

Evaluation of Posterior Endoscopic Cervical Foraminotomy and Discectomy: Preliminary Study of 16 Consecutive Patients with Cervical Radiculopathy

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ABSTRACT

Objectives: to evaluate posterior endoscopic cervical foraminotomy and discectomy (PECF,D) as a new minimally invasive technique for isolated radiculopathy. **Methods:** From January 2004 to December 2007 a prospective study was carried out according to inclusion and exclusion criteria for evaluation of posterior endoscopic cervical foraminotomy and discectomy (PECF, D) in isolated radiculopathy due to either unilateral foraminal stenosis, osteophyte or disc. The study included 16 patients (9 males, and 7 females). Age ranged between 27–52 years (mean 42.8 years). Preoperatively, all patients underwent static and dynamic plain X-rays and MRI on cervical spine. Postoperatively, all patients underwent static and dynamic plain X-rays and MRI or 3 D-CT on cervical spine. Patients were routinely evaluated at 1 week, 2 weeks, 4 weeks, 3 months, 6 months, and 1 year. Follow up period ranged between 6–48 months. **Results:** All patients (n=16) reported neck and radicular pain. Nine patients observed radicular weakness and only one patient had quadriplegia due to large lateral disc. Twenty surgical levels in 16 patients (4 patients had 2 levels) were operated upon. The most affected levels were recorded in C5-6, and C6-7 in 8 patients (40%) for each. Posterior endoscopic cervical discectomy (PECD) was carried out in 12 patients and lasted 90-120 minutes, while only foraminotomy (PECF) in 4 patients and lasted 60-90 minutes. Vertical skin incision was used in 11 patients, while transverse skin incision in 5 patients. A minimal amount of blood loss was observed in all patients (20-50 cc). Complete resolution of radicular pain was observed in 12 patients (75%), while 3 patients (18.8%) experienced infrequent paresthesia. Only one patient (6.2%) reported unchanged radicular pain, resulted from residual disc fragment, however, patient was lost in follow up. Of 10 patients presented with motor deficit, 8 patients (80%) experienced immediate post operative complete motor recovery, while one patient (10%) reported delayed (after 1 week) complete motor recovery. One patient (10%) presented with quadriplegia due to large lateral disc, reported deterioration of motor deficit. One patient underwent further anterior cervical plate. Two patients recorded intraoperative durotomy but without CSF leak. All patients were discharged from hospital after 1-1.5 days without neck collar. They returned to moderate activity after 7-10 days, while to normal activity after 30-45 days (n= 14). Follow up period ranged between 6–48 months. The study revealed that 11 patients (68.8%) reported excellent results, while 3 patients (18.8%) showed infrequent paresthesia, with Complete resolution of motor deficit and returned to normal work. **Conclusion:** PECF, D is a safe efficacious technique in relieving root compression due to isolated disc, osteophyte, or foraminal stenosis with less tissue destruction. It obviates the need of implant fixation, and preserves the motion segment resulting in rapid recovery and early return to normal activities and work.

Key Words: posterior endoscopic cervical foraminotomy and discectomy (PECF,D), minimally invasive spine technique, isolated radiculopathy, unilateral foraminal stenosis, osteophyte or disc.

INTRODUCTION

The use of anterior techniques in the surgical management of cervical disc disease has become the standard after Cloward, Bailey, and Robinson in the late 1950s,^(1-4,26). Consequently, anterior cervical decompression should be followed by fusion which is further affect the motion segment at that level, and increase the risk of adjacent-level degenerative changes^(13,18).

The concept of foraminotomy with or without discectomy had been adopted by Scoville and Whitcomb⁽²⁴⁾ and Frykholm⁽¹⁰⁾. Laminoforaminotomy in isolated lateral disc and or osteophyte, reported 93 to 97% success rate^(12,14). However, due to wide incisions and extended paraspinous muscle dissection, post operative neck pain and neck muscle spasm was reported resulting in slower enthusiasm towards this approach. Many refinements have resulted in a smaller incision, improved percutaneous access, enhanced microscopic or endoscopic visualization and significantly

improved hemostasis, have been reported good results^(9,23).

PATIENTS & METHODS

From January 2004 to December 2007 a prospective study was carried out according to inclusion and exclusion criteria (table 2) for evaluation of posterior endoscopic cervical foraminotomy and discectomy PECF,D in isolated radiculopathy due to either unilateral foraminal stenosis, osteophyte or disc. The study included 16 patients (9 males, and 7 females). Age ranged between 27–52 years (mean 42.8 years).

Preoperatively all patients underwent static and dynamic plain X-rays and MRI on cervical spine. Postoperatively, all patients underwent static and dynamic plain X-rays and MRI or 3 D CT on cervical spine. Patients were routinely evaluated at 1 week, 2 weeks, 4 weeks, 3 months, 6 months, and 1 year. Follow up period ranged between 6 – 48 months.

Table 1. The distribution of age, sex and follow up duration

Age	27-52 y
Males	9
Females	7
FU	6 - 48 m

Table 2. The Inclusion and Exclusion Criteria for 16 patients with isolated radiculopathy

Inclusion Criteria	Exclusion Criteria
Unil radiculopathy	kyphosis
Unil disc	Myelopathy
Unil osteophyte	OPL L
Unil foraminal stenosis	central stenosis
	Infection
	Tumor
	Instability

Operative Technique

Under general endotracheal anesthesia patients were positioned prone on chest rolls and the head was fixed with a Mayfield head holder (Figure 1). A vertical skin incision was initially made 1 cm off midline, 18mm long at the required level (transverse skin incision was used in the last 5 cases).



Figure (1): Under general endotracheal anesthesia patients were positioned prone on chest rolls

Under fluoroscopy control, a spinal needle was inserted through the skin down to the facet of the required level. We stopped use the guide wire or 1st dilator (5.3mm) to avoid dura puncture. The cervical fascia was incised with a sharp scissors without cutting muscle fibers to avoid unnecessary blood loss. Application of the sequential dilators followed by tubular retractor (18-mm) was then inserted under control of fluoroscopy (Figure 2). A flexible retractor affixed the tubular retractor to the operating table side rail and locked in position at the junction of the lamina and lateral mass on the interlaminar space. Then introduction of endoscope through the working channel, adjusting the image and orientation of anatomy was carried out.



Figure (2): Identification of the level was carried out under fluoroscopy

A bipolar, cautery was then used to remove the remaining muscle and soft tissue overlying the lateral mass and facet. An imaginary quadrangle must be followed in consequence; the inferior limb is the upper border of the lower lamina, the lateral limb is the root foramina and the lateral mass, the superior limb is the lower border of the upper lamina, and the medial limb is the lateral surface of the base of the spinous process. A small, angled Kerrison (1mm, 40°, up) was then used to begin the foraminotomy. Smooth dissection of ligamentum flavum and dura from the bone helps to prevent incidental dural tears. Epidural veins bleeding was controlled by using long-tipped bipolar cautery. Using Kerrison (2mm, 40°, up) for thinning out the medial facet and lateral mass until the proximal part of the nerve root became clear.

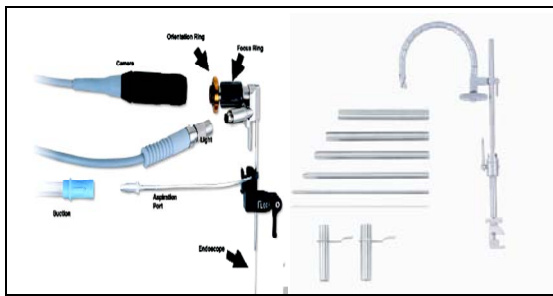


Figure (3): The spinal endoscopy system includes the endoscope, the camera, the light cable, the holder, and the sequential dilators.



Figure (4): The Spinal endoscopic instruments on the table include kerrisons, curettes, and disc rongeurs

Using Penfield dissector to mobilize the nerve root superiorly to expose the disc space and then the disc fragment was removed in a standard manner with curettes and disc rongeur. When, osteophyte was encountered, it was decompressed by using Kerrison (2mm, 40° up) and curettes. At the end, exploration of the nerve root with nerve hook, and good hemostasis was carried out. A small piece of gel-foam was gently placed over the laminoforaminotomy defect. The tubular retractor and endoscope were then removed. The fascia and subcutaneous tissue were sutured with 2 stitches. The skin was sutured with subcuticular sutures. No drain or hard collar were used. Patients were discharged from hospital after 1–1.5 days.

RESULTS

All patients (n=16) reported neck and radicular pain .Nine patients observed radicular weakness and only one patient reported quadriparesis due to large lateral disc (table 3).

Table (3): The distribution of clinical presentation of 16 consecutive patients

C/P	Patients
Neck Pain	16
Radiculopathy	16
Radiculomyelopathy	9
Quadriparesis	1

Twenty Surgical levels in 16 patients (4 patients had 2 levels) were operated upon. The most affected levels were recorded in C5-6, C6-7 in 8 patients (40%) for each (table 4). Posterior endoscopic cervical discectomy (PECD) was carried out in 12 patients and lasted 90-120

minutes, while foraminotomy (PECF) in 4 patients and lasted 60-90 minutes. Vertical skin incision was used in 11 patients, while transverse skin incision in 5 patients with a minimal amount of blood loss was observed in all patients (20-50 cc) (table 5).

Table (4): Demonstration of the different surgical levels

Levels	No	%
C4-5	4	20%
C5-6	8	40%
C6-7	8	40%
Total	20	
2 levels	4	20%

Table (5): Demonstration of the surgical procedures, duration and type of skin incision

Procedures	Patients	Duration
PECD	12	90 – 120 min
PECF	4	60 – 90 min
Transverse incision	5	
Vertical incision	11	

Complete resolution of radicular pain was observed in 12 patients (75%), while 3 patients (18.8%) experienced infrequent parasthesia. Only one patient (6.2%) reported unchanged radicular pain, resulted from residual disc fragment, however, patient was lost in follow up. (table 6). Off 10 patients presented with motor

deficit, 8 patients (80%) experienced immediate post operative complete motor recovery, while one patient (10%) reported delayed complete motor recovery (after 1 week). One patient (10%) presented with quadriparesis due to large lateral disc, reported deterioration of motor deficit (table 7).

Table (6): Outcome of postoperative pain after PECF,D procedures

Outcome of pain	Patients	%
Infrequent parasthesia	3	18.8%
Complete Resolution	12	75 %
Unchanged pain	1	6.2%

Table (7): Outcome of the motor deficit after PECF,D procedures

Outcome of motor deficit	Patients	%
Delayed complete motor recovery	1	10%
Immediate complete motor recovery	8	80%
Deterioration of motor deficit	1	10%
New motor deficit	0	
Total	10	

Complications

One patient (diabetic, hypertensive) who underwent posterior endoscopic cervical discectomy (PECD) was exposed to neck trauma, and developed post traumatic facet fracture, underwent further surgery in the form of anterior cervical plate. One patient reported temporary weakness, which recovered completely after 1 week. One patient presented with quadriparesis resulted from large lateral disc, reported deteriorated motor power postoperatively. Two

patients recorded intraoperative durotomy but without CSF leak. One patient reported unchanged radicular pain, resulted from residual disc fragment, however, patient was lost in follow up. Neither infection nor recurrence was recorded (table 8). All patients were discharged from hospital after 1-1.5 days without neck collar. They returned to moderate activity after 7-10 days, while to normal activity after 30-45 days (n= 14) (table 9).

Table (8): Distribution of complications after PECF,D procedures

Complications	Patients
Traumatic facet fracture	1
Permanent Weakness	1
Temporary weakness	1
Durotomy	2
CSF leak	0
Infection	0
Recurrence	0
Residual disc	1

Table (9): The demonstration of duration of hospital stay and return to work after PECF, D procedures

Hospital stay	1-1.5 days
Return work	n=14
-Moderate activity	7-10 days
-Normal activity	30-45 days

Outcome

Patients were routinely evaluated at 1 week, 2 weeks, 4 weeks, 3 months, 6 months, and 1 year. Follow up period ranged between 6–48 months. The study revealed that 11 patients (68.8%) reported excellent results, while 3 patients (18.8%) showed infrequent parasthesia, with complete resolution of motor deficit and returned to normal

work. Only one patient (6.2%) reported unchanged radicular pain, resulted from residual disc fragment, however, patient was lost in follow up. One patient (6.2%) presented with quadriparesis due to large lateral disc, reported poor outcome due to deterioration of motor deficit (table 10).

Table (10): The overall outcome of 16 patients presented with isolated radiculopathy and underwent PECF, D procedures

Outcome	Patients	%
Excellent Complete resolution of pain Complete resolution of motor deficit Normal mobility Return to normal work and activities	11	68.8 %
Good Infrequent paresthesia Complete resolution of motor deficit Normal mobility Return to normal work	3	18.8 %
Fair Persistant pain or Persistent motor deficit Unable to return to work	1	6.2 %
Poor Unresolved / increased pain Unresolved / increased motor deficit Unable to return to work	1	6.2 %
Total	16	100 %

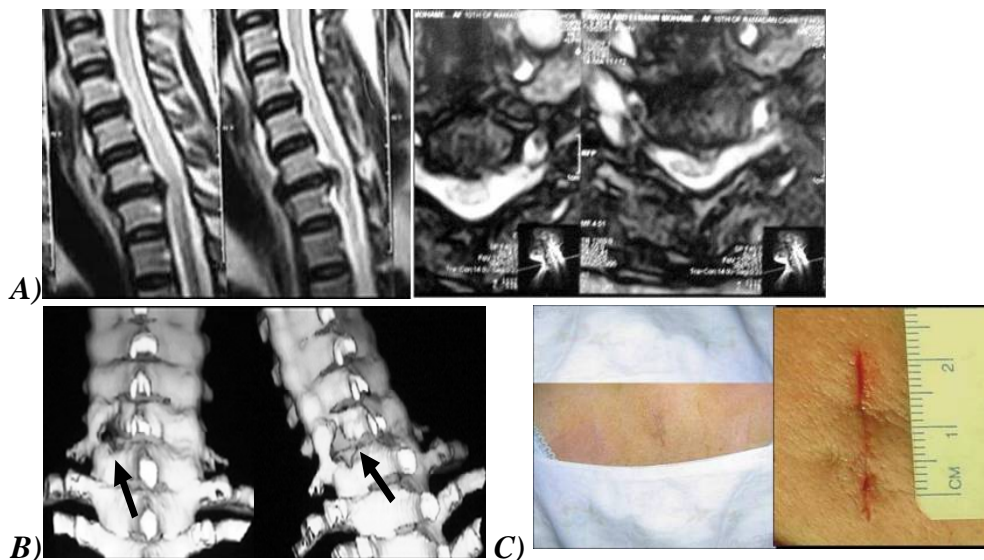


Figure (5): A) preoperative MRI shows lateral disc C6-7. B) 3D-CT scan shows the site of foraminotomy and intact facets and joints. C) A small vertical skin incision (2cm)



Figure (6): A) preoperative MRI shows C5-6, C6-7 lateral discs. B) postoperative MRI shows 2 levels endoscopic discectomies. C) postoperative plain X-rays reveal intact stability and the site of foraminotomies

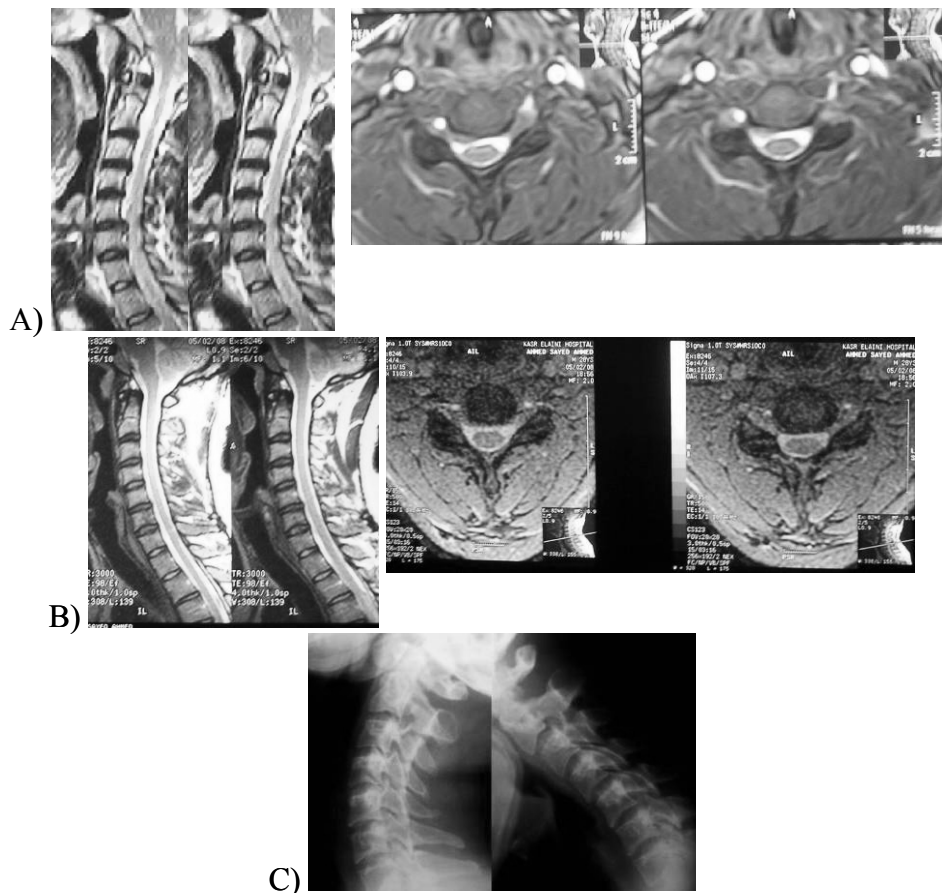


Figure (7): A) preoperative MRI reveals C5-6 lateral disc. B) postoperative MRI reveals free root at C5-6. C) postoperative dynamic x-rays shows intact stability

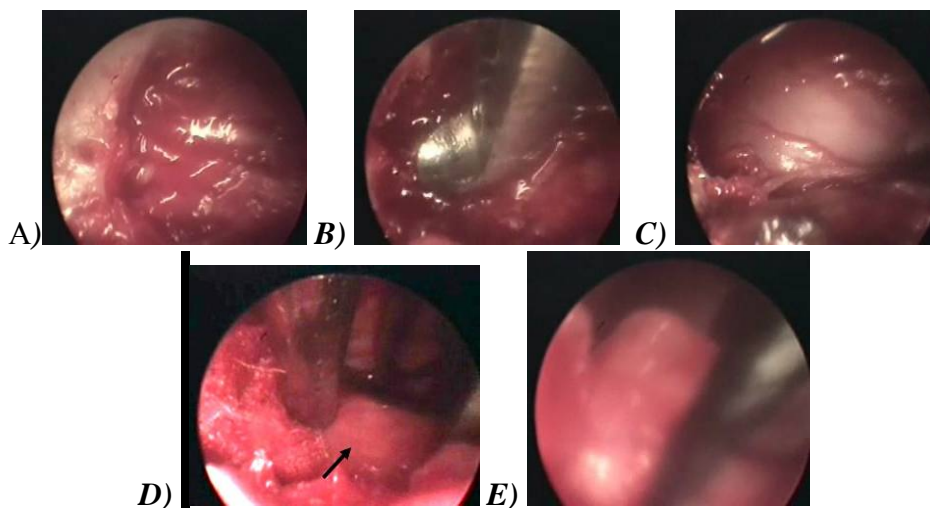


Figure (8): Intra-operative endoscopic pictures
 A) lower border of superior lamina and interlaminar space with ligamentum flavum. B) using Kerrison for laminoforaminotomy. C) clear dura after removing ligamentum flavum. D) identification of disc. E) removal of disc material

DISCUSSION

Through the last four decades, many studies have been published on posterior cervical laminoforaminotomy for isolated radiculopathy^(1,10,12,14,15,21,24,30).

Because of wide extended muscle dissection, and high incidence of cord injury, the popularity of laminoforaminotomy has been tempered by the limited surgical view, and the difficulty in resecting osteophytes^(8,15).

After Cloward, Bailey, and Robinson in the late 1950s^(1-4,26), many surgeons shifted to anterior cervical approaches as it became the standard in the surgical management of cervical disc disease. Consequently, anterior decompression should be followed by fusion which is further affect the motion segment at that level, and increased risk of adjacent level degenerative changes^(5,13,18).

More recent refinements introduce the concept of "keyhole" via endoscope^(9,23). It offers adequate foraminal exposure without destroying the facet joint⁽²⁰⁾ removing less than 50% of the facets keeping the biomechanics of the cervical spine intact^(20,22). It may provide better exposure for decompression of the exiting root and for removal of lateral osteophytes and discs⁽²³⁾. The endoscopy overcomes a limited surgical view, difficulty in resecting osteophytes, and limited visualization of the distal foramen⁽²³⁾. However, endoscopic cervical foraminotomy obviates the need for implant fusion with less cost effect^(13,18). Although the standard anterior cervical approach reports the risks of injury to the anterior structures of the neck, including the trachea, esophagus,

thyroid, thymus, carotid arteries, jugular veins, vagus nerve, recurrent laryngeal nerve, superior laryngeal nerve, ansa cervicalis, and thoracic duct, it is not a significant comparison as it is rarely reported. However, there is no statistically significant difference in results between anterior and posterior approaches for the management of isolated cervical radiculopathy⁽⁷⁾. Consequently, avoiding arthrodesis when possible seems particularly prudent to avoid the increased incidence of adjacent-level problems after cervical fusion^(13,18).

Posterior cervical foraminotomy is preferred in cases of isolated radiculopathy due to posterolateral disc herniation, osteophyte, focal lateral thickening of the ligamentum flavum, or facet arthropathy. The foraminotomy technique is not the ideal procedure for cases of myelopathy, central or paracentral stenosis, deformity, or instability.

In a comparison study between endoscopic and open posterior cervical foraminotomy validation studies demonstrated that the average vertical and transverse diameters of the laminotomy defect were essentially identical for both the open and the endoscopic groups. The average proportion of facet removal and length of nerve root decompression was actually greater in the endoscopic groups than the open decompressions.⁽²³⁾

Although our study represents a preliminary reports of an early clinical experience with PECFD technique, the results are comparable to those have been reported in literatures.^(1,7,8,12,14,16,19,22,27,29,30)

We reported 80% of operated levels were at C5-6 and C6-7 which is comparable to Henderson et al.⁽¹²⁾ of 85% at C5-6 and C6-7 out of 846

cases of lateral disc herniation and Krupp et al.⁽¹⁴⁾ 89%. The mean age of our study group was 42.8 years, which was less than that seen in other series, including that of Henderson et al.⁽¹²⁾ and Krupp et al.⁽¹⁴⁾ (mean age = 48 years) and Woertgen et al. (mean age = 46 years)⁽²⁹⁾.

Our patients reported excellent to good results in 87.6% better than have been recorded by Raaf⁽¹⁹⁾ (85% improvement) and by Murphey et al.⁽¹⁶⁾ (80% reduction of preoperative symptoms) but less than Scoville et al.⁽²⁵⁾, (95%, excellent to good results) Krupp et al.⁽¹⁴⁾ (98% improvement) and Odom et al.⁽¹⁷⁾ (94% improvement), while Tomaras et al.⁽²⁷⁾ reported successful outpatient surgical treatment in 200 patients with limited muscle dissection posterior foraminotomy.

We reported complete motor recovery in 9 patients (90%) while complete resolution of radicular pain was observed in 12 patients (75%). and infrequent parasthesia in 3 patients (18.8%). However, through the era of the microscope Henderson et al.⁽¹²⁾ reported 96% postoperative pain relief. One patient (10%) presented with quadriparesis due to large lateral disc, reported deterioration of motor deficit. After this patient we don't recommend PECD for patients with myelopathy even due to lateral disc.

Fessler and Khoo⁽⁹⁾ published a comparative study between endoscopic (25 patients) and open cervical laminoforaminotomy techniques (26 patients) for unilateral cervical root compression from either foraminal stenosis or disc herniation. In endoscopic group they reported symptomatic improvement for approximately 87 to 92% of different symptoms, complete resolution of radiculopathy in 54%, versus 48%,

improvement of radiculopathy in 38%, versus 40%, and unchanged in 8% of cases versus 12 % in open group. However, the follow-up of the endoscopic group (range, 1.5–12 mo), was shorter than open group (range, 9–33 mo). They recorded a shorter postoperative stay for endoscopic group (20 hours versus 68 hours), and needed fewer narcotics.

Our patients were discharged after 1-1.5 days and were followed up for 6-48 months. In series of 53 patients Aldrich⁽¹⁾ reported a mean postoperative stay of 2 days, while Woertgen et al.⁽²⁹⁾ reported a longer stay of 9 days in series of 54 patients. In contrast, Henderson et al.⁽¹²⁾, they routinely discharged their patients on the 5th postoperative day.

We encountered transient weakness in 1 patient recovered completely after 1 week. Deterioration of motor deficit occurred in 1 patient presented with quadriparesis due to large lateral disc. We experienced intraoperative durotomy in 2 patients but without postoperative CSF leak, as we stopped use the guide wire and the 1st dilator (5.3mm) in our procedure. Durotomy and CSF leak was reported as 2-9 % in literatures^(10,16,17,19,22,25).

We recognized that PECD, D is a safe efficacious technique in relieving root compression due to isolated disc, osteophyte, or foraminal stenosis with less tissue destruction. It obviates the need of implant fixation, preserving the motion segment resulting in rapid recovery and early return to normal activities and work. This comes in agreement to Davis, Gore, Henderson, Krupp, Odom, Scoville, White, Woertgen and Zeidman conclusions^(6,11,12,14,17,25,28,29,30)

CONCLUSIONS

PECF, D is a safe efficacious technique in relieving root compression due to isolated disc, osteophyte, or foraminal stenosis with less tissue destruction. It obviates the need of implant fixation, preserving the motion segment resulting in rapid recovery and early return to normal activities and work. Although this preliminary study was small, its demographic and clinical profile was comparable to the published data in literatures. A larger series and randomized study in comparison to anterior cervical techniques are mandatory.

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