

## Efficacy and Safety of Posterior Cervical Foraminotomy as an Operative Technique for Cervical Radiculopathy

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### Abstract

**Background:** Radiculopathy caused by cervical disc disease is a frequently encountered pathology among spine specialists. While non-operative treatment methods can effectively manage the condition, surgical interventions are available as an option if conservative treatment is unsuccessful. The objective of this study is to provide a brief account of our recent encounter with posterior cervical foraminotomy for the treatment of cervical radiculopathy.

**Aim of Study:** To present our short-term experience regarding posterior cervical foraminotomy for cervical radiculopathy. Efficacy, safety, and technique would be reported.

**Patients and Methods:** A review was conducted on our institution's database covering the period from 2019 to 2022. The review identified 35 patients who had consecutively undergone Posterior cervical foraminotomy. The study compared the pre-intervention visual analogue scale (VAS) with the post-intervention VAS at three months (post VAS 2) to evaluate the levels of neck pain (VASn) and arm pain (VASa).

**Results:** Concerning the functional outcome, the average VASn Pre was 6.17, the average VASn Final was 2.09, the average VASa Pre was 6.97 and the average VASa Final was 1.29. The difference between VASn Pre and VASn Final was statistically significant as the *p*-value was less than 0.05. The difference between VASa Pre and VASa Final was statistically significant as the *p*-value was less than 0.05. No complications were reported in our study.

**Conclusion:** Considerable clinical improvement was observed in patients suffering from radiculopathy caused by cervical disc disease who underwent treatment with posterior cervical foraminotomy. The aforementioned procedure has been deemed both safe and effective in the treatment of the aforementioned pathology.

**Key Words:** Cervical = VA Sa – VA Sn – Foraminotomy – Radiculopathy.

### Introduction

**RADICULOPATHY** caused by cervical disc disease is a frequently encountered pathology among spine specialists. While non-operative treatment

methods are effective in managing the condition, there are several surgical options available if conservative treatment fails. Spinal surgeons frequently treat cervical radiculopathy, which is among the most prevalent pathologies. Anterior cervical discectomy and fusion (ACDF) remains the primary surgical intervention for cervical radiculopathy. However, there has been a rise in the popularity of motion-preserving procedures such as posterior cervical foraminotomy (PCF) and disc replacement [1].

The technique of posterior cervical foraminotomy (PCF) was initially introduced as a motion-preserving procedure by Spurling and Scoville in 1944 [2]. However, with the advancements in medical technology, it can now be performed using minimally invasive techniques. Studies have shown that when performed as a minimally invasive procedure, the effectiveness is comparable to that of open techniques. Additionally, there is a notable reduction in postoperative length of stay, blood loss, and postoperative analgesic use. These findings have been reported in multiple sources [3,4,5]. The procedure may involve either minimally invasive PCF (MI-PCF) or MI posterior cervical discectomy (MI-PCD) with foraminotomy.

Indications for this surgical procedure include patients having soft-disc herniation compressing the nerve root lateral to the spinal cord or with foraminal stenosis due to osteophytes originating from the facet joint [3]. Contraindications to this procedure include pure axial neck pain without any neurological complaints, symptomatic central disc herniation, gross cervical instability, posterior longitudinal ligament ossification, and a cervical spine kyphotic deformity [6]. Many studies have illustrated that MI-PCF/PCD is an effective modality of treatment for cervical radiculopathy, but reviewing the literature revealed that there is lack

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of research focusing on the need for secondary surgery at the index or adjacent level after this surgery. The aim of our work was to show the outcomes and the need for secondary surgery.

*The aim of study:*

Is to present our short-term experience regarding posterior cervical foraminotomy for cervical radiculopathy. Efficacy, safety, and technique would be reported.

This surgical procedure is indicated for patients who have soft-disc herniation that compresses the nerve root located laterally to the spinal cord or those with foraminal stenosis caused by osteophytes originating from the facet joint [3]. The procedure should not be performed in cases of pure axial neck pain without any neurological complaints, symptomatic central disc herniation, gross cervical instability, posterior longitudinal ligament ossification, and a cervical spine kyphotic deformity [6]. These are considered contraindications to the procedure. Numerous studies have demonstrated the efficacy of MI-PCF/PCD as a treatment modality for cervical radiculopathy. However, a literature review has revealed a dearth of research on the necessity of secondary surgery at the index or adjacent level following this procedure. The objective of our study was to demonstrate the results and necessity of subsequent surgical intervention.

The objective of this research is to provide a brief account of our recent encounter with posterior cervical foraminotomy as a treatment for cervical radiculopathy. The report will include information on efficacy, safety, and technique.

### **Material and Methods**

The present investigation involved a retrospective analysis of our database at Beni-Suef University Hospitals, focusing on patients who undergone posterior cervical foraminotomy between 2019 and 2022. The procedure was performed on patients who reported cervical radiculopathy resulting from cervical foraminal stenosis, with or without cervical disc herniation. A comprehensive analysis was conducted on data obtained from historical and physical examinations, operative notes, discharge summaries, follow-up office visits, and MRI reports. Instances of surgical complications and failures that necessitated revision were observed. Patients who needed to undergo revision surgery due to persistent or new-onset radicular symptoms, and whose radiographic imaging consistently showed the need for revision, were categorized based on the level of revision required. This included either the index level or adjacent level(s).

*Primary hypothesis:*

The minimally invasive posterior cervical foraminotomy is a safe and effective treatment option for cervical radiculopathy.

*Study population:*

The present investigation was conducted in a retrospective manner by scrutinizing databases at Beni-Suef University hospitals within the timeframe spanning from May 2019 to October 2022. The study included 35 patients who underwent minimally invasive posterior cervical foraminotomy (MI-PCF) and met the inclusion criteria. The study's inclusion criteria comprised of patients with cervical radiculopathy that did not respond to nonsurgical intervention, a follow-up period of at least 2 years, complete medical records, a hospital stay of less than 3 days, and 1 or 2 cervical operative levels. The surgical indications for this case were limited to patients diagnosed with cervical radiculopathy without myelopathy. The operating surgeon conducted a thorough review of the radiological studies and performed a meticulous neurological examination to exclude myelopathy. The clinical picture of the patient was also taken into consideration. The exclusion criteria for the study included cases with a history of cervical surgery. The research and ethical committee of the department of neurosurgery at our university approved the study's purpose and methodology. Posterior cervical foraminotomy was performed on a total of 35 patients. No source of selection bias was identified.

The medical records were used to gather general demographic information such as sex, age, and body weight. The visual analogue scale (VAS) was used to record baseline outcome scores for each patient. On the day preceding the procedure, the patient provided a signature on the written informed consent document. A clinical assessment at the baseline was conducted. Comprehensive laboratory tests were conducted to evaluate the patient's complete blood count, International Normalized Ratio (INR), hepatic and renal functions, and blood glucose levels to confirm their suitability for the surgical procedure.

*The procedure:*

The procedure of posterior cervical foraminotomy was carried out while the patient was under the influence of general anaesthesia. The surgical procedure was executed with the patient lying face down on an operating table that is transparent to X-rays. The surgical area located at the posterior aspect of the neck underwent a thorough sterile preparation process. The precise surgical site was

identified with the use of a C-arm fluoroscopic device. The patient's symptoms were used to confirm the necessity of surgery. The C-arm was utilised to confirm the precise cervical level. The procedure involved making an incision, followed by the use of blunt dissection and fascia splitting. The procedure of subperiosteal muscle separation was performed, and the precise location of entry was verified using a C-arm. The soft tissues that were left were extracted using Pituitary rongeurs. Subsequently, the microscope was employed. Subsequently, a high-speed drill was employed to reduce the thickness of the lateral portion of the lamina and the medial portion of the facet joint. It is important to note that only the medial third of the facet joint was removed. Upon reaching the nerve root, the foraminotomy procedure was performed utilizing Kerrison rongeurs measuring 1 and 2 millimeters. The objective was to free the nerve root from any constriction caused by bone or soft tissue impingement. Following adequate irrigation and confirmation of appropriate hemostasis, the procedure involved anatomical closure in layers. The fascia was stitched down using an absorbable Vicryl-suture, while the skin was closed with a continuous subcuticular nonabsorbable Prolene-suture. The post-operative instructions given to the patients included a requirement to maintain a recumbent position for a duration of 2 hours. A comprehensive neurological assessment and thorough investigation for any possible post-operative complications were conducted. All patients were discharged on the day of surgery. Subsequent questionnaires were collected post-surgery.

*Statistical analysis:*

Data were statistically reported using the mean, standard deviation (SD), median, and range, or, when appropriate, frequencies (number of occurrences), and percentages. The Kolmogorov-Smirnov test was used to determine if numerical data supported the normal assumption. A paired *t*-test was used to compare the VAS levels between pre- and post-operative values. It was deemed statistically significant when the two-sided *p* value was less than 0.05. All statistical analyses were performed using IBM SPSS (Statistical Package for the Social Science; IBM Corp., Armonk, NY, USA) release 22 for Microsoft Windows.

*Outcome measures:*

The main results were a reduction in pain and an improvement in functional impairment. VAS was used to measure pain alleviation. Both the arm pain and the neck pain results were evaluated. Three months (post-VAS) of follow-up allowed

for the analysis of the outcomes. The secondary result was the frequency of further revision surgeries. If a patient improved their VAS, they were deemed a categorical success.

**Results**

The study was conducted on 35 patients complaining of cervical radiculopathy with mean age of 47.7 years old. The number of females was 16 and the number of males was 19. The procedure was done on a single level in 31 patients and double level on 4 patients. The level of the procedure was five patients C 3-4, 4 patients C 4-5, 9 patients C5-6, 13 patients C6-7 and 4 patients C & T1. Three patients from the whole study underwent revision surgery. 14 patients were smokers and 21 were nonsmokers. The average follow-up period was 27.9 months. The average age at reoperation was 49.6 years old, the average total time to revision was 26 months (Table 1).

Concerning the functional outcome, the average VASn Pre was 6.17, the average VASn Final was 2.09, the average VASa Pre was 6.97 and the average VASa Final was 1.29 (Table 2).

The difference between VASn Pre and VASn Final was statistically significant as the *p*-value was less than 0.05. The difference between VASa Pre and VASa Final was statistically significant as the *p*-value was less than 0.05. No complications were reported in our study.

Table (1): Patient characteristics.

	N	Minimum	Maximum	Mean	SD
Age at Operation (years)	35	30	58	47.74	5.757
Average FU (months)	35	24	35	27.94	3.613
Age at Reoperation	3	45	54	49.67	4.509
TTR	3	24	28	26.00	2.000

Values are expressed as mean ± SD. FU : Follow-up.  
 N : Number. TTR: Time to revision.  
 SD: Standard deviation.

Table (2): Functional outcome scores.

	N	Minimum	Maximum	Mean	SD
VASn Pre	35	5	8	6.17	1.014
VASn Final	35	1	3	2.09	0.658
VASa Pre	35	6	9	6.97	0.985
VASa Final	35	1	2	1.29	0.458

Values are expressed as mean ± SD. N : Number.  
 VASn: Visual analog scale for neck. SD: Standard deviation.  
 VASa: Visual analog scale for arm.

## Discussion

Posterior cervical foraminotomy (PCF) is an established technique for alleviating radiculopathy resulting from foraminal stenosis caused by herniation of a soft disc and/or narrowing of foramina by hypertrophied ligaments. PCF has the same clinical outcome for treating radiculopathy as anterior cervical discectomy and fusion (ACDF) [7].

Other PCF advantages are the lower risk of injury of esophagus and recurrent laryngeal nerve and preserving neck motion when compared with the ACDF [8].

In a meta-analysis including 1,410 patients: successful outcome was 94.2% with PCF and 89.6% with ACDF, poor outcomes were 5.7% with ACDF vs 2.3% with PCF, overall rate of complication was 7.2%; a slightly higher rate of complication with anterior approach (7.9%) compared to (6.7%) with posterior approach. The revision rate was higher after ACDF (4.2%) compared to (2.2%) after PCF [9].

PCF with O-arm-assisted navigation is a safe, effective, and minimally invasive method for treating lateral disc herniation and foraminal stenosis in the lower cervical spine and Cervico-Thoracic junction, with the benefit of sufficient decompression and a lesser risk of segmental instability [10].

PCF is a well-known technique for cervical nerve roots decompression with posterolateral herniation of a soft disc and/or foraminal stenosis. PCF was first reported by Spurling and Scoville, 1944 [11] and Frykholm, 1947 [12], and was redesigned by Scoville et al. in 1951 [13].

Prevention of approach- and graft-related problems seen in anterior procedures, as well as avoidance of fusion while preserving segment stability and movement, have increased spine surgeons' interest in posterior foraminotomy. The METRx system tubular retractor (Medtronic Sofamor Danek, Memphis, TN) is minimally invasive, allowing muscle-splitting dissection without the traditional extensive subperiosteal stripping of the paraspinal musculature, which is used in open posterior approaches and increases postoperative pain, blood loss, muscle spasm, and dysfunction. The procedure's morbidity is thereby minimized, resulting in faster recovery and a shorter hospital stay. However, minimally invasive PCM is difficult to execute in obese individuals with short necks, particularly in the lower cervical spine or C-T junction [10].

The utilisation of a microscope for cervical foraminotomy was initially documented in 1983 by Williams. According to the report, 96.5% of patients experienced relief from stubborn radicular pain within three days [14]. In the same period, Henderson and colleagues published a report detailing their 15-year clinical experience with 846 cases of radiculopathy that underwent surgery. The study found that 96% of patients experienced pain relief [15]. The absence of cervical instability and significant complications, similar to those observed after ACDF, were reported in both papers. The studies concluded that posterior foraminotomy offers lower complication rates and is effective in alleviating pain. These findings suggest that posterior foraminotomy may be a viable alternative to ACDF [16].

In 2000, two cadaver studies were conducted to describe the minimally invasive PCF/PCD technique. The studies found that this technique achieved comparable nerve root decompression and bony resection to traditional open techniques [17,18]. The utilisation of minimal access techniques and advancements in minimally invasive technology have resulted in a noteworthy reduction in operative blood loss, duration of hospital stay, and morbidity associated with the approach, as compared to open posterior approaches [19-21]. Open posterior procedures involve a thorough subperiosteal dissection of paraspinal musculature, which can result in considerable postoperative morbidity. This morbidity can be permanently disabling in a significant percentage of patients, ranging from 18% to 60% [18]. According to clinical studies, the use of MI-PCF/PCD has resulted in a symptom relief rate of 87% to 97%. The efficacy of this method is comparable to that of traditional open procedures, as evidenced by studies cited in references [21-23]. Following cervical arthrodesis, an extended lever arm can cause excessive stress on adjacent levels. According to biomechanical studies, arthrodesis has an impact on the mechanical properties of intervertebral discs, leading to increased internal stress responses and hypermobility [25-27]. MI-PCF/PCD is believed to have an advantage over ACDF due to its ability to avoid fusion, which allows for the preservation of normal segmental motion. This theoretical benefit may result in a decrease in rates of adjacent-level disease. Postoperative segmental instability at the index level is a potential issue associated with MI-PCF/PCD. This is caused by the partial facet resection, which can result in cervical instability and kyphosis, as stated in reference [28]. According to Zdeblick et al. [29], biomechanical studies indicate that removal

of more than 50% of the facet leads to considerable hypermobility in the cervical segment.

#### Conclusions:

Considerable clinical improvement was observed in patients suffering from radiculopathy caused by cervical disc disease after undergoing posterior cervical foraminotomy treatment. The aforementioned procedure has been deemed safe and efficient in the treatment of this particular medical condition.

#### Authors' Statements:

No conflicts of interest were identified, and all study procedures were conducted in strict adherence to established ethical guidelines. No financial disclosure is present. Informed consent was obtained from the patients. The medical and ethical committee of the neurosurgery department at our institute granted approval for the study's aim and design.

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## فعالية وسلامة توسيع مخارج الأعصاب العنقية من الخلف كتقنية جراحية لاعتلال جذور الأعصاب العنقية

الخلفية: اعتلال جذور الأعصاب العنقية الناجم عن الانزلاق الغضروفي العنقي هو من الأمراض الشائعة بين المتخصصين في جراحات العمود الفقري. في حين أن طرق العلاج غير الجراحية يمكن أن تعالج الحالة بشكل فعال، إلا أن التدخلات الجراحية متاحة كخيار إذا لم ينجح العلاج المحافظ. الهدف من هذه الدراسة هو تقديم وصف موجز لخبرتنا مع توسيع مخارج الأعصاب العنقية من الخلف كتقنية جراحية لاعتلال جذور الأعصاب العنقية.

الهدف من الدراسة: تقديم خبرتنا قصيرة المدى فيما يتعلق توسيع مخارج الأعصاب العنقية من الخلف كتقنية جراحية لاعتلال جذور الأعصاب العنقية. سيتم تقييم فعالية وسلامة التقنية.

المرضى والطرق: تم إجراء مراجعة على قاعدة بيانات المستشفى في الفترة من ٢٠١٩ إلى ٢٠٢٢ حددت المراجعة ٣٥ مريضاً خضعوا على التوالي لتوسيع مخارج الأعصاب العنقية من الخلف كتقنية جراحية لاعتلال VAS مع (VAS) جذور الأعصاب العنقية. قارنت الدراسة المقياس التناظري البصري قبل التدخل وآلام الذراع (VASn) لتقييم مستويات آلام الرقبة (VAS 2) بعد التدخل في ثلاثة أشهر (VASa).

النتائج: فيما يتعلق بالنتيجة الوظيفية، كان هناك فرق إحصائي واضح بين آلام الذراع ما قبل وبعد الجراحة

الخلاصة: لوحظ تحسن سريري كبير في المرضى الذين يعانون من اعتلال جذور الأعصاب العنقية الناجم عن الانزلاق الغضروفي العنقي والذين خضعوا للعلاج لتوسيع مخارج الأعصاب العنقية من الخلف. يعتبر الإجراء المذكور أنفاً آمناً وفعالاً في علاج اعتلال جذور الأعصاب العنقية الناجم عن الانزلاق الغضروفي العنقي.