Surgical Techniques Ensuring Success in Posterior Endoscopic Cervical Foraminotomy and Discectomy at C6-7 in Patients with Prominent Shoulders and Short Necks

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ABSTRACT

Introduction: There is a steep learning curve for a successful posterior endoscopic cervical foraminotomy and discectomy (PECFD), an important surgery for cervical foraminal or lateral disc herniation, and cervical radiculopathy due to a small operation field. PECFD becomes even more challenging in patients who have prominent shoulders and/or short necks with C6–7-disc herniation, because of the difficulty to localize C6–7 vertebral structure under fluoroscopy.

The study objective is to prove that the PECFD can be performed safely and successfully to C6–7-disc herniation on patients with prominent shoulders and/or short necks following our novel surgical techniques under fluoroscopic guidance.

Materials and Methods: PECFD was performed on a patient who had an extruded foraminal disc herniation at C6–7 on the left with left arm pain and weakness. Due to his prominent shoulders and a short neck, the C6–7 anatomic site was not visible under traditional anterior-posterior (AP) and lateral fluoroscopic views. The authors inserted a reference needle to C4–5 facets between C4 and C5 pedicles under AP and lateral fluoroscopic views. Following the reference needle, the C6–7 facets were easily located with an oblique fluoroscopic view. A large endoscopic cannula was used initially for adequate resection of C6–7 facets, followed by a small cannula for nerve root handling with minimal pressure and discectomy.

Results: The novel surgical techniques resulted in a complete resection of the C6–7-disc herniation and resolution of the patient's radiculopathy with no postoperative complications.

Conclusion: PECFD can be safely and successfully applied for C6–7-disc herniation in patients with prominent shoulders and/or short necks using our novel surgical techniques.

INTRODUCTION

The prevalence of cervical radiculopathy in the US is about 3.5 cases per 1,000 population.[1] About 3/4 of cervical radiculopathy is caused by disc space narrowing, uncovertebral joint degeneration, and facet joint hypertrophy, while the remaining 1/4 is a result of cervical disc herniations.[2] Anterior cervical discectomy and fusion (ACDF) is considered a standard operation for cervical radiculopathy.[3,4] Despite its excellent clinical outcome, ACDF is associated with access- and hardware failure-related complications, such as esophagus injury, laryngeal nerve injury, and pseudoarthrosis. Posterior cervical foraminotomy has been used to treat cervical radiculopathy for more than three decades.[5] In the last decade, posterior endoscopic cervical foraminotomy and discectomy (PECFD) has gained popularity due to its excellent clinical outcome and minimal postoperative neck pain.[6] However, PECFD is highly technically demanding due to a small operation filed and becomes even more challenging in patients who have big shoulders and/or short necks with C6–7-disc herniations because of the difficulty to localize C6–7 vertebral structure under fluoroscopy in these patients. In this paper, the authors present key surgical steps of PECFD, ensuring a successful discectomy of C6–7 herniation under fluoroscopic guidance on a patient with prominent shoulders and a short neck.

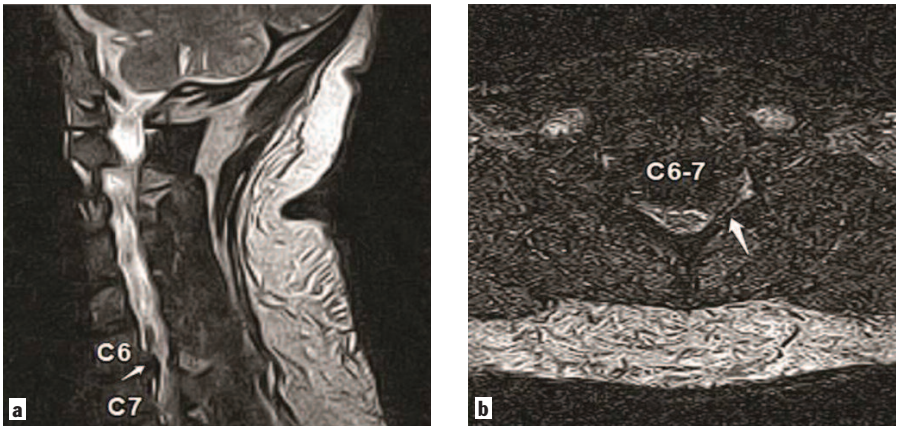

Figure 1. The patient's preoperative cervical spine MRI images. a) The sagittal view of a T2 image on a left paracentral cut showing the C6–7-disc hernia compressing the thecal sac of the spinal cord (white arrow). b) The axial view of a T2 image showing the left C6–7 foraminal narrowing with C7 nerve root obliteration (white arrow).

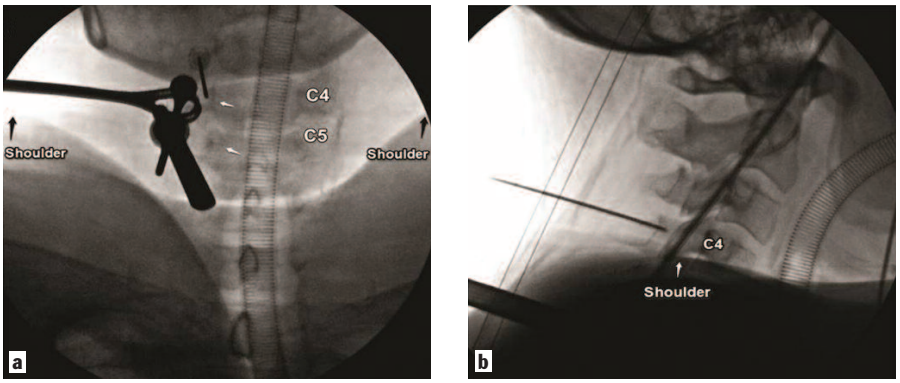

Figure 2. The anterior-posterior (AP) and lateral fluoroscopic views of the position of the reference needle. a) The AP view shows that the reference needle was inserted to facet at pedicle level (white arrows) above the shoulder peak shadows (black arrows). b) The sagittal view confirms that the reference needle was inserted at the level of the C4 pedicle, above the shoulder peak shadow (white arrow).

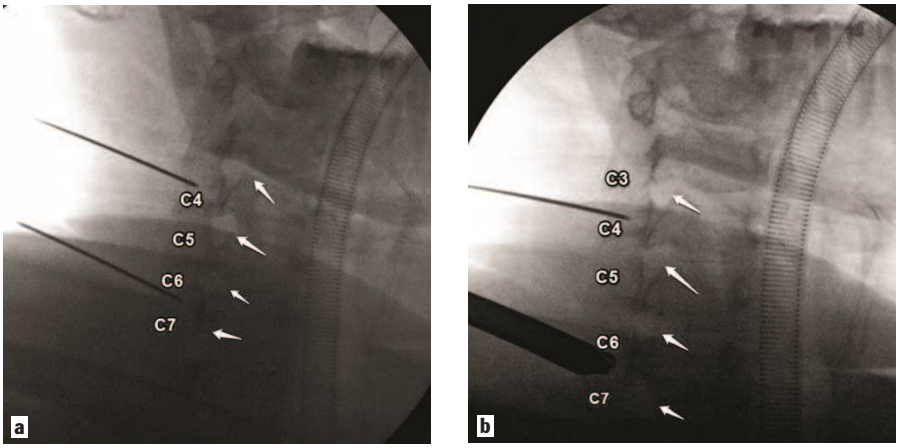

Figure 3. Positions of the guiding needle and the endoscopic cannula under the oblique fluoroscopic view. a) The guiding needle was inserted to the left C6–7 facets toward the C6–7 foramen. b) Following the guiding needle, the endoscopic working cannula was inserted into the left C6–7 foramen. White arrows point to the left cervical foramen at the C3–4, C4–5, C5–6, and C6–7.

CLINICAL CASE

The patient is a 33-year-old male with left arm pain, level 3/10 by visual analog scale before surgery, and weakness for about a year. Chiropractic care, physical therapy, and pain management failed to improve his symptoms. The patient had prominent shoulders and a short neck. Cervical spine magnetic resonance imaging (MRI) showed an extruded foraminal disc herniation compressing the thecal sac of the spinal cord at C6–7 from the left (Fig. 1a and b). The patient was offered ACDF and PECFD and chose to have PECFD.

SURGICAL TECHNIQUE

The patient was given general anesthesia with continuous neurological monitoring by electromyogram. He was turned into a prone position with facial support and shoulder straps to pull bilateral shoulders down on each side. The bed was turned to a 20-degree reverse Trendelenburg position. The patient was sterilized and draped in a standard fashion.

Under anterior-posterior (AP) and lateral fluoroscopic views, his shoulder peak shadows reached C4–5 level (Fig. 2a and b). An 18-gauge reference needle was inserted to the middle of the C4–5 pedicle line above the shadows of the shoulder peaks (Fig. 2a and b). The reference needle was kept in position until

surgery completion.

After confirming the correct position of the reference needle, an 18-gauge guiding needle was inserted into the left C6–7 foramen under oblique fluoroscopic view with the C arm being rotated to the patient's right side about 30 to 45 degrees (Fig. 3a). A 1cm sagittal skin incision was made crossing the guiding needle, and the guiding needle was then removed. A pair of male scissors were advanced to the foramen from skin, gently driven by a hammer to open the soft tissue canal by muscle splitting but not cutting. The scissors were removed, and an endoscope dilator (SPINENDOS GmbH, Munich, Germany) and a beveled endoscopic working cannula (8mm/7.2mm external/internal diameters) were inserted to the left C6–7 foramen (Fig. 3b).

After ensuring the correct position of the endoscope cannula, a large endoscope (7mm diameter) for the 8mm cannula was used initially for foraminotomy. The C6–7 laminal junction and facet joint on the left was exposed under direct endoscopic visualization. A diamond burr was used to undercut the C6 inferior articular process laterally and cephalad from the laminal junction. Then the C7 superior articular process was undercut laterally and inferiorly from the laminal junction. A Kerrion was used to undercut the more bony structure to make sure the C6 and C7 pedicles were reached. Each of the C6 and C7 medial facets was resected 4mm using endoscopic measurement, about one diameter of a complete endoscopic view of the working cannula (7.2mm internal diameter of the cannula), which is adequate to maintain spinal stability (Fig. 4a). Following the bone margins of the resected facets, a nerve probe was used to expose and identify the inferior (axilla) and superior (shoulder) borders of the left C7 nerve root (Fig. 4b and 4c). The perineural facial was gently removed with pituitary rongeur to further expose the nerve root. The mobility of the nerve root from both the axilla and shoulder of the nerve was evaluated using the nerve probe (Fig. 4d).

After determining the C7 nerve axilla had adequate space to accommodate a small endoscope cannula (6mm/5.5mm external/internal diameters), the 8mm endoscope cannula was replaced with a 6mm endoscope cannula over a small endoscope dilator (Fig. 5). The 5.3mm endoscope was then inserted to the small

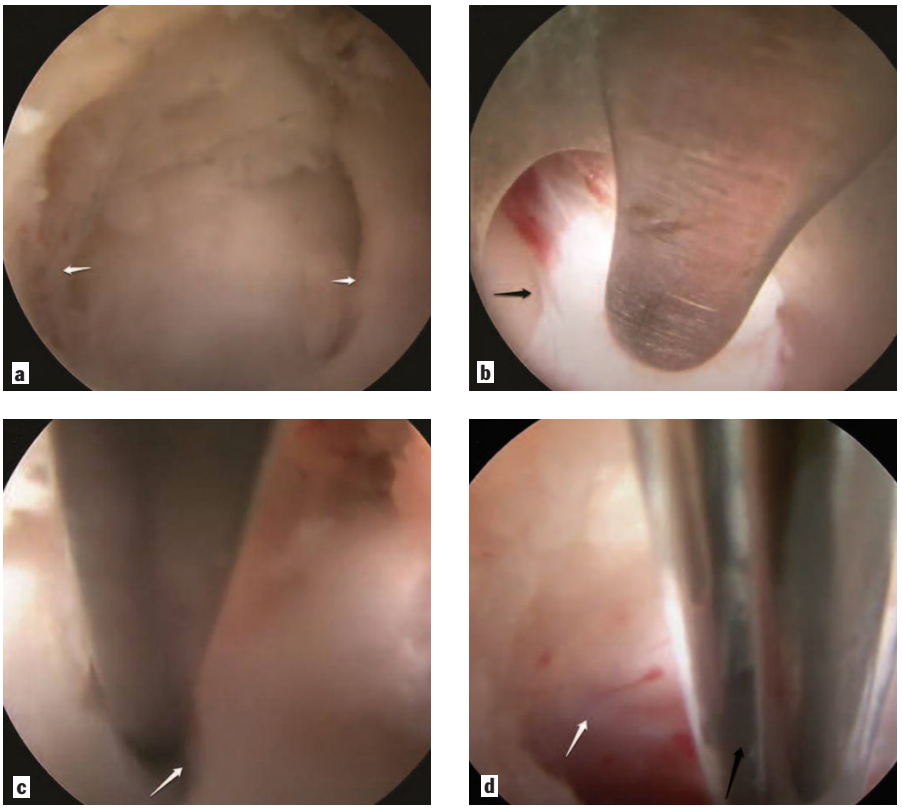

Figure 4. Foraminotomy of the left C6–7 using a large 7mm endoscope for an 8mm working cannula. Resection of the C6 and C7 facets reached to the C6 and C7 pedicles (white arrows) (panel a). Following the bone margins of the resected facets, a nerve probe was used to expose the inferior (black arrow) (panel b) and the superior (white arrow) of the left C7 nerve root (panel c). Additionally, the radio frequency probe (black arrow) was used to move and evaluate the mobility of the nerve root (white arrow) (panel d).

Figure 5. Large and small endoscopes and working cannulas. The large endoscope (diameter 7mm, black arrow, far left) for a large working cannula (external and internal diameters 8mm and 7.2mm respectively, black arrow, far right) was used for foraminotomy to undercut C6 and C7 facets. The small endoscope (diameter 5.3mm, white arrow, left) for a working cannula (external and internal diameters 6mm and 5.5mm respectively, white arrow, right) was used for nerve root retraction and discectomy to avoid nerve overstretching during the surgery.

cannula to perform the remaining surgery. To expose the herniating disc, the C7 nerve root was pushed superiorly from the axilla using the bevel of the 6mm cannula (Fig. 4b). The disc herniation sac was opened with a radiofrequency probe (Fig. 6a), and the herniated disc was completely removed with a pituitary rongeur under direct visualization through the small endoscope (Fig. 6b). The herniated disc material was completely removed under the clear visualization of the posterior vertebral bodies of the C6 and C7 and the C6–7 intradiscal space (Fig. 6c). The C7 nerve root was placed back to its normal position covering the discectomy site with plenty of free space ventrally (Fig. 6d). No nerve or cord injury was identified during the final evaluation, and nerve decompression was satisfied.

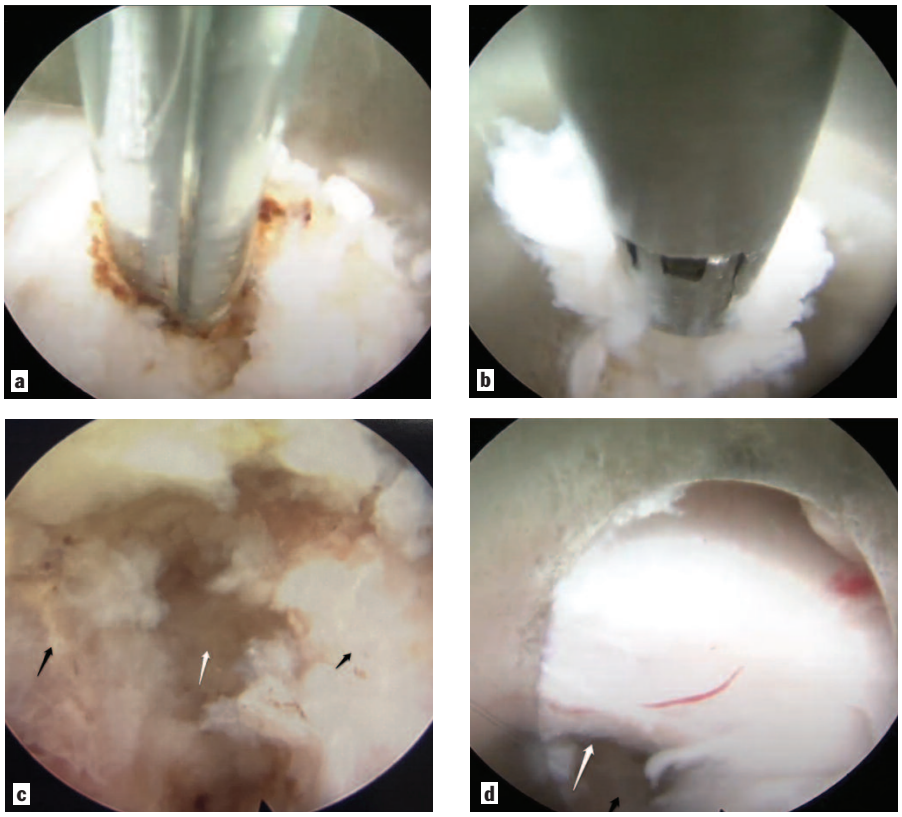

Figure 6. Endoscopic discectomy through the small (6mm) working cannula. a) The disc herniation sac was opened with a radiofrequency probe. b) The herniated disc was removed with a pituitary rongeur. c) The complete resection of herniated disc material was confirmed by visualizing the posterior vertebral body of the C6 and C7 (black arrows) and C6–7 intradiscal space (white arrow). d) The C7 nerve root (white arrow) was placed back to its normal position covering the discectomy site with free space ventrally (black arrow).

POSTOPERATIVE EVALUATION

After PECFD, the patient's left arm weakness improved significantly, and his left arm pain disappeared. MRI and computed tomography (CT) scan images showed complete resection of C6–7-disc herniation (Fig. 7a–c).

DISCUSSION

The patient presented in this paper had prominent shoulders and a short neck with a large, extruded disc herniation in the left C6–7 foramen. He chose to receive PECFD over ACDF. During surgery, his shoulder peaks reached C4–5 in AP and lateral fluoroscopic views. It was impossible to identify the C6–7 using the traditional way under AP and lateral fluoroscopic views. To solve the problem, the authors used a reference needle inserted to the middle of the C4–5 pedicle line above the shadows of the shoulder peaks under AP and lateral fluoroscopic views. C2–3 to C6–7 neuroforamen were then clearly visualized with no problem under the oblique fluoroscopic view with the assistance of the reference needle.

Once the C6–7 spinal structure was correctly identified, the endoscope dilator and cannula were placed to the C6–7 lamina and facet junction for bony resection.

To avoid jeopardizing spinal stability, it is critical to have sufficient bony resection without overdoing it. In our practice, the cutting of the inferior articular process of the C6 to reach the C6 pedicle and 4mm lateral from the lamina facet junction point is adequate. The cutting of the C7 superior articular process needs to reach the C7 pedicle as well.

Figure 7. Postoperative cervical spine CT scan and MRI images. a) The CT scan shows partial resection of the C6–7 medial facets by foraminotomy (white arrow). b and c) The axial and sagittal views of the MRI show complete resection of C6–7-disc herniation (white arrow).

We used the endoscope cannula to measure the surgical resection, knowing that a radius of the large canula used in this case is 3.6mm. Since the bony resection is only a few millimeters, the stability of the cervical spine is not a concern.[7,8]

Within such a small operation field, retracting the nerve root away from disc herniation using the 8mm endoscope cannula is limited and may produce a great amount of pressure to the nerve root. It is critical to switch the 8mm cannula to a 6mm cannula which is adequate to move the nerve root away from the disc herniation to allow for complete discectomy with minimal nerve root traction.

Recently, Zhang et al. reported PECFD assisted by O-arm-based navigation.[9] O-arm is helpful in PECFD for difficult patients with short necks and big shoulders. However, it is extremely expensive, and thus is only feasible in large hospitals in the US. PECFD is often performed in the same-day surgery settings where the O-arm is typically unrealistic. Therefore, surgeons still need to learn to perform a successful PECFD under fluoroscopic guidance. These technique key points presented in this paper will help surgeons to apply the PECFD to their patients with great success. However, even with our improved techniques, PECFD is still limited to patients with central or predominant central disc herniations due to obstruction of the cervical spinal cord.

CONCLUSION

By using our novel surgical techniques, PECFD may be applied for C6–7-disc herniation in patients with prominent shoulders and/or short necks safely and successfully with spinal stability maintained, disc herniation resected, and nerve root and cord injury-free. STI

AUTHORS' DISCLOSURES

The authors have no conflicts of interest to disclose.

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