successfully identified and completely removed via sequestrectomy.[13]

Operative metrics and follow-up

1. Standardized technique: navigation-assisted posterior interlaminar endoscopic foraminotomy and sequestrectomy.
2. Navigation system: medtronic O-Arm and biportal mechanic arm by Medtronic as dynamic reference frame.
3. Total operative time: 95 minutes.
4. Estimated blood loss (EBL): 20 ml.
5. Hospital stay: one day.
6. Postoperative analgesia: a foraminal and facet block was administered at C7-C8-T1-T2 with methylprednisolone, followed by standard postoperative analgesia consisting of tramadol infusion and a COX-2 agonist for 24 hours.

Quantitative outcomes and ethical statement: the patient reported *complete pain resolution (VAS: 0/10)* and full resolution of paresthesia 24 hours after surgery; this excellent result was sustained throughout the six-month follow-up. Triceps motor strength recovered fully to 5/5. The NDI score showed a drastic improvement from 48% (pre-operative) to 6% (post-operative), enabling the patient to *return to his usual work activity* just three weeks post-operatively.[12,14] *No intraoperative or postoperative complications were reported.*[13]

Written informed consent was obtained from the patient for both the surgical procedure and the subsequent publication of this case report.

DISCUSSION

Cervical disc herniation at the C7-T1 level is recognized as an uncommon pathology, accounting for a small percentage (4-10%) of all cervical disc disease.[1,2] The unique anatomical constraints of the cervicothoracic junction-specifically, the depth, the unique angulation of the C7-T1 intervertebral foramen, and the difficulty of visualization-pose significant surgical challenges that must be addressed.[2]

1. **Problematic backup and statistics:** the imperative for precise intervention is paramount in this region, given the high risk of catastrophic neurological or vascular injury.[7] Traditional gold-standard treatments, such as **ACDF**, while deemed effective, necessitate fusion, a process linked to reported long-term risks of adjacent segment disease (ASD) (rates between 2.2 and 3.9% annually) and the inevitable loss of motion segment.[3,4,15] Moreover, the anterior approach to T1 frequently necessitates partial sternotomy or manubrial resection, measures that significantly heighten soft-tissue disruption and surgical morbidity.[2,5,6] Conversely, posterior conventional microforaminotomy and the full endoscopic approach, when executed without navigational assistance, are intrinsically limited by the shoulder overlap phenomenon, which profoundly obscures fluoroscopic guidance required for accurate portal placement and level confirmation.[7-9,14]
2. **Critical comparison of the technique used:** the *navigation-assisted posterior interlaminar endoscopic foraminotomy and sequestrectomy* presents several distinct advantages over these alternatives. Relative to anterior approaches, our technique is strictly motion-preserving, directly treating the radiculopathy while circumventing

the risks associated with implant placement and fusion.[3,16] When compared to conventional posterior microforaminotomy, the endoscopic approach minimizes muscle dissection, yielding superior visualization and faster recovery profiles.[10] Crucially, the integration of intraoperative navigation effectively resolves the primary technical hurdle associated with this challenging segment.[7]

3. **Emphasis on navigation:** the utilization of the Medtronic O-Arm navigation system served as the pivotal element of this procedure.[11] It provided real-time, high-definition, three-dimensional localization of the C7-T1 level, the target trajectory, and the critical structures (nerve root and vertebral artery).[7,11] This capability substantially enhanced the confidence and overall safety of the decompression, particularly within a region where standard bi-dimensional fluoroscopy is notoriously unreliable due to bony obstruction.[7,8] The necessity for repeated fluoroscopic shots was significantly reduced (limited solely to initial registration verification), offering the added benefit of minimizing cumulative radiation exposure for both the patient and the surgical team.[7,8] However, it must be acknowledged that the navigation system inherently introduces potential limitations, including increased initial operative time for registration (not individually tracked in this case but estimated to add ~15-20 minutes) and the inherent costs and learning curve associated with such specialized technology.[17]
4. **Limitations of the article and avoiding generalizations:** the excellent quantitative outcomes observed in this patient (NDI improvement from 48 to 6%; VAS reduction from 9/10 to 0/10) align favorably with the results reported for endoscopic surgery in other cervical segments.[18,19] Nevertheless, this article presents the findings of a **single case report**, which, by its nature (Level IV evidence), is subject to limitations, including a short-term follow-up of only six months. Therefore, sweeping generalizations must be avoided.

CONCLUSIONS

The primary message derived from this case report is the *feasibility and rapid functional recovery* successfully achieved using navigation-assisted endoscopy at the challenging C7-T1 level.[9] This conclusion is strongly supported by the objective quantitative outcomes: the patient achieved complete pain resolution (VAS reduced from 9/10 to 0/10) within 24 hours, and functional status drastically improved (NDI reduced from 48% preoperatively to 6% at six months).[12,14]

These favorable patient-reported outcomes align well with those published in larger series detailing posterior cervical endoscopic foraminotomy.[12,19] Furthermore, our results demonstrate a superior recovery profile compared to what is typically reported for open posterior approaches in this complex segment, which often involve more extensive soft-tissue trauma.[10]

The technical approach utilized here-navigation-assisted endoscopy-is particularly significant when juxtaposed with the historical gold standard, **ACDF**, which mandates fusion.[3,16] The patient's immediate pain relief and preservation of segmental mobility clearly differentiate this technique.[4] This case explicitly demonstrates the unique contribution of **navigation** by: (1) enhancing surgical accuracy for level localization; (2) providing continuous control over the interlaminar trajectory; and (3) minimizing dependence on repeated fluoroscopy, which remains problematic due to the shoulder overlap at C7-T1.[7,8,14]

Secondary outcome metrics further solidify the minimally invasive nature of the procedure, including

Figure 4: The entry point is located using neuronavigation, and the endoscope is used for the laminectomy.

a low estimated blood loss (20 ml), a short hospital stay (one day), and a rapid return to work (three weeks). These metrics are highly competitive with other minimally invasive techniques and superior to standard open surgery.[10]

The primary strength of this article lies in the detailed technical reporting of applying neuronavigation to successfully overcome a well-documented anatomical challenge.[7] However, we acknowledge the inherent weaknesses of this article: it is a *single case report* (level IV evidence) with a *follow-up limited to six months*. Complete long-term metrics were not assessed beyond this period.[12]

In conclusion, this case illustrates that *navigation-assisted posterior interlaminar endoscopic foraminotomy and sequestrectomy may be a feasible minimally invasive alternative in selected C7-T1 cases of C8 radiculopathy*.[1,9] The evident advantages-motion preservation, high accuracy, and minimal soft-tissue disruption-are clear.[17,20] *We strongly recommend that future large comparative series be conducted to fully define the long-term safety profile, radiation exposure, and cost-effectiveness of navigation in the cervicothoracic junction*.[8,17]

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