

Anterior Cervical Foraminotomy for Unilateral Radicular Disease

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Study Design. A clinical series of patients with unilateral radiculopathy treated with the anterior cervical foraminotomy procedure.

Objective. To establish procedural techniques and clinical and radiologic outcomes for the anterior cervical foraminotomy procedure.

Summary of Background Data. Cervical radiculopathy is typically caused by unilateral disc herniation or uncovertebral osteophytes that compress the ventral aspect of the nerve. Direct removal of a cervical lesion causing radicular symptoms without concomitant fusion seems to be an ideal treatment in selected patients. The indications for an anterior cervical neural foraminotomy are limited to unilateral radicular symptoms at one or two levels, with minimal neck pain.

Methods. Twenty-one patients were treated with the anterior cervical neural foraminotomy procedure during a 3-year period with follow-up from 6 to 36 months. There were 13 men and 8 women (age range, 27-58 years). Fourteen patients had symptomatic soft disc herniation, and 7 had uncovertebral osteophytes confirmed by magnetic resonance imaging and/or myelogram and computed tomography. Sixteen patients had a single anterior cervical neural foraminotomy, and 5 had procedures at adjacent levels.

Results. Nineteen patients (91%) had improved or resolved radicular symptoms, and 2 (9%) had persistent radicular symptoms necessitating further surgery (one two-level anterior cervical neural discectomy and fusion and one posterior foraminal decompression).

Conclusions. Patients treated with the anterior cervical neural foraminotomy procedure have equivalent or better outcomes than those who undergo current cervical procedures. It appears to be a good alternative procedure for carefully selected patients with unilateral cervical radiculopathy and avoids a fusion of the disc space. [Key words: anterior, cervical, foraminotomy, radiculopathy] **Spine 2000; 25:905-909**

Cervical radiculopathy from intervertebral disc herniation was originally described by Mixter and Barr in 1934,¹² and the treatment has evolved steadily since then.^{1,3,10,12,13} The initial surgical management was a posterior laminectomy or a smaller keyhole foraminotomy approach that provided exposure of the nerve root that may include removal of a nonvisualized disc herniation or osteophytes by curettage ventral to the

nerve. This was the only treatment for many years. It had the advantage of preserving the spinal motion segment and has been reported extensively to have good success.^{2,3,6,14}

Many surgeons continue to use the posterior foraminotomy procedure today, but the difficulty of an indirect posterior exposure and inability to remove some ventral lesions led to the current and more common use of anterior discectomy procedures first described by Robinson and Smith in 1955¹³ and Cloward in 1958.¹ These represented a significant technical advance that provided surgeons with direct access to lesions most often located ventral to the exiting nerve. Fusion of the interspace provided immobilization of potentially painful degenerative disc and facet joints and justified a more extensive nerve decompression procedure. Alternatively, discectomy without fusion has also been performed with similarly favorable results, but most of these patients may actually have fusion in the surgically treated segment.^{5,11} Unfortunately, bony fusion of a motion segment in the highly mobile cervical spine may result in further progression of degenerative changes at other disc levels eventually requiring further surgery, but the incidence remains unknown. Reason suggests that preservation of motion segments by avoiding fusion where possible should be considered in patients with cervical radiculopathy. This can be accomplished with the anterior cervical foraminotomy procedure that was refined by Jho⁷ in 1996, after previous similar reports in the literature dating to 1968.^{4,8,9,15,16} These indicate that favorable results could be achieved with this procedure for selected indications, but a systematic outcome study has not been reported in the modern era.

■ Patients and Methods

Patients and Evaluation. Twenty-one patients were evaluated and treated for unilateral cervical radiculopathy. There were 13 men and 8 women with a mean age of 43 years (range, 27-58 years). All patients had been treated, and a minimum of 3 months of conservative therapy had failed. All patients had evaluation with plain cervical radiographs with flexion-extension views and magnetic resonance imaging (MRI). Patients with severe uncovertebral osteophytic formation underwent additional myelography and computed tomographic (CT) scans.

Indications. Patients who were considered for anterior cervical foraminotomy had symptomatic unilateral cervical radiculopathy from 1 or 2 adjacent levels. They had a preponderance of radicular symptoms and comparatively less neck pain. There

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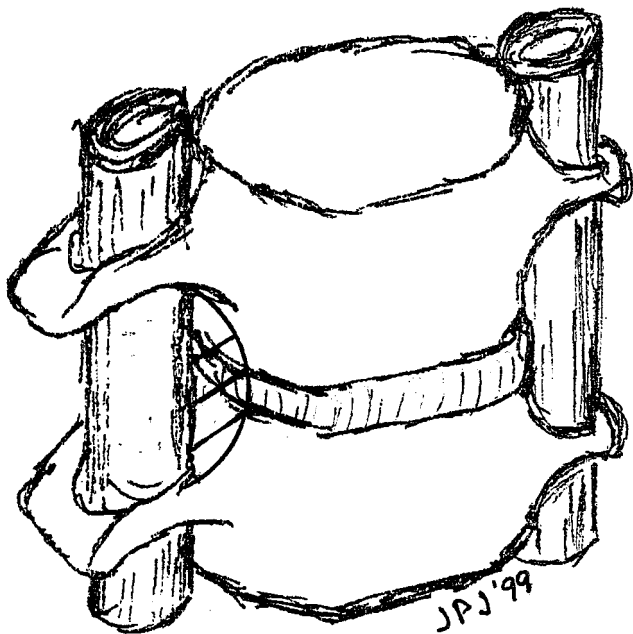


Figure 1. Illustration depicting anatomy and region of uncovertebral joint drilled in anterior cervical foraminotomy.

was no evidence of spinal instability on flexion–extension radiographs. Magnetic resonance scans demonstrated variable changes within the symptomatic and adjacent disc spaces that were commensurate with the age of the patient.

Surgical Procedure. The surgery was performed with patients supine, and a prevertebral surgical exposure of the affected cervical disc level was accomplished on the affected side as described by Cloward.¹ Figures 1 and 2 (A–E) illustrate the site of surgical decompression and summarize the steps of the procedure. The anterior cervical retractor naturally tends to maintain exposure centered over the medial border of the longus colli muscle. A long segment of the colli muscle was mobilized laterally to expose the transverse processes above and below the affected disc space without removal of the muscle (Figure 2A). Dissection around the circumference of the vertebral body between the transverse processes and lateral to the uncus with a curet or Freer type instrument was accomplished. Fluoroscopic imaging (Figure 3) was helpful to guide the placement of a 1/4-in. or 3/8-in. malleable blade retractor inserted between the vertebral body and vertebral artery that maintained retraction of the colli muscle and protected the artery. The malleable retractor was attached to a table-mounted (Greenburg type) retractor to maintain the exposure (Figure 2B). The lateral view fluoroscopic image showed correct placement of the retractor inserted to the midvertebral body to avoid compression of the nerve root posteriorly. The remainder of the procedure was then completed with microscopic magnification. The lateral portion of the uncovertebral joint was drilled (Figures 1 and 2C) until a thin posterior cortical rim was left posteriorly that was removed with curettage and Kerrison rongeurs to expose the lateral posterior longitudinal ligament overlying the exiting nerve root. Further exploration for removal of any compressive ligament, herniated disc, and osteophytes on the adjacent endplates allowed removal (Figure 2D). The small remaining por-

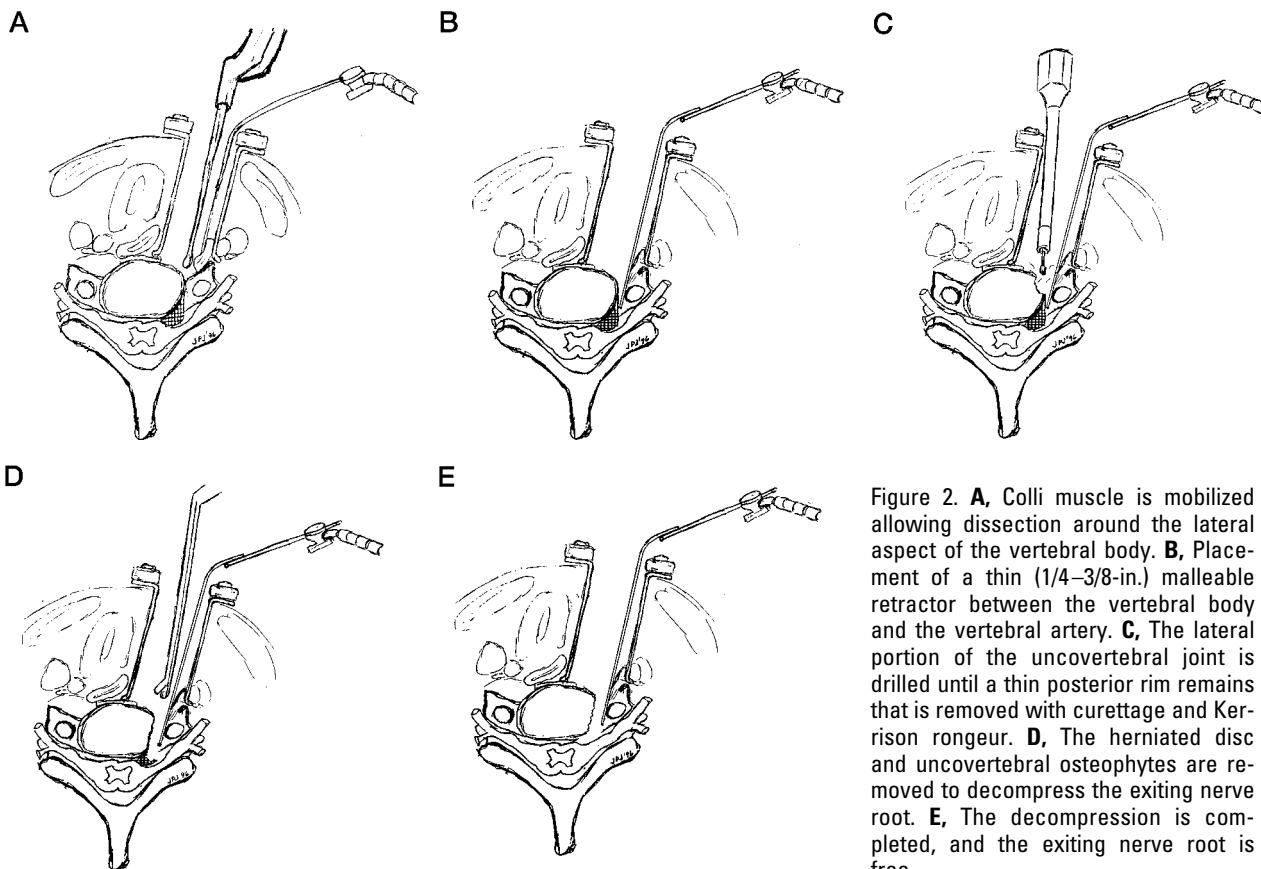


Figure 2. **A**, Colli muscle is mobilized allowing dissection around the lateral aspect of the vertebral body. **B**, Placement of a thin (1/4–3/8-in.) malleable retractor between the vertebral body and the vertebral artery. **C**, The lateral portion of the uncovertebral joint is drilled until a thin posterior rim remains that is removed with curettage and Kerrison rongeur. **D**, The herniated disc and uncovertebral osteophytes are removed to decompress the exiting nerve root. **E**, The decompression is completed, and the exiting nerve root is free.

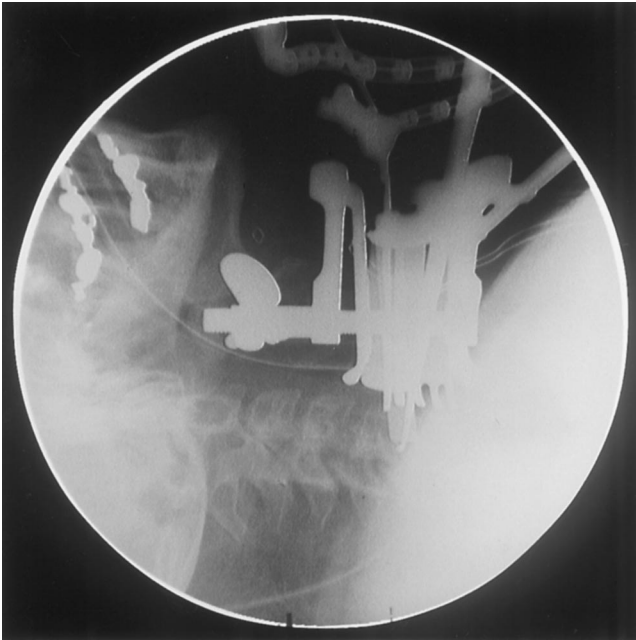


Figure 3. An intraoperative lateral fluoroscopic view shows the malleable retractor placed between the vertebral body and artery. A curet is seen in the ventral aspect of the neural foramen.

tion of the uncus was then removed to complete the anterior foraminal decompression (Figure 2E).

Clinical Follow-up and Outcome Evaluation. All patients were evaluated with clinical and radiographic follow-up that ranged from 12 to 42 months. Outcomes based on preoperative and postoperative modified Oswestry Pain Scale data, visual analog scale for perceived symptomatic results, and lateral view flexion-extension radiographs. The cervical radiographs were reviewed by the staff radiologist to determine whether segmental instability had occurred at the surgically treated level. The differences between preoperative and postoperative Oswestry Pain scale data were reviewed. The visual analog scale analyzed postoperative symptoms as excellent, good, fair, or worse. Statistical analysis for comparison of percentages used the Bernoulli method with statistical significance at 95% ($P < 0.05$) confidence intervals (CIs).

■ Results

Patient Series

There were 14 patients with subacute soft disc herniation, and 7 had severe foraminal osteophytes. Sixteen patients had one-level and 5 had two-level disease (Table 1). The involved levels treated with the foraminotomy procedure are listed on Table 2. The operative time for these procedures ranged from 65 to 205 minutes, which represented both one- and two-level procedures. This also represented a learning curve that decreased with subsequent operations after the initial procedures. The mean blood loss for these procedures was 65 mL. The mean hospital stay was 0.7 days (range, 0–2 days). Postoperative pain control was managed with oral analgesics.

Table 1. Pathology and Number of Foraminotomies* Treated With Anterior Cervical Foraminotomy Procedure (N = 21)

Pathology	
Soft disc herniation	14
Uncovertebral osteophyte	7
Number of foraminotomies*	
Single level	16
Two level	5

* 26 foraminotomies in 21 patients.

Table 2. Involved Levels Treated With Anterior Cervical Foraminotomy (N = 26)

C3,4	1
C4,5	4
C5,6	11
C6,7	9
C7, T1	1

Outcomes

The modified Oswestry Pain Scale improved in 91% of the patients from a mean preoperative score of 64 to 83 after surgery ($P < 0.05$). The postoperative visual analog scale outcomes are listed in Table 3. Flexion and extension cervical spine radiographs obtained at 3 months after surgery indicated that none of the patients had evidence of delayed instability. There was no significant loss of disc height at the surgical level on lateral radiographs. Modified return-to-work status (*i.e.*, light duty for laborers and normal duty for sedentary work) after 30 days was 95%.

Complications and Reoperations

There were no deaths or major morbidity associated with the anterior cervical foraminotomy procedure. There were no spinal nerve or vertebral artery injuries. There were no cases of Horner's syndrome. One patient had a complete but superior laryngeal nerve palsy after a right C6–C7 anterior cervical foraminotomy that resolved after 3 months. There were two patients who underwent reoperation. One had a symptomatic residual ventral uncovertebral osteophyte at C6–C7 after left C5–C6 and C6–C7 anterior cervical foraminotomies that required a Smith–Robinson type discectomy and fusion and progressed well. The other patient who underwent reoperation had a left C7–T1 anterior cervical foraminotomy with continued dominant hand weakness. She underwent an elective posterior foraminotomy at the same level despite equivocal electromyography (EMG) findings, because it involved her dominant hand.

Table 3. Functional Outcomes Based on Postoperative Visual Analogue Scale

Excellent	70%
Good	15%
Fair	10%
Worse	5%

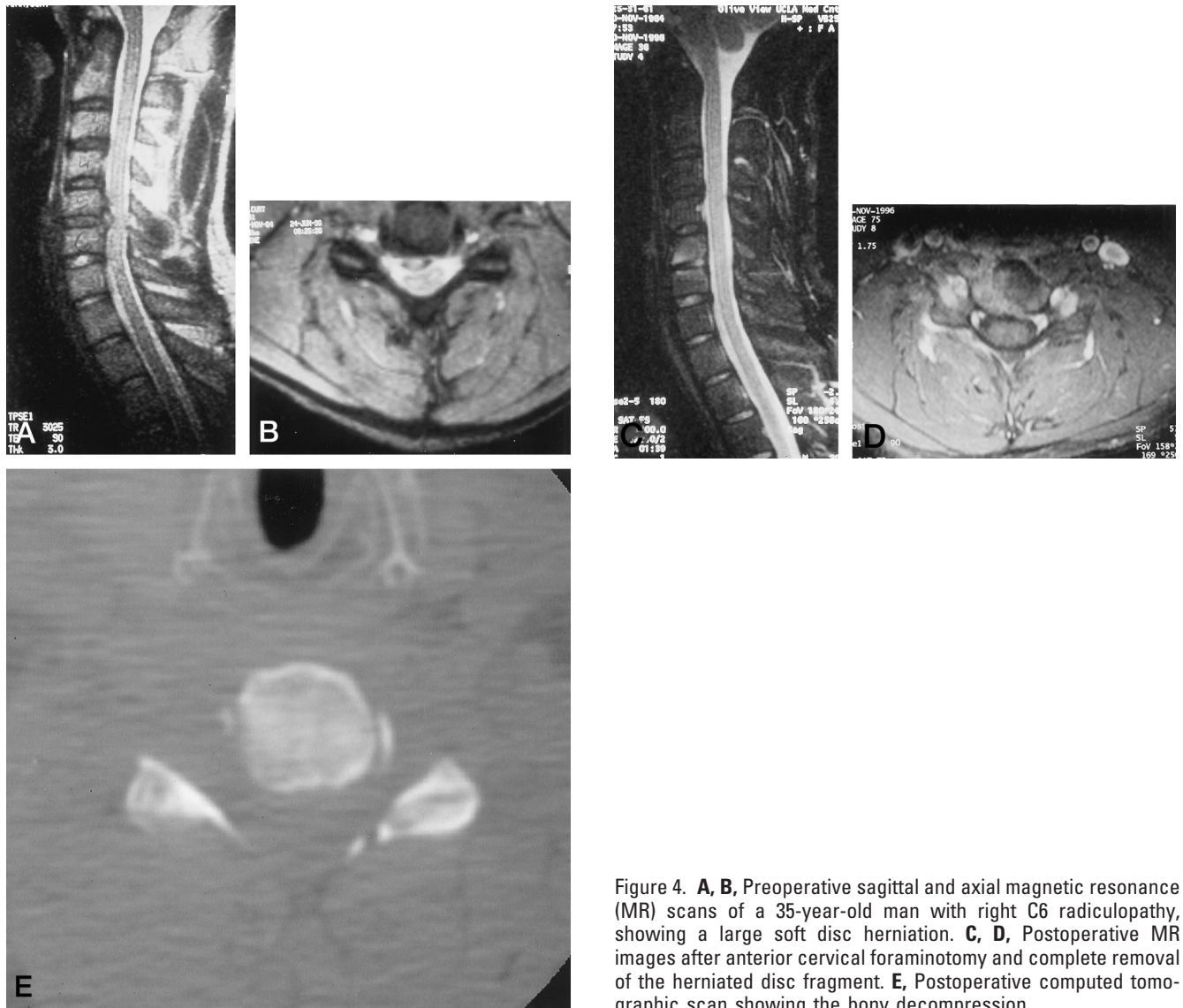


Figure 4. **A, B**, Preoperative sagittal and axial magnetic resonance (MR) scans of a 35-year-old man with right C6 radiculopathy, showing a large soft disc herniation. **C, D**, Postoperative MR images after anterior cervical foraminotomy and complete removal of the herniated disc fragment. **E**, Postoperative computed tomographic scan showing the bony decompression.

Discussion

Cervical Radiculopathy Overview

The treatment of cervical radiculopathy has evolved from posterior approaches in the early days of spinal surgery to anterior approaches since the mid-1950s that are a major part of current treatment.^{1-3,11,13} Although there is controversy regarding the need for fusion when a cervical disc is removed, most surgeons place an interbody graft and instrumentation in patients with radiculopathy.^{1,10,13} Many patients have unilateral symptoms that arise from a single level and require focal treatment. Those patients with soft disc herniation and nerve root compression have been treated in the past with a discectomy through a posterior laminectomy and partial facetectomy approach.^{2,3,6,14} These procedures are difficult to visualize because of the need to work around the ventral aspect of the nerve, which cannot be easily retracted. Some surgeons are more adept at this procedure, but one of the primary reasons in the evolution toward anterior

discectomy procedures is that a ventral fragment or osteophyte can be directly dissected and removed.^{5,10}

Anterior Cervical Foraminotomy

This procedure has origins dating back to 1968 when Verbeist¹⁶ reported on the lateral approach to the cervical spine for vertebral artery insufficiency and radiculopathy symptoms. It was a rather involved and complex procedure with mobilization of the vertebral artery to remove symptomatic uncovertebral osteophytes and was a landmark in describing access to a difficult territory, but it received little attention for treatment of radicular disease. Several other reports of anterior transforaminal surgical treatment of cervical spinal disease appeared subsequently.^{4,7-9,15}

Hakuba⁴ reported on 40 patients with a variety of diagnoses including radiculopathy, myelopathy, and vascular insufficiency. All the patients underwent decompression, but half also underwent a fusion procedure in which a bone graft was placed in the uncovertebral de-

fect. The outcomes were favorable, but there did not appear to be a discernible difference between the fusion and nonfusion groups.

LeSoin et al⁹ reported a small series of five patients with foraminal decompression of cervical radiculopathy with good results. This technique used mobilization of the vertebral artery as described by Verbeist¹⁶ and underscored the need for preoperative CT scanning to properly evaluate the foraminal stenosis.

Snyder and Bernhardt¹⁵ reported a large series of 66 patients in which more than one third had only "fair" and "poor" results. The procedure they described involved a greater amount of disc removal. A portion of the posterior uncovertebral joint remained that may have caused persistent nerve root compression. It is conceivable that their experience and report had a negative influence on interest in this technique within the surgical community.

The refined technique reported by Jho⁷ in 1996 provided an accurate description of the anatomic and surgical details for this procedure, but an outcome-based series with a long follow-up was needed. In the present series the careful surgical techniques as described by Jho were used; however, the colli muscle was preserved. The outcomes and patient satisfaction for the anterior cervical foraminotomy are comparable to those of historical cohorts for existing techniques. Figure 4, A–E, is an illustrative case in which removal of a large herniated disc fragment was achieved by anterior cervical foraminotomy, with postoperative imaging demonstrating decompression and preservation of the disc space and motion segment. The advantages of this technique are many, including removal of only the offending mass, preservation of most of the disc and motion segment, a shorter operative procedure and hospital stay, avoidance of a fusion procedure and the attendant potential problems, and earlier return to full activity. The disadvantages are unfamiliarity with the procedure and the long-term issues related to disc degeneration and unilateral removal of an uncovertebral joint.

The present study is now beyond 3 years' follow-up and there have been no late failures. The authors believe that patient selection is the most important issue and that patients with unilateral (one- or two-level) radicular symptoms and a minimal amount of neck pain are appropriate candidates.

■ Conclusions

Anterior cervical foraminotomy for cervical radiculopathy is effective in well-selected candidates. Initially, the

procedure is more technically demanding but it can be performed safely when the appropriate techniques are used.

■ Key Points

- This procedure provides direct access to lesions causing unilateral cervical radiculopathy with a variation of the familiar anterior approach.
- Preservation of the motion segment avoids fusion of the disc space and potentially the long term degenerative changes at adjacent disc levels.

References

1. Cloward RB. The anterior approach for removal of ruptured cervical discs. *J Neurosurg* 1958;15:602–14.
2. Fager CA. Management of cervical disc lesions and spondylosis by posterior approaches. *Clin Neurosurg* 1976;24:488–507.
3. Frykolm R. Lower cervical vertebrae and intervertebral discs: surgical anatomy and pathology. *Acta Chirurgica Scand* 1951;101:345–9.
4. Hakuba A. Trans-unco-discal approach. A combined anterior and lateral approach to cervical discs. *J Neurosurg* 1976;45:284–91.
5. Hankinson HL, Wilson CB. Use of the operating microscope in anterior cervical discectomy without fusion. *J Neurosurg* 1976;43:452–6.
6. Hendersom CM, Hennessy RG, Shuey HM Jr, et al. Posterior-lateral foraminotomy as an exclusive operative technique for cervical radiculopathy: A review of 846 consecutively operated cases. *Neurosurgery* 1983;13:504–12.
7. Jho HD. Microsurgical anterior cervical foraminotomy for radiculopathy: A new approach to cervical disc herniation. *J Neurosurg* 1996;84:155–60.
8. Johnson JP. Anterior cervical foraminotomy (letter). *J Neurosurg* 1996;85:525–7.
9. LeSoin F, Biondi A, Jomin M. Foraminal cervical herniated disc treated by anterior disceforaminotomy. *Neurosurgery* 1987;21:334–8.
10. Lunsford LD, Bissonette DJ, Jannetta PJ, et al. Anterior surgery for cervical disc disease. Part 1: Treatment of lateral cervical disc herniation in 253 cases. *J Neurosurg* 1980;53:1–11.
11. Martins AN. Anterior cervical discectomy with and without interbody bone graft. *J Neurosurg* 1976;44:290–5.
12. Mixer WJ, Barr JS. Rupture of the intervertebral disc with involvement of the spinal canal. *N Engl J Med* 1934;211:210–5.
13. Robinson RA, Smith GW. Anterolateral cervical disc removal and interbody fusion for cervical disc syndrome (abstract). *Bull Johns Hopkins Hosp* 1955;96:223–4.
14. Scoville WB, Dohrmann GJ, Corkill G. Late results of cervical disc surgery. *J Neurosurg* 1976;45:203–10.
15. Snyder GM, Bernhardt M. Anterior cervical fractional interspace decompression for treatment of cervical radiculopathy. A review of the first 66 cases. *Clin Orthop* 1989;246:92–9.
16. Verbeist H. A lateral approach to the cervical spine: technique and indications. *J Neurosurg* 1968;28:191–203.

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