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Posterior laminoforaminotomy in the treatment of lateral cervical herniated disc and foraminal stenosis

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Background/aim: Posterior cervical laminoforaminotomy is an effective surgical treatment in selected cases of cervical radiculopathy caused by posterolateral herniated discs or foraminal stenosis. The aim of the present study was to evaluate the surgical techniques, rates of complications, long-term outcomes, advantages, and disadvantages of keyhole foraminotomy retrospectively.

Materials and methods: Keyhole foraminotomy was performed in 83 patients. In 51 patients (61.5%) soft disc herniation was removed, and in 32 of them (38.5%) osteophytes were evident. The clinical data were evaluated according to Odom's criteria, and the mean follow-up time was 6 months.

Results: Postoperative results were classed as excellent in 66 patients (79.5%), good in 13 patients (15.7%), fair in 3 patients (3.6%), and poor in only 1 patient (1.2%). Radiculopathy symptoms regressed in 79 patients (95%). Among the 83 patients, surgical complications (dural injury and level error) were noted in 2 patients (2.4%).

Conclusion: Posterior laminoforaminotomy is applied to selected patients with a low complication rate. The advantages of this surgery are suitable visualization of the nerve root, preserved motion of the operated segment, avoidance of cervical instability, and a decrease in the length of hospital stay.

Key words: Cervical herniated disc, foraminal stenosis, posterior laminoforaminotomy

1. Introduction

Commonly observed in the 3rd and 4th decades, cervical disc disease is a group of diseases affecting the spinal cord and roots (1). While conservative approaches are preferable, surgical treatment is applied in limited cases. Surgical approaches may vary according to a patient's cervical anatomy, localization of the herniated disc, and presence of osteophyte formation. Two main approaches are currently possible: anterior and posterior (2). Since the introduction of the anterior approach, the posterior approach has become relatively less adopted for cervical disc herniation. Although these two approaches have relative advantages and disadvantages over each other, both may be used with effective results. Depending on the localization of the herniation, it is necessary to select the appropriate surgical method. Posterior cervical laminoforaminotomy is an effective surgical procedure for the treatment of radicular pain due to cervical foraminal stenosis and laterally located soft disc herniation. When compared with anterior techniques, posterior approaches with keyhole laminoforaminotomy provide better visualization of the nerve root, disc, and osteophytes (3,4). Foraminotomy provides good or excellent results in most of the patients suffering from pain. The best results are obtained in cases with single level disc disease and laterally located soft disc herniation. The aim of the present study was to outline the surgical technique used in the posterior approach and to explain the surgical results evaluated by Odom's criteria for patients operated on with the posterior approach known as keyhole laminoforaminotomy (5).

2. Materials and methods

The current study was approved by the appropriate ethics committee and was performed in accordance with the ethical standards laid down in the 1964 Declaration of Helsinki and its later amendments.

In the present study 83 patients underwent keyhole laminoforaminotomy with the diagnosis of lateral cervical soft disc herniation or osteophytes. The study took place in İzmir Bozyaka Training and Research Hospital Neurosurgery Clinic with patients who were evaluated with regards to indications, techniques, and results.

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Despite the use of conservative treatment for at least 1 month, all patients had radicular pain or weakness due to degenerative cervical disc disease at the level C3–T1. Posterior laminoforaminotomy was performed at 1 or 2 levels. Patients who were operated on due to traumatic or neoplastic diseases were excluded from the study. All preoperative neurological examinations, symptoms on presentation, radiological examinations, concordance of the clinical and the radiological findings, surgery results, and complications were evaluated. Cervical vertebra radiography and cervical spinal MRI were performed preoperatively. Cervical CT imaging was performed in some cases. All surgical procedures were performed under surgical microscope. Postoperative 1st and 2nd day patients were evaluated according to Odom's criteria, according to which patients were rated from excellent to poor depending on resolution, improvement, or persistence of preoperative symptoms (Table 1). The mean follow-up time was 6 months.

The statistical evaluation was performed using SPSS (10.0). ANOVA was used for the analysis of numerical variables and Pearson's chi-squared test was used for the analysis of nominal ordinary variables. $P < 0.05$ was considered significant.

The surgery was performed in the sitting or prone position by fixing the head with a Mayfield cap. The prone position was used for only 5 patients. The reason that the sitting position is frequently preferred is that the epidural bleeding withdraws from the surgery site and provides a clearer view of anatomic orientations. If the required conditions are provided, the sitting position is as safe as the prone position. A central venous catheter was inserted and the end-tidal carbon dioxide degree and arterial pressure were monitored. The head was placed in a slight flexion position. After determining the level with a C armed scope, a midline incision was performed by considering spinous processes. A 3-cm incision is sufficient for a single level. Muscles were dissected subperiosteally. A small hemilaminectomy retractor and a surgical microscope were used in a standard technique, and the facet–lamina junction was distinguished. Extraction was performed at the lamina–facet junction, below the upper lamina and above the lower lamina. A high speed drill was used for drilling the bone. To prevent spinal instability, at least 50% of the facet should be protected. After visualizing the nerve root by observing from the axilla of the root, the disc was evacuated in the presence of soft disc herniation, and foraminotomy was carried out. Due to the presence of a hard disc, no attempt was made to enter the disc space. After decompression was completed, cervical fascia and subcutaneous tissue were sutured with absorbable material.

Table 1. Odom's criteria.

Outcome	Criteria
Excellent	All preoperative symptoms relieved; abnormal findings improved.
Good	Minimal persistence of preoperative symptoms; abnormal findings unchanged or improved.
Fair	Definite relief of some preoperative symptoms; other symptoms unchanged or slightly improved.
Poor	Symptoms and signs unchanged or exacerbated.

3. Results

Forty-five subjects were male (54.2%) and 38 were female (45.8%); the mean age was 45.8 years and the age range was 27–68 years. The affected side was the left in 45 patients (54.9%) and the right in 37 patients (45.1%). Single-level disc herniation was found in 73 patients, while multiple-level disc herniation was found in 10 patients. In 8 patients with multiple-level disc herniation there were 2 neighboring disc levels, while in the remaining 2 patients there were 2 nonneighboring disc levels. The number of cases according to the operated disc herniation levels were as follows: C3–4 herniation: 1 case (1.08%); C4–5 herniation: 6 cases (6.4%); C5–6 herniation: 32 cases (34.4%); C6–7 herniation: 48 cases (51.6%); and C7–T1 herniation: 6 cases (6.4%). An overall total of 93 levels of herniated disc segments were removed. The percentages of operated disc levels and the distribution of patients are given in Table 2. The mean duration of hospital stay of the patients was 48 h, and there was no surgical mortality in the present study.

There were 51 cases of soft disc protrusion and 39 cases of hard disc protrusion. Foraminotomy without disc excision was performed in 32 patients (38.5%) and free fragment excision and foraminotomy in 44 patients (53%). Seven patients (8.5%) had a single, free fragment level removed, and foraminotomy was performed on the other levels due to hard disc protrusion.

The prone position was used in only 5 patients. Despite the frequent use of the sitting position, complications such

Table 2. Lesion levels.

Lesion level	Number of patients	Percentage (%)
C3–4	1	1.08
C4–5	6	6.4
C5–6	32	34.4
C6–7	48	51.6
C7–T1	6	6.4

as air emboli, tension pneumocephaly, brain and spinal cord ischemia due to hypotension, and vertebral artery injury were not noted in our study.

Radiculopathy symptoms in 79 patients (95%) regressed and arm pain decreased following surgery. Surgical results based on clinical status were evaluated using Odom's criteria and postoperative results were as follows: excellent in 66 patients (79.5%), good in 13 patients (15.7%), fair in 3 patients (3.6%), and poor in 1 patient (1.2%). These data are provided in Table 3.

The mean age for excellent results was 44.95 years, while the mean age for good results was 51.85 years. When the 2 groups were compared, the mean age for excellent results was significantly lower than the mean age for good results ($P < 0.05$). Because the numbers of patients in groups with poor and fair results were low, comparison with the other groups was not made.

While 82.1% of patients in whom foraminotomy was performed had excellent results, 12.8% had good results according to Odom's criteria. Of those in whom disc excision was performed, 76.5% had excellent results and 19.6% had good results. Excellent and good result rates were 95% in both groups. The statistical analysis showed no significant difference between the 2 groups in which foraminotomy and disc excision were performed ($P > 0.05$). This result suggested that in the posterior approach, in cases where an extruded fragment does not exist, foraminotomy is also effective in relieving the patient's pain. These data are provided in Figure 1.

Among the 83 patients, surgical complications were noted in only 2 (2.4%). Dura damage was seen in 1, who was treated successfully during surgery. Level error was made in 1 patient, who was operated on again.

In early surgical results, 3 patients were evaluated as fair and 1 patient was evaluated as poor by Odom's criteria. The patient with the poor result and one of the patients with fair results had undergone foraminotomy and extruded fragment excision, while the other 2 patients with fair results had undergone foraminotomy only. Control cervical MRI was performed since the patients had severe radicular symptoms on the 1st and 2nd postoperative days. There was no extruded fragment in their control MRI. Reoperation

Table 3. Surgical results according to Odom's criteria.

Results	Number	Percentage (%)
Excellent result	66	79.5
Good result	13	15.7
Fair result	3	3.6
Poor result	1	1.2
Total	83	100.0

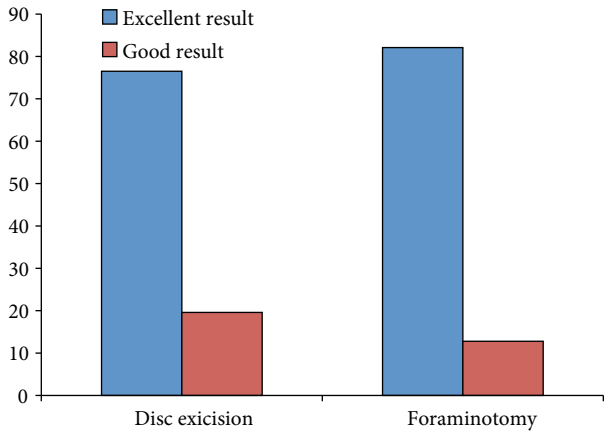

Figure 1. Surgical results according to Odom's criteria for 2 groups in which foraminotomy and disc excision were performed.

was not considered for these patients since, with analgesics and steroids, the symptoms regressed over 1 week.

In the later surgical results a patient developed kyphosis in the second year postoperative follow-up and was subsequently operated on using the anterior approach. Recurrent herniation was detected at the surgery level on the MRI of 2 patients with the recurrence of radicular symptoms in the 6th month and 2nd year of follow-up, respectively. Foraminotomy and extruded fragment excision were performed in these recurrent cases. Reoperation was not considered since the complaints decreased with medical treatment.

Preoperative and postoperative images of a patient who had cervical disc herniation at the C6–7 level are given in Figures 2–6.

Figure 2. Cervical sagittal T2-weighted MRI demonstrating cervical disc herniation at the C6–7 level.

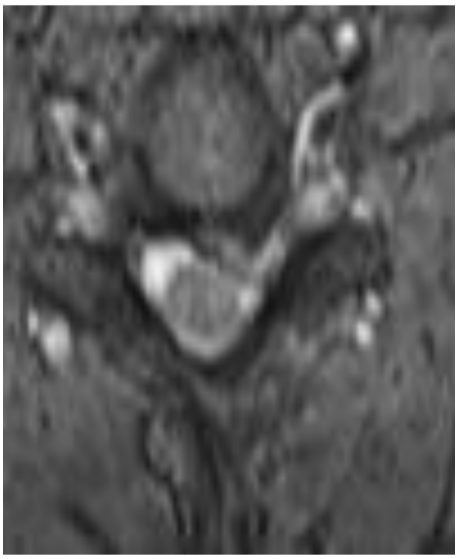

Figure 3. Cervical axial image showing soft disc herniation on the left side.

Figure 4. Cervical sagittal T2-weighted MRI demonstrating that soft disc herniation was removed and lordosis was prevented.

Figure 5. Cervical axial image showing that soft disc herniation was removed.

Figure 6. The laminectomy area is seen on the left side of the C6 lamina on the cervical CT image.

4. Discussion

The posterior approach to cervical pathologies was reported by Mixter and Barr (6), and keyhole foraminotomy was popularized by Scoville (2) and Epstein (7). Others used the term laminoforaminotomy (8,9). Although it has less intraoperative and postoperative risk in lateral cervical pathologies, the posterior cervical approach is used less often than the anterior approach. There are several disadvantages of anterior surgery and corpectomy in cervical disc hernia and cervical spondylotic myelopathy; almost always strong bone grafts are required. The fusion rates are lower among the elderly, diabetics and smokers, while adjacent segment disease and graft complications are common.

Thus, posterior surgery has not lost its popularity and has a wide range of surgical indications (10). Clinical results of the cervical posterior foraminotomy have been reported as quite good more than 90% in a high number

of the cases (10,11). In a study by Scoville et al. (8) the posterior cervical approach produced good to excellent results (85%) in 171 patients who underwent lateral disc surgery and who were followed from 5 to 33 years. In a study by Henderson et al. (11) 96% pain relief and 98% recovery of motor deficits were reported in 736 cases; there was no difference between cases of disc herniation and foraminal stenosis. Kumar et al. (12) published a study including 89 cases, in which, when cervical posterior foraminotomy was performed, the patients were followed up for 8.6 months and good and excellent result rates were found to be 95% according to Odom's criteria. A study published by Jagannathan et al. (13), with 162 cases, reported 95% recovery of preoperative symptoms; postoperative follow-up was performed for 77 months and it was emphasized that foraminotomy did not increase the tendency of kyphosis. In a study by Caglar et al. (14) with 84 patients, among the patients with an average follow-up of 8 years 96% had very good or good results. These studies are similar to each other in terms of mean age and observational clinical outcomes. In the present study with 83 patients, postoperative excellent results were observed in 66 patients (79.5%) and good results in 13 patients (15.7%). In total, a 95% recovery rate was observed in preoperative symptoms, and the results were concordant with those reported in the literature.

Keyhole foraminotomy and laminoforaminotomy are posterior cervical approaches used for the resection of lateral and cervical foraminal disc hernias and spurs (10,11,15). Unilateral single-level or more than one level and bilateral single or more levels (fenestration approach) may be performed. This may be combined with laminectomy or laminoplasty. In the present study 82 patients had unilateral, one or more than one level laminoforaminotomy, and a single patient was operated on using the bilateral single-level fenestration approach. Laminectomy was performed in these cases while laminoplasty was not performed.

It is still controversial as to whether the anterior or posterior approach should be used in lateral and foraminal cervical disc herniation. Keyhole foraminotomy and laminoforaminotomy provide the opportunity for dorsal resection without the instability present in the anterior approach, and thus cause less mortality. The most obvious benefit of the dorsal approach is that the ascending nerve root may be followed accordingly with the amount of resection, whereas larger facetectomy may require fusion because of instability (7). The need for facet resection during laminoforaminotomy is usually 25% and very rarely 50% (16–20). Chen et al. (16) have stated that laminoforaminotomy destabilizes the cervical spine less than fusion and nonfusion anterior discectomy. In the present study, the medial part of the pedicle was drilled in certain cases in order to minimalize the retraction of the dural sac and root. Preoperative and postoperative (the mean follow-up period was 6 months) imaging of the cervical vertebrae was ordered for all patients in this study and it was observed that laminoforaminotomy did not predispose to kyphosis. It was, however, observed that it predisposed to postoperative lordosis even in some patients where cervical lordosis was flattened. Kyphosis developed only in 1 patient in the 2nd year of postoperative follow-up and the patient was operated on subsequently using the anterior approach.

Posterior cervical microendoscopic foraminotomy is becoming increasingly popular in the treatment of cervical radiculopathy (21–23). The advantages of the endoscopic technique compared with a traditional keyhole approach include the following: a smaller incision, less muscle injury and blood loss, lower postoperative pain, and a shorter hospitalization period (21,22,24). Although the endoscopic technique has these theoretical advantages, a consensus relating to the best approach is not yet available (24).

In patients operated on with laminoforaminotomy, a 2.2% or more intraoperative complication rate was reported (14). Muscle dissection and removal of bone were observed more frequently in posterior surgery than in anterior surgery. Thus, axial neck pain may be considered a disadvantage of posterior surgery. Among obese patients operated on using the prone position, there may be excessive blood loss during surgery. Among patients who were operated on in a sitting position, cord and brain ischemia may be seen due to hypotension. Cerebrospinal fluid fistula, epidural bleeding, pneumocephaly, vertebral artery, and cord and root injuries are other probable complications of this surgery (15,20). In the cases in the present study, no major complications were observed. Dural damage developed in 1 patient, while a level error was made in another. Early postoperative results were fair and poor in 4 patients. In the long-term follow-up, kyphosis developed in 1 patient and recurrent herniation was detected in 2 patients.

In conclusion, the anterior cervical approach is the preferred approach in cervical disc herniation surgery at present. However, posterior laminoforaminotomy is an effective and safe surgical procedure with low complication rates performed for spine and root decompression due to cervical disc herniation. It is especially appropriate for foraminal disc herniation and foraminal stenosis. The advantages of this procedure are as follows: good visualization of the nerve root, minimal lamina resection, undisrupted stability, and no fusion requirement. Appropriate patients, correct levels, appropriate decisions for surgery, and appropriate techniques should improve the success rate.

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