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Posterior Cervical Keyhole Foraminotomy in Treatment of Cervical Radiculopathy Following Anterior Cervical Discectomy and Fusion

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Abstract

Background Data: Cervical radiculopathy after prior anterior cervical discectomy may result from residual compression after the first surgery or development of new compression at the same level or an adjacent level. Treatment for recurrent or residual symptoms can involve conservative measures or surgery. The anterior approach may be used with ease for the treatment of fresh level disc disease although it may be difficult in recurrent or residual situations.

Purpose: To describe the surgical outcome of posterior keyhole foraminotomy with or without discectomy for treatment of cervical radiculopathy following anterior cervical discectomy and fusion (ACDF).

Study Design: Retrospectively analysis of a prospectively collected database of a consecutive series of patients.

Patients and Methods: We included patients that had undergone microscopic posterior cervical keyhole foraminotomy with or without discectomy surgeries for residual or recurrent cervical radiculopathy after prior ACDF. Patients with central canal compression were excluded. The site of recurrence and outcome after surgery has been reported and correlated with the procedure performed. The clinical outcome was evaluated by pain Visual Analogue Score (VAS), Neck Disability Index (NDI) and Oswestry Disability Index (ODI). Postoperative complications were reported. Chi-Square or Fisher exact test was used to compare categorical variables and Mann–Whitney U test was used to compare continuous variables.

Results: we identified twenty-one patients who had 24 posterior cervical keyhole foraminotomies (18 single and 3 double level) after prior anterior cervical discectomy and fusion (19 single and 2 double level) through 2013 to 2016. In 12 patients (57%), the complaint was related to the primary level, of whom 3 patients had additional level to the primary one. Nine patients (43%) had a complaint related to the new disc level other than the primary level of surgery. The clinical outcome was generally satisfactory, where pain VAS, Neck Disability Index (NDI) and Oswestry Disability Index (ODI) were significantly reduced after surgery. Eighteen (85.7%) patients had an excellent or good clinical outcome. Two patients had wound infection and one patient had wound hematoma, all treated conservatively. No neurologic deficit has resulted from the posterior cervical keyhole foraminotomy. No postoperative mortality. No recurrence of symptoms has been reported trough the period of follow up.

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Conclusion: Microscopic posterior cervical keyhole foraminotomy with or without discectomy is a safe and effective procedure in the treatment of recurrent or residual cervical radiculopathy following prior anterior cervical discectomy and fusion. (2017ESJ138)

Keywords: Posterior cervical foraminotomy, recurrent cervical radiculopathy, anterior cervical discectomy and fusion, Keyhole

Introduction

Cervical radiculopathy refractory to medical treatment is an indication for surgical intervention. Anterior cervical discectomy and fusion (ACDF) has been commonly used for cervical disc disease since the description by Smith and Robinson in 1958.[1] An alternative treatment for cervical radiculopathy is posterior cervical keyhole foramintomy, first descriped by Scoville and Frykholm 1951,[13,33] This procedure has been reported as effective as the ACDF in decompression of selected nerve roots.[42]

ACDF has advantages over posterior cervical keyhole foraminotomy where it avoids cord and root retraction, can deal with both lateral as well as medial pathology and can deal with soft as well as hard disc.[22,27,29] The outcomes following Primary ACDF for cervical disc disease have been generally excellent, with high rates of clinical improvement and minimal rates of morbidity.[17,2,28,29,31,38]

Unlike primary anterior cervical surgery, revision surgery may be difficult due to scarring.[23] Fused vertebrae may interfere with disc removal and requires aggressive bone removal, distorted soft tissue and bone anatomy may lead to an overall higher morbidity and lower cure rate.[24] Besides ACDF may not easily access recurrence at high or low cervical levels specially in short neck patients. In such patients posterior cervical keyhole foraminotomy may be an option for selected patients of cervical radiculopathy. Although many papers have been published on re-operative ACDF,[5,19,23,26,37] the posterior cervical keyhole foraminotomy after prior ACDF is not well investigated. In this article we review and evaluate the posterior cervical keyhole foraminotomy and evaluate it for treatment of recurrent cervical radiculopathy following anterior cervical discectomy and fusion.

Patients and Methods

We reviewed a prospectively collected database of all patients who underwent posterior cervical foraminotomy with or without discectomy as needed, as a re-operation for recurrent cervical radiculopathy after prior anterior cervical discectomy. The study was conducted on 21 patients treated in the University Hospitals of Menoufia and Tanta School of Medicine through 2013 and 2016.

Demographic data, prior treatments such as surgical interventions and/or medical measures, duration of surgery, estimated blood loss; surgical outcome and complications were retrieved from our database. All patients were routinely preoperatively investigated by cervical plain X ray, CT and MRI. Post-operative MRI and CT was done to evaluate our decompression.

The clinical outcome was classified according the pain VAS (Visual Analogue Score) into excellent (VAS= 1-2), good (VAS= 3-4), fair (VAS= 5-6) and poor (VAS= 7-10); Disability was assessed using the Neck Disability Index (NDI)[39] where no disability (NDI=0-4), mild (NDI= 5-14), moderate (NDI=15-24), severe (NDI= 25-34) and complete (NDI > 34). Quality of life was assessed using ODI with disability classified as: minimal (ODI= 0-20%), moderate (ODI=21-40%), severe (41-60%) and crippled (ODI= 61-80%).[9,36,40]

Surgical Technique:

We used prone position for all of our patients. We start by localizing the desired level with intra-op fluoroscopy. A 2–3 cm midline incision is adequate. Periosteal elevators are used to dissect muscles off the lamina and facet joint in the sub-periosteal plane on the side of the brachialgia. Then the correct level is confirmed with intraoperative x-ray. A unilateral retractor was employed.

A powered drill has been used to make an opening in the medial one-third to one-half of the inferior facet of the vertebra above the desired disc space, extending slightly medially into the junction with

the lamina. First the inferior facet was drilled out to expose the superior facet of the inferior vertebral level which was also thinned with the drill caudally to where it meets the pedicle. A small Kerrison rongeur has been used some times to slightly enlarge the laminectomy. We did not remove more than half the facet joint to preserve spinal stability.

The ligamentum flavum overlying the lateral aspect of the spinal cord dura was removed. The nerve root can be followed as it exits from the thecal sac travels between the pedicles of the level above and below. Fibrous bands across the dorsum of the nerve were removed to further expose the dura of the nerve root. The venous plexus around the nerve root was coagulated with bipolar cautery and then divided to mobilize the nerve. The nerve may then be gently moved a few millimeters rostrally using a micro nerve hook. The dura overlying the spinal cord should not be manipulated, and the disc space need not be entered. Inspection for free disc fragments should begin in the nerve root axilla using a blunt nerve hook. Next, the space anterior to the root (the region of the disc) may be palpated. Any disc fragments that are dislodged were removed with a small pituitary rongeur. If the disc fragment was contained anterior to the posterior longitudinal ligament (PLL), the PLL may be incised in the region of the nerve root axilla with a #11 scalpel blade in a motion that is directed downward and laterally, away from the nerve root and spinal cord. The foraminotomy may be extended slightly laterally if the foramen still feels tight when probed. In some patients, simple posterior decompression of the nerve root, without removing a disc fragment, may be adequate to relieve compression. (Figure 1,2)

Statistical Evaluation:

Continuous variables are displayed as mean values ± standard deviation and range. Categorical values are shown as percentages. Chi-square or Fisher exact test was used to compare categorical variables and. Mann–Whitney *U* test was used to compare continuous variables. A *P*-value of less than 0.05 was considered significant.

Results

We identified 21 patients from 2013 to 2016 who had re-operation for 24 levels of posterior cervical keyhole foraminotomy for treatment of recurrent cervical radiculopathy (Table 1). The index level was at the same level of prior surgery in 12 patients (57%) of which 3 patients had additional level to the prior one and other 9 patients (43%) had a new disease at another level than the prior affected one. The 12 patients with brachialgia related to the primary level had foraminal stenosis in 10 patients and unilateral disc fragment in 2 patients. The numbers of levels operated in the 21 patients were 24 levels (18 single and 3 double level), where the number of levels operated in previous surgery in 21 patients was 23 levels (19 single and 2 double level). Eleven patients presented with right brachialgia and 10 patients presented by left brachialgia. The average length of time from the previous surgery was 24 months. The average length of time from the previous surgery was significantly less in residual disc group (4 month versus 45 months, in true recurrence group $P<0.01$, Mann–Whitney U Test). Posterior cervical foraminotomies were done in the 24 levels affected. Discectomy for soft disc fragments was performed in 10 (41.7%) levels where it was soft.

The average post-operative follow up was 16 months (Range 3-50 months). The clinical outcome was generally satisfactory, where pain VAS, Neck Disability Index (NDI) and Oswestry Disability Index (ODI) were significantly reduced after surgery. Brachialgia VAS improved from 7.5 preoperative to 2.5 postoperative ($P<0.05$). NDI improved from 720.48 preoperative to 5.52 postoperative ($P<0.05$). ODI improved from 57.6 preoperative to 9.24 postoperative ($P<0.05$) (Table 3). The clinical outcome was generally satisfactory, where 18 (85.7%) patients had excellent or good outcome of whom 9/18 (50%) patients had pathology at the same level of initial complaint and the other 9/18 (50%) had brachialgia due to compression of fresh level. All patients with unsatisfactory outcome (3 patients) had residual symptoms after the first surgery with pathology at the prior index level. We had 2 patients with wound infection and one patient with wound hematoma, all resolved by conservative treatment.

Table 1. Preoperative Patients Characteristics

Characteristic	Value (%)
No of patients	21
Male	12 (57)
Female	9 (43)
Age (years)	43±10
Previous surgery	
One level surgery	19 (90.5)
Two level surgeries	2 (9.5)
Time from previous operation (months)	24±19
Clinical Presentations	
Right brachialgia	11 (52.4)
Left brachialgia	10 (47.6)
Brachialgia at the prior operated level	12 (57)
Brachialgia at new level	9 (43)

Table 2. Operative Procedures (N=21 patients, 24 levels)

Procedure	No. of Patients (%)
Posterior cervical keyhole foraminotomy	14/24 (58.3)
Posterior cervical keyhole foraminotomy and Discectomy	10/24 (41.7)
Single level	18 (85.7)
Double level	3 (14.3)
Operated levels	
C4/5	4 (16.6)
C5/6	9 (37.5)
C6/7	7 (29.2)
C7/T1	4 (16.6)

Table 3. Clinical outcome of Operative Procedures

Parameters	Preoperative mean	Postoperative mean	P value
Pain VAS	7.5	2.5	<0.05
NDI	20.48	5.52	<0.05
ODI	57.6	9.24	<0.05

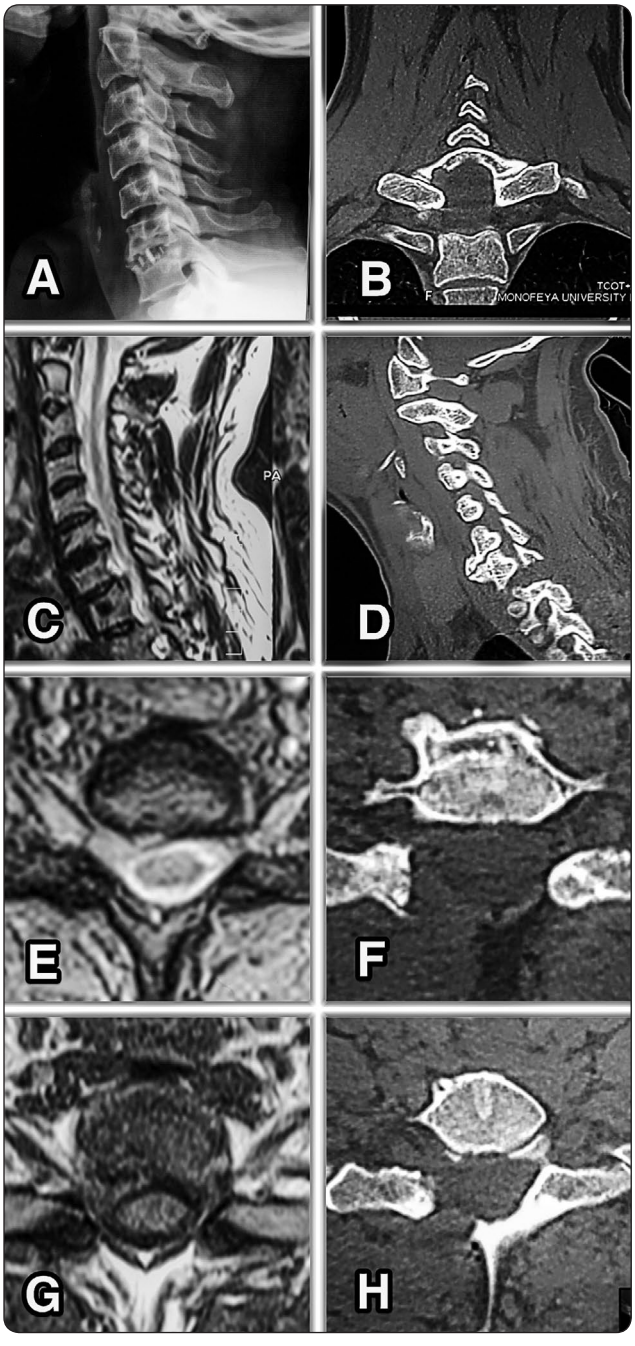

Figure 1. A forty-two years old man presented by C7/D1 right brachialgia since 4 months. He had C6/7 ACDF 3 years earlier. He had posterior cervical keyhole foraminotomy with excellent outcome. Preoperative images (Left column, A,C,E,G), plain X ray and MRI images showing D7/T1 right foraminal disc fragment. Postoperative images (Right column, B,D,F,H) showing the right D7/T1 wide foraminotomy with removal of part of the lamina and medial facet and preservation of the lateral half of the facet.

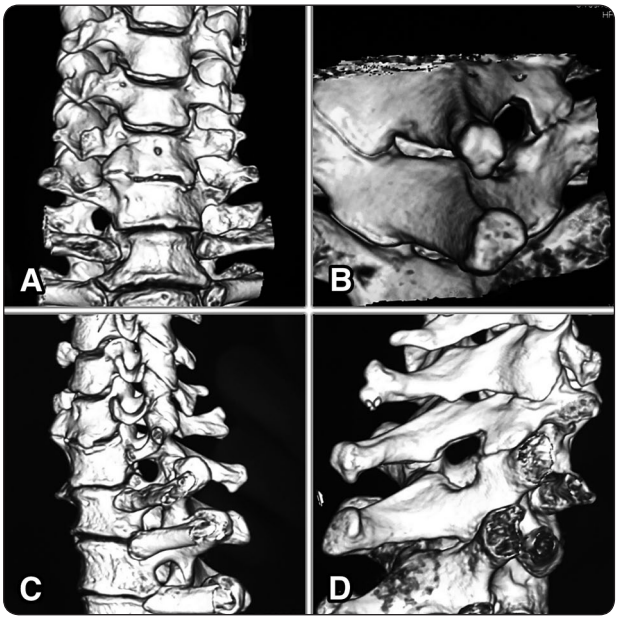

Figure 2. Postoperative 3D CT-scan multiple reformats (A,B,C,D) of the same patient showing wide foraminotomy and decompression and foraminal decompression.

Discussion

In this study we tried to show that posterior cervical keyhole foraminotomy surgery can lead to excellent results for recurrent or residual radiculopathy, regardless of whether the cause was residual or recurrent disc disease.

Although we initially hypothesized that ACDF surgery would be less likely to lead to disc residual after primary surgery because of adequate exposure of the entire disc perimeter, and recurrence is usually related to de novo adjacent segment disease. Our results showed that the use of an ACDF, may lead to fewer postoperative residual disc materials. These results indicate that the surgeon's judgment and experience and adequate foraminotomy may have more to do with the extent of cure than the use of an anterior approach versus a posterior approach. Our surgical philosophy of wide posterior foraminotomy and removal of disc material when indicated can improve the extent of cure of pain. Only the medially located disc material was a barrier to complete disc removal, which follows with our general surgical philosophy of excluding patients with medially located disc material without risking permanent damage to the spinal cord. Central canal compromise that cannot be reached through a posterior keyhole foraminotomy can be more safely addressed with anterior revision of the ACDF or posterior laminectomy for multiple level pathology.[8,18,32,41] More aggressive attempts at resecting medially located disc material are associated with higher morbidity.[34]

We have also found that recurrent radiculopathy due to disc disease at the index level is more commonly a residual stenosis rather than a true disc recurrence, which was more common at fresh level. The most common cause is failure to adequately open the whole unco-vertebral joint and inadequate anterior foraminotomy.[3] Inherent in the posterior cervical keyhole foraminotomy approach is a wider foraminotomy since we remove both the inferior and superior facet bone to expose the nerve root without the need for medially retracting the dura. This aspect of the approach and technique may lead to adequate foraminotomy and enables direct removal of disc fragment causing root compression. Moreover, as also reported by others[4,16,20,21,44] the posterior decompression is effective even in patients with hard disc where keyhole wide foraminotomy adequately decompresses the nerve root without the need to remove the disc material or enter the disc space (Figure 2). Early direct root exposure may ease disc fragment removal compared with the more limited late decompression provided after anterior discectomy and removal of uncovertebral joint. Such technique of anterior decompression may also lead to increased residual posterior to uncovertebral junction after ACDF compared with posterior cervical keyhole foraminotomy. This finding was noticed by Bommireddy et al,[2] who reported that foraminal narrowing persisted in 66% of the first post-operative scans and did not resolve in the follow-up scans up to 6 months. Witzmann et al,[44] also emphasized the benefit of posterior cervical keyhole foraminotomy approach for removing disc fragment from lateral recess without the need for anterior cervical discectomy.

Perhaps the more surprising finding is the frequency of a residual compression at the index level (10 patients) than a new recurrence at the adjacent level (9 patients). One might suppose that this represents a higher percentage of inadequately

decompressed nerve roots. This explains the significantly shorter duration from prior surgery in the residual group than the group with new level affection (4 months versus 45 months respectively).

Despite the fact that anatomy is altered in patients of recurrence by scar tissue and bodies attempts at healing, the clinical outcome is comparable to the primary outcome for ACDF and posterior cervical keyhole foraminotomy.[1,4,6,10,12,16,17,20,21,24,28,29,34,43-46] This is because the intervening imaging shows the location of the residual disc or compression that was missed in the first operation. This knowledge is essential for the second operation, regardless of whether the posterior cervical keyhole foraminotomy or ACDF is used. In such situation the posterior approach has the advantage of fresh surgical field without the need to go through scar tissue. The development and use of minimally invasive instruments further facilitates and improves the outcome of posterior cervical keyhole foraminotomy.[7,11,14,25,30]

Our results were generally satisfactory (85.7%), although there were no significant relations with other variables. It was noticed that the three patients with unsatisfactory outcome had their pathology at the same level of prior disease and failed to improve after the first surgery which could be explained by nerve root permanent injury and scaring. Factors that may affect clinical outcome of recurrent or persistent radiculopathy after repeated surgeries either ACDF or posterior cervical keyhole foraminotomy may need to be explored in future studies.

Re-operations, in general, carry a higher complication rate than first time operations for all surgical interventions based on the body's natural ability to heal by scar formation.[15,16,34,35] Our data shows that re-operations do not appear to carry a higher rate of complications than first time operations.

Limitations:

Being a retrospective study, most of the data were acquired by chart review. Also, these patients are only those recurrences that were brought to us hence; the overall percent of patients requiring re-operation cannot be determined. The details of the primary surgery are insufficient so we cannot make any conclusions regarding the first surgery.

Conclusion

Microscopic posterior cervical keyhole foraminotomy with or without discectomy is a safe and effective procedure in the treatment of recurrent or residual cervical radiculopathy following prior anterior cervical discectomy and fusion.

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الملخص العربي

توسيع مخرج الجزور العصبية العنقية لعلاج اعتلال الجزور العصبية في المرضي الذين أجري لهم مسبقا التحام الفقرات من الأمام

البيانات الخلفية: اعتلال الجذور العصبية العنقية بعد استئصال الغضروف العنقي من الأمام قد ينجم عن الضغط المتبقي بعد الجراحة الأولى أو تكون ضغط جديد على نفس المستوى أو مستوى مجاور وقد يحتاج المريض إلى علاج الأعراض المتكررة أو المتبقية عن طريق العلاج التحفظي أو الجراحي.

الغرض: وصف النتائج الجراحية للثقبة العنقية الخلفية مع توسيع مخرج ومجري الجذر العصبي العنقي مع أو بدون استئصال الغضروف في الحالات التي تم لها سابقا استئصال الغضروف العنقي وعمل التحام بين الفقرات من الأمام.

تصميم الدراسة: قمنا بدراسة المرضى الذين يعانون من اعتلال الجذور العصبية المتبقية أو المتكررة بعد استئصال الغضروف العنقي وعمل التحام بين الفقرات من الأمام والذين تم معالجتهم بعمل ثقبة عنقية خلفية مع توسيع مخرج ومجري الجذر العصبي العنقي مع أو بدون استئصال الغضروف. تم تقييم الحالات باستخدام المقياس البصري للألم وتقييم مضاعفات ما بعد الجراحة.

المرضى والطرق: تم استبعاد الحالات التي تعاني من ضيق القناة العصبية المركزي من سلسلتنا مع ملاحظة موقع تكرار المرض والنتيجة بعد الجراحة.

النتائج: أجريت الدراسة علي واحد وعشرون مريضا تم إجراء 24 ثقبة عنقية خلفية في الفترة من 2013 إلى 2016 . وكانت النتائج ممتازة أو جيدة في 85 % من الحالات بدون أي وفيات أو تدهور في الوظائف العصبية وبدون ارتجاع للأعراض.

الاستنتاج: الثقبة الجراحية الخلفية للفقرات العنقية عن طريق المجهر الجراحي مع أو بدون استئصال الغضروف العنقي فعالة للغاية في علاج اعتلال الجذور العصبية المتكررة في الحالات التي تم لها سابقا استئصال الغضروف العنقي وعمل التحام بين الفقرات.