Case Report

Minimal Invasive Posterior Cervical Laminoforaminotomy for Treatment of Degenerative Cervical Radiculopathy: A Technical Report and Review of the Literatures

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Posterior cervical laminoforaminotomy is a surgical procedure used for treating cervical radiculopathy. The procedure with its minimally invasive, non-fusion surgical technique has gained much in popularity over recent years. The aims of the present study were to reveal indications, contraindications, surgical technique, clinical results, and complications of posterior cervical foraminotomy for treating degenerative cervical radiculopathy.

Keywords: Minimal invasive, Laminotomy, Foraminotomy, Cervical, Radiculopathy

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Cervical radiculopathy may be caused by several pathologies, most being cervical disc herniation and osteophyte formation. Symptoms consist of radicular pain, sensory deficit, motor weakness, and/or diminish reflex. Most patients can be treated conservatively, however five to ten percent require operative treatment ranging from decompression alone (anterior cervical foraminotomy/discectomy, posterior cervical foraminotomy), decompression, and artificial disc replacement to anterior cervical discectomy and fusion [ACDF].

Although ACDF is popular among surgeons, there are still some concerns about the procedure. There are risks of injury to the anterior cervical structure such as esophagus, trachea, carotid artery, recurrent laryngeal nerve, and sympathetic plexus. The risk of dysphagia after anterior surgery was reported in up to 50 percent. In addition, the fusion procedure causes loss of cervical range of motion and creates stress to the nearby cervical level. The adjacent segment degeneration was reported at around 3% per year after fusion surgery[1].

Posterior cervical foraminotomy was first described in the 1940s[2] (ten years prior to ACDF development). Previously, it seemed to be less popular compared to ACDF technique. However, the procedure with its minimally invasive surgical technique for posterior foraminotomy has gained much in popularity over recent years. Although there is no accepted definition of minimally invasive spine surgery, the general principle includes small incision and less soft tissue damage. The goals are to reduce post-operative pain, shorten hospitalization and promote quicker return to work/daily life. Several studies showed equivalent clinical results between minimally invasive and open surgery; however, minimally invasive surgery revealed less pain and a more rapid recovery rate[3,4]. Minimally invasive posterior cervical foraminotomy was designed with a paramedian approach through tubular retractor via muscle splitting. The procedure is done via microscopic or endoscopic assisted techniques.

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Indication[5]

- Cervical radiculopathy caused by foraminal stenosis associated with soft disc herniation or osteophyte formation in case of unremitted pain, even full conservative treatment or progressive neurodeficit especially motor weakness
- Persistent or recurrent radiculopathy after anterior cervical surgery
- Cervicothoracic disc herniation
- Cervical disc disease in patients for whom anterior approaches are relatively contraindicated

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(anterior neck infection, tracheostomy, prior irradiation)

Contraindication

- Myelopathy
- Central or paracentral stenosis secondary to a soft disc or osteophytic origin
- Deformity or instability

Advantages

- Direct visualized cervical nerve root
- Non-fusion technique
- No need for instrumentation
- Avoid injury to anterior cervical structure
- No need for post-operative immobilization
- With minimally invasive technique: early recovery, short hospitalization

Disadvantages

- Iatrogenic instability if more than 50% of facet joint is removed
- Difficult to access anterior pathology: to remove the herniated disc anteriorly, traction force would be applied to the nerve root

Surgical technique

Positioning

There are two types of positioning, prone and sitting position. The procedure is usually carried out in the prone position to avoid risk of air embolism and ischemic complications. The head is secured by Mayfield or Gardner well tong and the neck is positioned 20 to 30 degrees of flexion to open the interlamina space and open up the facet joint. The table is then adjusted to the reverse Trendelenburg position to decrease bleeding from engorged epidural vein. The adhesive tape is applied to the shoulder and back for increased radiographic visualization and to decrease skin folds. Finally, prepping, draping and sterilization techniques are done.

Incision and approach

The fluoroscopic radiographic image is used to confirm the surgical level. The longitudinal incision, approximately 2 to 3 centimeters, is located about 1.5 centimeters off the midline on the operated side. The K-wire is inserted under fluoroscopic guide to the lamino-facet junction of the operated level. Tubular dilators are serially inserted to dilate muscles to the periphery. The final tubular retractor, about 22 millimeters, is inserted and secured to the operation table.

Lamino-foraminotomy

Under microscopic visualization, the medial facet/interlaminar apex junction is identified. Partial laminotomy and foraminotomy are performed with high speed drill. Care is taken not to remove more than 50% facet joint because it might cause iatrogenic instability[6,7]. The soft disc sequestration can be removed with small rongeur, suction, or nerve hook after retracting nerve root to the cephalad or caudad.

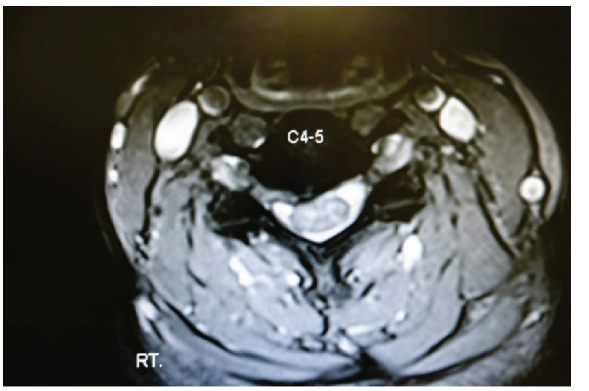

Figure 1. MRI: left foraminal stenosis from cervical disc herniation.

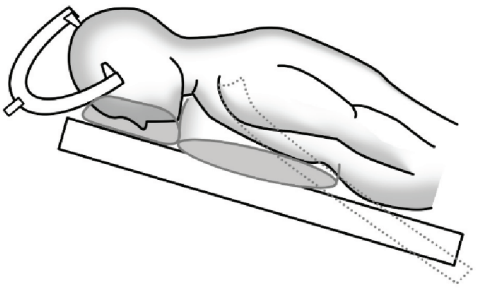

Figure 2. Positioning: prone.

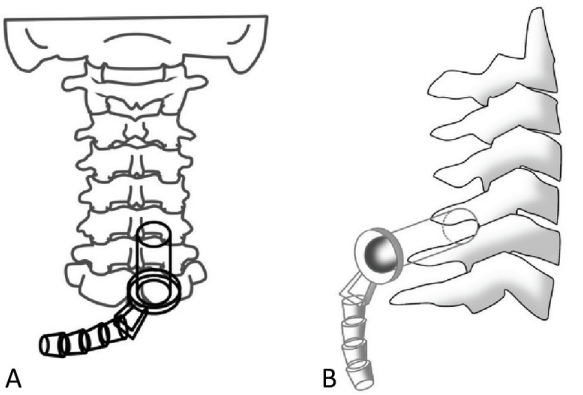

Figure 3. Minimal invasive approach via tubular retractor (A: anteroposterior view, B: lateral view).

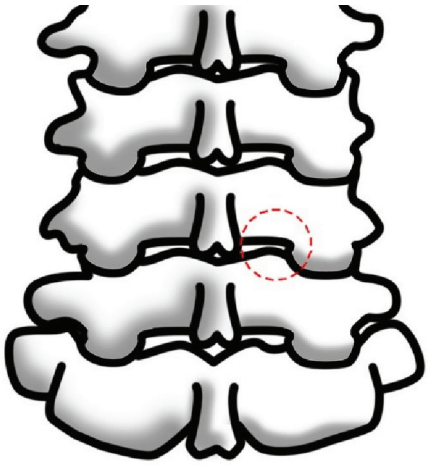

Figure 4. Area of the bone to be removed.

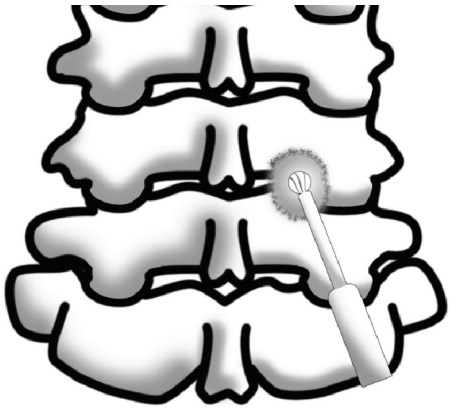

Figure 5. Foraminotomy are performed by high speed drill under microscopic visualization.

Hemostasis

The perineural venous plexus surrounding the nerve root can cause bleeding. This may require bipolar cauterization or Gelfoam hemostasis. This step is especially important to avoid postoperative drainage tube.

Closure

Tight closure is done with multiple layers non-absorbable suture.

Post-operative care

Patients are permitted to ambulate as soon as they recover from dizziness from the anesthetic drug. They usually stay at the hospital overnight. A soft collar is worn for comfort in the first few weeks. Neck motion exercise and rehabilitation can begin as soon as the surgical pain subsides.

Results

There are several reports about clinical results of posterior cervical foraminotomy (open and minimal invasive) for cervical radiculopathy as shown in Table 1. Most showed more than 90% favorable outcomes. Variation of results may come from difference in definitions of favorable outcome results. Jagannathan et al[8] reported long-term results of more than five years. One hundred sixty-two patients were collected and found over 95% improvement in terms of radiculopathy. A recent report by Bydon et al[9] in 2014, studied 151 patients. There were 9.9% reoperation rate (6.6% at the same level and 3.3% at another levels) within the average 2.4 years after posterior cervical foraminotomy. The reoperation rate was 24.3% in the patients with follow-up period of more than 10 years. Patients with preoperative neck pain had higher reoperation rate after foraminotomy.

Clark et al[10] compared minimally invasive versus open posterior cervical foraminotomy by systematic review method. The present study included 19 publications. The results showed that a minimally invasive percutaneous approach had lower blood loss by 120.7 ml (52.8 ml versus 173.5 ml), shorter operative time by 50 minutes (58.3 minutes versus 108.3 minutes), less analgesic use by 25.1 (2.5 Eq versus 27.6 Eq), and shorter hospitalization by 2.2 days (1.0 day versus 3.2 days) when compared to open approach. Kim and Kim[4] reported results of a randomized controlled study [RCTs] that compared tubular retractor assisted (22 patients) and opened posterior foraminotomy (19 patients). They found that the tubular retractor assisted group resulted in smaller skin incision, shorter hospitalization, less analgesic used and lower post-operative neck pain in the first four weeks after surgery. Surgical outcomes were not different between the two groups. Larger, well designed RCTs are needed to evaluate which approach yields better results.

Complications

The complication rate of posterior foraminotomy is approximately 5% as shown in Table 1. Most are minor complications including superficial wound abscess and controllable dural tear. The most common neurologic complication is transient nerve root palsy that usually recovers in six days[11]. C5 nerve root is most commonly affected. The rare and more serious complications include excessive blood loss, particularly in obese patients with prone position. The

Table 1. Outcome and complication of posterior cervical foraminotomy

Author	Journal, year	No. of cases	Follow-up (months)	Outcome improvement	Recurrence	Complication
Woertgen, et al.[13]	Neurosurgery, 1997	51	12	94%	NR	4% - 2 dural tear
Silveri, et al.[14]	Orthopedics, 1997	60	73	98%	NR	1% - 1 suture abscess
Witzman, et al.[12]	Neurosurgical Review, 2000	67	19	93%	NR	1.5% - 1 wound dehiscence
Grieve, et al.[7]	Neurosurgery, 2000	63	40	85%	NR	1% - 1 nerve root damage
Fessler and Khoo[3]	Neurosurgery, 2002	51	16	92% radiculopathy 87% neck pain 88% radiculopathy 89% neck pain	NR	6% - 2 dural tear treated with lumbar drain - 1 partial thickness dural tear
Jödicke, et al.[15]	Surgical Neurology, 2003	39	33	96% (six weeks) 85% (long-term)	15%	15% - 2 transiently paresis - 1 dural tear - 2 residual radicular irritation - 1 fracture of lateral process of T1
Jagannathan, et al.[8]	Journal of Neurosurgery Spine, 2009	162	77	95% radiculopathy	NR	NR
Kim, et al.[4]	Journal of Korean Medical Science, 2009	22	33	86.4%	NR	0%
Lidar, et al.[16]	Journal of Spinal Disorders and Techniques, 2011	32	39	100% weakness 84% sensory	NR	6.2% - 1 dural tear - 1 persistent neck pain
Skovrlj, et al.[17]	Spine, 2014	70	32	Improve NDI and VAS score	5.3%	4.3% - 1 dural tear - 1 wound hematoma - 1 radiculitis
Bydon, et al.[9]	Journal of Neurosurgery Spine, 2014	151	50	85% radiculopathy	6.6%	NR

NDI = neck disability index; VAS = visual analogue scale; NR = not reported

sitting position increases the risk of air embolism[12] and stroke caused by hypotension. Spinal cord injury and vertebral artery injury occur rarely.

Recurrence of radiculopathy at the level of surgery may occur as the result of incomplete decompression or progression of the degeneration. Several series reported various recurrence rates according to follow up period as shown in Table 1. Approximately 2% to 5% per year recurrence rate were found. This number is most likely the same as adjacent segment degeneration after anterior fusion procedure.

Conclusion

Posterior cervical foraminotomy is a long standing surgical procedure used for treating cervical radi culopathy. The main advantages are its non-fusion technique, no requirement for instrumentation and avoidance of injury risk to the anterior cervical structures. With this minimally invasive technique using tubular retractor, the procedure could be done with smaller surgical wound, less blood loss, less surgical time, and shorter hospital stay. Highly favorable outcomes (more than 90%) were reported. Most complication rates are minor and resolvable. It is reasonable to select this procedure for treating cervical radiculopathy in appropriate patients.

What is already known on this topic?

Posterior laminoforaminotomy is a procedure to decompress cervical nerve root. It has been done for couple decades using standard open technique. Several studies showed its effectiveness to relief arm pain and radiculopathy. However, using standard open technique, there were complications with posterior cervical muscle damage and more post-operative neck pain comparing with ACDF. Recently, the minimal invasive technique (minimal invasive laminoforaminotomy) procedure has gained popularity. However, there are some debate and variation about its indications, contraindications, surgical techniques, clinical results, and complications of the posterior minimal invasive cervical laminoforaminotomy.

What this study adds?

The authors analyzed and recommended the indication, contraindications and preferred surgical technique according to the previous evidences as well as our experience for this procedure. We also reviewed the update evidences in term of surgical outcomes and complication rates of laminoforaminotomy. The authors hope that the present article would give information (pros and cons) for surgeons to choose the minimal invasive laminoforaminotomy as a non-fusion, minimal invasive procedure to treat cervical radiculopathy.

Potential conflicts of interest

The authors declare no conflict of interest.

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