Cervicothoracic radiculopathy treated using posterior cervical foraminotomy/discectomy

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Object. The authors conducted a study to identify the effectiveness and morbidity rate associated with treating cervicothoracic disc disease (radiculopathy) via a posterior approach.

Methods. Nineteen patients underwent posterior cervicothoracic laminoforaminotomy during a 5.6-year period. Medical records, imaging studies, office charts, hospital records, and phone interview data were reviewed. Specific information analyzed included patient demographics, side of lesion, and conservative treatment, symptoms, and pre- and postoperative pain levels. Pain was rated using a visual analog scale and classified into a radicular and neck component.

Data in 19 patients (seven women and 12 men) who underwent 20 procedures (one patient underwent separate bilateral foraminotomies) were analyzed. The mean patient age was 54.8 years (range 38–73 years), and the follow-up period ranged from 23 to 62 months. Symptom duration ranged from 1 to 14 months (mean 3.4 months) and consisted of weakness, numbness, and painful radiculopathies in 11, 16, and 20 cases, respectively. Motor weakness was identified in 11 of 19 patients (mean grade of 4.35), and postoperatively strength normalized in eight of 11 (mean grade of 4.79). The improvement in motor scores was significant (p = 0.007). Pain was the most common presenting symptom. Preoperative radiculopathies were rated between 0 and 10 (mean 7.45), and postoperatively scores were reduced to 0 to 3 (mean 0.2) which was significant (p < 0.0001). Preoperative neck pain was rated between 0 and 8 (mean 2.55), and on follow up ranged from 0 to 2 (mean 0.5), which was also significant (p = 0.001).

Conclusions. Posterior cervicothoracic foraminotomy was a safe and effective procedure in the treatment of patients with laterally located disc herniations.

KEY WORDS • cervicothoracic spine • foraminotomy • posterior approach • radiculopathy • discectomy

A NTERIOR cervical decompression with fusion has become the chosen surgical therapy for the treatment of cervical radiculopathy after failure of conservative therapy. An anterior cervical exposure is more difficult at the extremes of the cervical spine. In particular, the caudal cervical spine is confined by large vascular structures, the esophagus, pharynx, trachea, sternum, and the thoracic rib cage. This region is also the transition zone from the thoracic kyphosis to the cervical lordosis, making bone fusion difficult because of a biomechanical disadvantage.

An alternative treatment option in this region is a posterior cervical foraminotomy alone or with a concurrent discectomy. To access the efficiency and safety of such approach, we retrospectively analyzed data obtained in a relatively large group of patients with cervicothoracic radiculopathy in whom surgery was performed via a posterior approach only.

Clinical Material and Methods

Patient Population

Nineteen patients were treated with posterior laminoforaminotomy for either lateral disc herniation or foraminal stenosis between July 1995 and February 2001. All patients were evaluated by the senior authors (F.A.S. and S.J.D.) and were offered surgery when clinical symptoms correlated with findings on appropriate neuroimaging studies and after conservative therapy failed or when they presented with acute motor loss of hand function. During the initial evaluation, if myelopathy due to congenital cervical stenosis with a lordotic cervical spine was found, cervical laminectomy and concurrent foraminotomy were performed. No patients had sustained work-related injuries, were involved in Worker’s compensation cases, or had legal representation concerning their lesions.

All medical records and imaging studies were reviewed. Data were also collected through office charts, hospital records, and phone interviews. Specific information analyzed included patient demographics, side of lesion, conservative therapy regimen, symptoms (numbness and weakness), and pre- and postoperative pain levels. Pain was assessed using a visual analog scale. Pain was also divided into a radicular and isolated neck component. Muscle strength was graded using a six-point (0–5) scale.12 Operative reports were also reviewed to determine
operative records were deficient. Data in the remaining 19 patients (7 women, 12 men) who underwent 20 procedures (in one patient bilateral foraminotomies were performed at separate intervals) were analyzed. The follow-up period ranged from 17 to 62 months. Patients ranged in age from 38 to 73 years (mean 54.8 years). Eleven patients suffered left-sided radiculopathies and nine right-sided lesions.

Onset of symptoms varied between 1 and 14 months (mean 3.4) and consisted of weakness, numbness, and painful radiculopathies in 11, 16, and 20 of 20 cases, respectively. Numbness was localized to the fourth and fifth digits; third, fourth, and fifth digits; and second, third, fourth, and fifth digits in 11, two, and one of 16 patients, respectively. The paresthesias resolved in nine of 16 patients. Seven patients suffered persistent numbness after the decompression, but their status was improved over preoperative condition. The two patients with the most severe numbness also suffered severe motor weakness.

Motor weakness (mean score of 4.35) was initially identified in 11 of 19 patients, and noted to be immediately (< 1 week) and completely improved postoperatively in eight (73%) of the patients with weakness (mean score of 4.79) (p = 0.007). Of the four patients with persistent weakness, a delayed recovery occurred in two. The two patients with lingering weakness initially exhibited anti-gravity strength (Grade 3/5), and this improved in one to Grade 4/5 strength. No patient experienced greater weakness as a result of the decompressive surgery. In seven patients appreciable atrophy of the first dorsal interosseous muscle was observed.

Pain was the most common presenting symptom. Preoperative radiculopathies were rated between 0 (no pain) and 10 (intractable pain), and the mean score was 7.45. Postoperatively the scores decreased to between 0 to 3 (mean 0.2) (p < 0.0001). Preoperative axial neck pain was rated between 0 and 8 (mean 2.55), and on follow-up examination ranged from 0 to 2 (mean 0.5) (p = 0.001).

Statistical analysis of data regarding the patient’s age, sex, level of operative treatment, side, motor status, pain symptoms, atrophy, and conservative treatment regimen compared with operative procedure (a foraminotomy alone or a combined foraminotomy/discectomy) demonstrated no positive or negative predictive factors. There was, however, a correlation between the duration of symptoms and treatment (p = 0.035); the mean presentation prior to surgical intervention for a foraminotomy was 4.9 months whereas it was only 2.1 months for those who underwent foraminotomy and concurrent discectomy.

In the present series there were no superficial or deep infections. One patient underwent a second operation performed by a different surgeon 4 years after his previous surgery. This consisted of a four-level anterior C2–5, which was entirely cranial to the original posterior operation from which the patient noted complete resolution of symptoms. The second operation was not performed as a revision surgery but instead for new degenerative symptoms.

One of the four patients who underwent a cervical laminectomy, instrumentation-augmented fusion, and concurrent foraminotomies developed a sudden onset of left-hand intrinsic weakness. This occurred 7 days after the original operation. Plain, flexion, and extension radiographs demonstrated no remarkable findings. Cervical
myelography and postmyelography computerized tomography scanning demonstrated only thinning of the C-7 nerve root, whereas the C8–T1 nerve roots had no filling defects. The patient underwent surgical reexploration, and no nerve root compression was observed. The patient's hand function completely recovered and the cause of the weakness was proposed to be vascular in nature, related to his underlying small vessel disease secondary to diabetes.

All patients underwent clinical and radiographic follow-up examination. Although the follow-up period has been brief, no cervical instability or cervical deformity has been demonstrated in any case.

Discussion

There have been numerous descriptions of procedures for treating cervical radiculopathy via an anterior or posterior approach. Mixter and Barr first reported the posterior approach for resection of lumbar and cervical disc herniations. Their technique was modified by Scoville, Fager, and Guanciale. Recently, there have been additional variations of these procedures involving use of the endoscope or a transpedicular route.

Cervicothoracic disc herniations and radiculopathies are uncommon. In several large clinical series authors have reported the incidence to be only between 4 and 7%. There has been no study to address specifically the surgical treatment of this disorder via a posterior approach. In our study, therefore, we have examined this uncommon condition's symptoms and clinical outcomes and will discuss the advantages of a posterior approach in the cervicothoracic spine.

Symptoms of Cervicothoracic Lesion

Acute or intractable pain is the major presenting symptom in patients with a monoradiculopathy. Most patients in our series suffered painful radiculopathies (19 of 20 cases); additionally patients also presented with concurrent hand intrinsic weakness (11 cases) or numbness (16 cases) due to compression of the C-8 or T-1 nerve roots (Figs. 1 and 2). Axial neck pain was present in the majority of cases but was a minor component (mean score of 2) and was most likely secondary to muscle spasms.

Clinical Outcome

Our clinical results correlate with those reported in other large series of posterior cervical foraminotomy in which outcome of good/excellent recovery ranged from 90 to 100%. In our series there was a reduction in the radicular component of pain, from a mean score of 7.45 to 0.2 (p < 0.0001). Improvement in motor function also occurred, as indicated by a mean increase from 4.35 to 4.79 (p < 0.007). Henderson, et al., reported the largest series,

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* disc = discectomy; form = foraminotomy.
accrued during 17 years, consisting of 736 patients (846 procedures); radicular symptoms were relieved in 96% and motor defects were resolved in 98%. In their series, no surgery included removal of the herniated disc, and only foraminotomies were performed. Although the goal of surgery was to treat the radicular pain and motor weakness, there was also a statistical correlation in the reduction of axial neck pain \( (p = 0.0001) \) from a mean score of 2.55 to 0.5, which is in agreement with our series. Herkowitz, et al.,\(^{22}\) performed the only prospective study, which consisted of 33 patients. Seventeen patients were randomized to undergo an anterior procedure and 16 to a posterior decompression. Although a good/excellent result was associated with 85% of the anterior procedures and only 75% of the posterior foraminotomies, the difference was not statistically significant. The authors should be commended for the study. They concluded, however, that “anterior discectomy and fusion is the recommended procedure for the surgical management of a cervical anterolateral disc herniation.” This is not supported by the results obtained in our study.

Anterior cervical discectomy and fusion also is reported to be associated with excellent relief of postoperative pain and neurological deficits. Gore and Sepic\(^{17}\) have reported a 96% improvement in symptoms in 146 patients. Disc herniations situated more laterally, however, can be difficult to decompress anteriorly because of limited access and visibility. In an anatomical study, Raynor\(^{26}\) found that, via a posterior decompression, between 3 and 5 mm of the cervical nerve root can be visualized, whereas only 1 to 2 mm can be appreciated via a standard anterior approach. Additionally, through a posterior approach multiple nerve roots can be decompressed simultaneously without requiring complex cervicothoracic anterior reconstruction.

**Biomechanical Factors**

Historically, posterior-approach cervical decompressive surgery has been thought to result in cervical instability and the formation of a kyphotic or swan-neck deformity. This was believed to be the result of excessive resection of the facet joints after laminectomy. Investigators of several in vitro studies have shown that the cervical spine maintains its stability if less than 50% of the facet joint is resected bilaterally after laminectomy.\(^{8,31,38}\) Zdeblick, et al.,\(^{38}\) demonstrated that with less than 50% resection of the facet joint strain, torsional stiffness, and flexion were maintained. These studies involved bilateral laminectomy and removal of the facet joints, whereas typically in cases of a posterior foraminotomy only a unilateral procedure is performed and only a minor portion of the facet is removed. If greater than 50% destruction of the facets is required, then the motion segment may require stabilization with posterior fusion.
Posterior cervical foraminotomy/discectomy

Anterior procedures, in contrast, are typically performed in conjunction with fusion. The distraction provided by the bone graft allows the neural foramen to be opened wider and causes the posterior longitudinal ligament to become stretched, reducing any buckling. The elimination of posterior ligamentous buckling theoretically increases the size of the spinal canal. Anterior fusion has been shown to reduce motion by 50 to 100%, which may improve axial neck pain. This, however, may result in increased stresses on the adjacent vertebral segments. 

Hilibrand, et al, have shown that 10 years after cervical interbody fusion 19% of their patients suffered accelerated adjacent-level degeneration.

Procedure-Related Complications

Posterior cervical foraminotomy is a safe procedure associated with a very low rate of complications (0–4%). The greatest complications are wound infections or serious drainage. Other complications include cerebrospinal fluid leakage secondary to a dural puncture, wound hematomas, and, rarely, transient or permanent nerve root symptoms.

An anterior cervical operation requires dissection around soft tissue and vascular structures. Inadvertent traction or dissection can lead to esophageal perforations, vertebral artery injury, pneumothorax, Horner syndrome (due to injured sympathetic nerves), and tracheal/laryngeal injury or dysfunction. These laryngeal/tracheal injuries can lead to dysphonia, hoarseness, dysphagia, and aspiration. The reported rates of vocal cord paralysis after anterior cervical spine surgery have been reported between 0.98 and 3% for permanent paralysis, and 1.7 and 11% for temporary vocal cord injury. Finally, via either approach the nerve root and spinal cord may also be transiently or permanently injured.

Typically, after completion of the anterior discectomy a bone graft is placed, with or without instrumentation, to enhance a fusion. This can be accomplished using autograft or allograft. Allograft is associated with the theoretical risk of transmitting an infection from the donor. Autograft harvest as well can be associated with significant pain and infection. Boockvar, et al, reported a 36% rate of graft/plate failure after anterior reconstruction at the cervicothoracic junction. This is most likely due to a biomechanical disadvantage created by the transition from the cervical lordosis to a thoracic kyphosis along with a lesser exposure resulting from anatomical constraints. To date in our series, no patient has developed cervicothoracic kyphosis, but further long-term follow-up data are necessary.

Conclusions

Although posterior foraminotomy is an established treatment, this technique has not been specifically reported on for application in the cervicothoracic region. The procedure can be performed with minimal risks and achieves excellent outcomes, while not exposing the patient to the infrequent but numerous complications of an anterior procedure at the cervicothoracic junction.

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