Pain Ther
https://doi.org/10.1007/s40122-024-00607-4

CASE REPORT

Percutaneous Foraminal Neuroplasty Using Reference Spinal Needles: Technical Description

Victor M. Silva-Ortiz · Alaa Abd-Elsayed · Jesus Medina-Razcon · Christopher L. Robinson

Received: March 1, 2024 / Accepted: April 17, 2024

ABSTRACT

***Background*:** Lumbar foraminal stenosis is a common cause of chronic lower back pain and radiculopathy often treated by epidural steroid injections. In the absence of imaging findings with a positive physical exam demonstrating symptoms, percutaneous neuroplasty (PNP) may be an alternative to transforaminal epidural steroid injections that have otherwise failed.

***Case Presentation*:** We present two cases (55-year-old man and 65-year-old woman) with chronic low back pain and radiculopathy with otherwise normal imaging demonstrating no lumbar foraminal stenosis refractory to transforaminal epidural steroid injections. PNP was performed using reference spinal needles with both patients achieving sustained > 50–75% pain relief.

***Conclusion*:** PNP offers interventional chronic pain physicians and patients with refractory chronic low back pain with lumbar radiculopathy due to fibrosis an alternative, safe treatment that offers sustained results. Furthermore, this is the first of its kind to offer a step-by-step procedural step of PNP using a reference spinal needle.

Keywords: Foraminal stenosis; Foraminal neuroplasty; Case series; Chronic axial back pain; Lumbar radiculopathy

V. M. Silva-Ortiz
Pain Management Department, Hospital Zambrano Hellion, Tecnologico de Monterrey, Escuela de Medicina y Ciencias de la Salud, San Pedro Garza Garcia, NL, Mexico

V. M. Silva-Ortiz (✉)
Pain Management Center, Centro Medico Zambrano Hellion, Monterrey, Av. Batallón de San Patricio 112, Real San Agustín, 66278 San Pedro Garza García, Mexico
e-mail: drvictorsilva@gmail.com

A. Abd-Elsayed
Department of Anesthesiology, University of Wisconsin School of Medicine and Public Health, Madison, WI, USA

J. Medina-Razcon
Medina Medical Specialties, Mexicali, BC, Mexico

C. L. Robinson
Department of Anesthesiology, Critical Care, and Pain Medicine, Harvard Medical School-Beth Israel Deaconess Medical Center, Boston, MA, USA

Published online: 15 May 2024

Key Summary Points

Why carry out this study?

Lumbar foraminal stenosis is a spinal pathology that leads to chronic low back pain and radiculopathy that significantly affects quality of life, is an often unrecognized condition, and accounts for approximately 60% of failed back surgeries.

Currently, there are few studies on the foraminal neuroplasty technique and none explain how to advance a neuroplasty catheter into the affected foramen.

What was learned from the study?

In this study we propose a step-by-step technique to perform a percutaneous foraminal neuroplasty guided by a reference spinal needle, to be more accurate and trying to avoid risks to damage the foraminal vessels and the exiting nerve root.

This foraminal neuroplasty technique offers an alternative with good and sustained results to treat patients with foraminal stenosis who do not respond adequately to pharmacological and interventional treatment such as foraminal steroid injection.

INTRODUCTION

Lumbar foraminal stenosis (LFS) is spinal pathology that leads to chronic lumbar back pain and radiculopathy significantly affecting the quality of life of those affected [1, 2]. As the foramen narrows, the affected nerve becomes compressed leading to the characteristic exacerbation of the lumbar radicular pain with lumbar extension. Causes of LFS include, but are not limited to, facet joint hypertrophy, vertebral endplate spurs, synovial cysts, decreased disc height or herniation, cephalic subluxation of the superior articular process of the lower vertebra, and hypertrophy of the ligamentum flavum [1, 2]. The prevalence of LFS is 8–11%, and it is believed that 60% of cases of post-laminectomy syndrome are due to the misdiagnosis of lumbar foraminal stenosis prior to surgery [3].

The lumbar intervertebral foramen is a space that contains the nerve root and the dorsal root ganglion, which are surrounded by epidural fat and vessels [2]. These two structures are primarily found in the anterior and superior region of the foramen and can occupy up to 30% of the total foraminal area [2]. The foramen is subdivided into three zones: the lateral recess and foraminal and the extraforaminal zone. The foramen has an area of 40–160 mm^2 and the foraminal height varies depending on the lumbar segment ranging from 20 to 23 mm. When the foraminal height measures ≤ 15 mm or the posterior height of the intervertebral disc is ≤ 4 mm on MRI, the diagnosis of LFS can be made [4, 5].

Percutaneous neuroplasty (PNP), also known as epidural adhesiolysis, is a procedure that aims to release or eliminate barriers, in this case series, fibrosis, that prevent the proper deposition of medications in the structures that are believed to be the source of pain [5]. PNP is achieved with the combination of mechanical release with a reinforced catheter and through injection of substances to achieve hydrodissection of the structures, separating them and subsequently depositing the medications to the target area [5]. In cases of LFS, one of the techniques that can be offered to patients suffering from LFS is a selective PNP to the affected foramen, also known as foraminal PNP.

Ethics committee approval was not required for this study. This study was conducted in accordance with the principles outlined in the Helsinki Declaration of 1964 and its later amendments, and informed consent was obtained from all individual participants included in the study.

TECHNIQUE

A reference spinal or guidance needle can be used as a guide to improve the precision and success of the foraminal PNP. Furthermore, it allows for the interventional pain physician to add a third dimension, depth, to the two-dimensional fluoroscopic foraminal PNP. To perform the

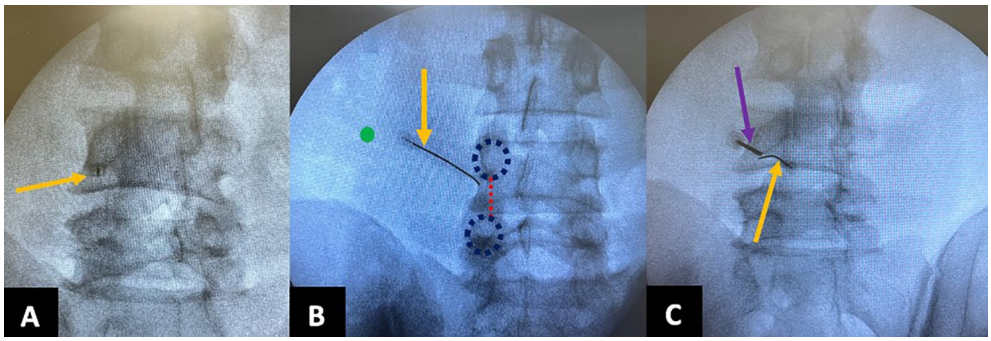

Fig. 1 Anteroposterior radiographs of initial foraminal access. **A** Initial foraminal access with the reference spinal needle in tunnel view (yellow arrow). **B** Neuroplasty epidural needle entry point (green dot), previously placed reference needle (yellow arrow), pedicles (dotted circles), and 6 o'clock limit at the foraminal level (dotted red line). **C** Epidural neuroplasty needle (purple arrow) heading toward the reference needle (yellow arrow)

foraminal PNP, identify the site where it is most likely that the foramen will allow the access to the catheter. Moreover, review the magnetic resonance imaging (MRI) in the sagittal, parasagittal, and axial views at the foraminal level and plan the advance of the catheter towards the narrow foramen. Our initial target to place the reference needle will be where the catheter can be advanced toward the foramen, placing it near the foramen. Take care not to advance to the anterior part of the foramen, where foraminal vessels can be found, especially in the superior and anterior foraminal portion. Of note, the lower in the foramen the needle is placed, the less likely these vessels are to be found [6]. However, care must be taken to avoid contacting the intervertebral disc at the most anterior aspect of the foramen.

Once the guide needle is placed in the planned location, the entry site of the Tuohy needle will be marked with the fluoroscopy image, approximately 4–5 cm lateral and 1.5–2 cm superior to the guide needle in order to advance the catheter from cephalad to caudad and lateral to medial and to be able to place the catheter between the nerve root and the intervertebral disc (Figs. 1, 2). In cases of foraminal PNP at the level of L5, the access may sometimes need to be higher if the iliac crest is elevated, as the height of the access point is influenced by the height of the iliac crest.

The foramen and the lateral recess are the targets of this technique, located just in front of

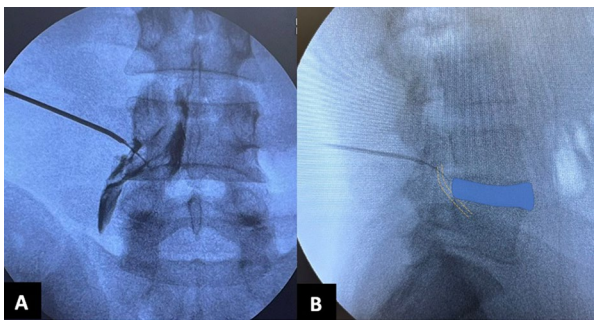

Fig. 2 Anteroposterior and lateral radiographs of neuroplasty catheter placement in the PNP procedure. **A** Neuroplasty catheter placement via foraminal access (AP view). **B** Neuroplasty catheter posterior to the disc and anterior to the nerve root (lateral view)

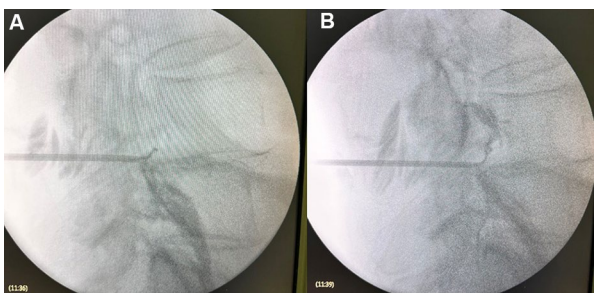

Fig. 3 Epidurograms in lateral view before (**A**) and after accessing (**B**) the foramen with a neuroplasty catheter observing the correct filling of the filling defect

the nerve root and posterior to the disc, in the anterior epidural space, and can be confirmed with an epidurogram (Fig. 3). Once the catheter has been placed, back and forth movements are made with the catheter with the intention of mechanically releasing the adhesions, and subsequently, creating space in the narrow area to inject the medications to treat the narrow foramen.

CASE 1

The patient is a 55-year-old man with a history of chronic lower back pain with lumbar radiculopathy in the L4–L5 distribution for 2 years duration. The patient reported a pain score on the visual analog scale of 8 out of 10. The patient's past surgical history is notable for a L4–L5 discectomy. Physical exam demonstrated a left straight leg rise test without paravertebral pain. Moreover, the patient failed conservative medical management with physical therapy and rehabilitation, buprenorphine patch (10 µg/h), gabapentin (200 mg every 12 h). The patient also has had minimal efficacy with pregabalin 75 mg twice a day and tramadol 75 mg as a rescue medication. A PNP foraminal neuroplasty was discussed with the patient and patient agreed to processed with the procedure.

For the procedure, the patient received 1.5 mg of midazolam and 75 µg of fentanyl intravenously for sedation and pain. Initially, the procedure was performed via the caudal approach. However, the neuroplasty catheter (Axon) was unable to be advanced to the L4–5 target because of excessive fibrosis in the area due to prior discectomy. Initially, a reference 22G spinal needle was used with an infrapedicular, supraneural access towards the foramen, which will later be used as a guide for the more lateral and superior transforaminal access with the neuroplasty needle and catheter (Axon); once the catheter was placed in the correct position, forward and backward movements were made with the catheter with the intention of making space for the medication that would be injected later, and an epidurogram was performed which demonstrated the correct distribution lateral recess. At the foraminal level, 4 mL of 0.9% saline was injected along with 8 mg dexamethasone and 2 mL of 1% lidocaine. Immediately after the procedure, the patient's VAS score was 2/10, at 1 month it was 3/10, at 3 months it was 2/10, at 6 months it was 3/10. Of note the patient had a reduction in his pregabalin to 75 mg once a day and tramadol to 37.5 mg when needed. Additionally, there were no complications with the procedure.

CASE 2

The patient is a 65-year-old woman with a history of L4–5 spondylolisthesis and chronic axial lower back pain axial with lumbar radiculopathy of several years' duration. The patient reported a VAS pain score of 8/10, and she reported minimal efficacy with conservative management including pregabalin 75 mg twice a day and tramadol 200 mg daily. The patient was offered a PNP foraminal neuroplasty.

For the procedure, the patient received 1 mg of midazolam and 50 µg of fentanyl intravenously for sedation and pain. The PNP foraminal neuroplasty was performed in the caudal approach with a neuroplasty catheter. Under fluoroscopy, a filling defect was noted at the left L4–5 foramen and lateral recess. Once the filling defect is identified, we take it as a target to perform a foraminal neuroplasty. With a 22G spinal needle as a reference directed towards the anatomical area that had previously been identified through MRI where it would be most likely to advance the neuroplasty catheter, subsequently, the reference needle served as a guide to access the foramen and advance the neuroplasty catheter (Axon) and perform forward and backward movements. A new epidurogram is then performed, revealing improved filling at the foraminal, extraforaminal, and lateral recess sites compared to the previous examination. Immediately after the procedure, the patient's VAS score was 3/10, at 1 month it was 3/10, at 3 months it was 3/10, at 6 months it was 3/10.

DISCUSSION

In patients with chronic radicular pain, with or without axial pain, transforaminal epidural steroid injection (TFESI) has been a common treatment. However, the beneficial effect may only last a short time or may not be as effective potentially as a result of epidural/foraminal adhesions that prevent the medication from reaching the affected area in an optimal way. In these cases, an alternative treatment option may be PNP.

One of the key targets when performing PNP is the peridural membrane (PM), a thin, well-innervated structure between dura mater and the wall of the spinal canal. Fibrosis of the PM can be a possible cause of low back pain when other causes of facetogenic or discogenic pain have been ruled out [7, 8]. The level of evidence (LOE) for PNP varies for conditions being treated such as spinal stenosis (LOE II), lumbar disc herniation (2), and post-laminectomy syndrome (I) [9–11]. PNP also offers an alternative treatment modality when traditional methods such as transforaminal epidural steroid injections have failed because of fibrosis [12].

In PNP, the epidurogram plays a vital role given its correlation with the patient's clinical condition and offers additional information unavailable from MRI such as when there is chronic lower back pain with or without radicular pain in the absence of central canal or foraminal stenosis on MRI [13, 14]. Whereas, the epidurogram allows for visualization via a filling defect in the presence of fibrosis, which may be causing the compression.

Four different approaches, all equal in effectiveness, have been described for PNP, with the classic and first approach via the sacral hiatus and others being via the S1 foramen, interlaminar, and transforaminal [15, 16]. The choice of approach depends on the feasibility of the target or if one approach does not allow access when tried. Of note, stenosis of both the foramen and central canal can be present and prevent movement of the catheter from the midline to the foramen because of the central canal stenosis. In these instances, foraminal access as the initial step may be indicated.

The reference needles help guide our final epidural needle towards the target, adding a third dimension (depth) to a fluoroscopy-guided procedure, which is inherently two-dimensional. This depth dimension provided by the reference spinal needle allows us to tailor our approaches according to the patient's needs, directing them towards the affected area or the region most likely accessible with the neuroplasty catheter. Ultimately, access to the foramen is achieved with the catheter, not the epidural needle, making the approach safer.

It is important to note that the utilization of reference needles for controlling depth in fluoroscopy-guided procedures extends beyond foraminal neuroplasty cases. It could also be applicable in procedures utilizing non-coaxial or non-tunnel vision approaches. This broadens the scope for exploring various procedures and expands the potential applications of this technique.

Limitations

This technique was meticulously developed to provide a systematic approach for conducting foraminal neuroplasty based on the affected or narrowed area, and its preliminary findings show promise. However, further research is needed to establish the effectiveness of this technique relative to existing methodologies and technology.

Furthermore, a critical aspect of this manuscript pertains to the absence of a control group utilizing an alternative technique, coupled with the relatively limited number of enrolled patients. Considering that participants are aware of receiving a more targeted therapy, the potential influence of a placebo effect must be acknowledged.

CONCLUSION

Here, we present for the first time the step-by-step protocol for PNP using a reference spinal needle to guide the interventional pain physician in a safe and practical manner. We discuss

two cases with imaging that does not demonstrate central canal or foraminal stenosis or have failed treatment with transforaminal epidural steroid injections and achieved sustained pain relief with PNP. We add to the expanding literature demonstrating the efficacy of PNP offering interventional pain physicians another option for management of chronic lower back pain with or without radiculopathy caused by fibrosis.

Author Contributions. Study conception and design: Victor M Silva-Ortiz. Data collection Victor M Silva-Ortiz, Alaa Abd-Elsayed, Jesus Medina-Razcon, Christopher L. Robinson. Analysis and interpretation of results: Victor M Silva-Ortiz, Alaa Abd-Elsayed, Jesus Medina-Razcon, Christopher L. Robinson. Draft manuscript preparation: Victor M Silva-Ortiz, Alaa Abd-Elsayed, Jesus Medina-Razcon, Christopher L. Robinson. All authors reviewed the results and approved the final version of the manuscript.

Funding. The authors have not declared a specific grant for this research from any funding agency in the public, commercial or not-for-profit sectors. No funding or sponsorship was received for this study or publication of this article.

Declarations

Conflict of Interest. Victor M Silva-Ortiz is a consultant and reports personal fees from Axon Productos Medicos. Alaa Abd-Elsayed is editorial board member for Springer Nature and was not involved in the selection of peer reviewers for the manuscript nor any of the subsequent editorial decisions. Jesus Medina-Razcon and Christopher L. Robinson have nothing to disclose.

Ethical Approval. Ethics committee approval was not required for this study. This study was conducted in accordance with the principles outlined in the Helsinki Declaration of 1964 and its later amendments, and informed consent was obtained from all individual participants included in the study.

REFERENCES

1. Choi YK. Lumbar foraminal neuropathy: an update on non-surgical management. Korean J Pain. 2019;32(3):147. https://doi.org/10.3344/KJP.2019.32.3.147.

2. Hasegawa T, An HS, Haughton VM, Nowicki BH. Lumbar foraminal stenosis: critical heights of the intervertebral discs and foramina. A cryomicrotome study in cadavera. J Bone Joint Surg Am. 1995;77(1):32–38.

3. Orita S, Inage K, Eguchi Y, et al. Lumbar foraminal stenosis, the hidden stenosis including at L5/S1. Eur J Orthop Surg Traumatol. 2016;26(7):685–93. https://doi.org/10.1007/S00590-016-1806-7.

4. Jenis LG, An HS. Spine update. Lumbar foraminal stenosis. Spine (Phila Pa 1976). 2000;25(3):389–94. https://doi.org/10.1097/00007632-200002010-00022.

5. Manchikanti L, Nick Knezevic N, Navani A, et al. Epidural guidelines epidural interventions in the management of chronic spinal pain: American Society of Interventional Pain Physicians (ASIPP) comprehensive evidence-based guidelines. http://www.painphysicianjournal.com. Accessed Jan 9, 2024.

6. Murthy NS, Maus TP, Behrns CL. Intraforaminal location of the great anterior radiculomedullary artery (artery of Adamkiewicz): a retrospective

review. Pain Med. 2010;11(12):1756–64. https://doi.org/10.1111/J.1526-4637.2010.00948.X.

7. Ansari S, Heavner JE, McConnell DJ, Azari H, Bosscher HA. The peridural membrane of the spinal canal: a critical review. Pain Pract. 2012;12(4):315–25. https://doi.org/10.1111/J.1533-2500.2011.00510.X.

8. Bosscher HA, Heavner JE, Grozdanov P, Warraich IA, Wachtel MS, Dertien J. The peridural membrane of the human spine is well innervated. Anat Rec (Hoboken). 2016;299(4):484–91. https://doi.org/10.1002/AR.23315.

9. Manchikanti L, Drive L, Knezevic NN, et al. Systematic review effectiveness of percutaneous adhesiolysis in managing chronic central lumbar spinal stenosis: a systematic review and meta-analysis. http://www.painphysicianjournal.com. Accessed Jan 10, 2024.

10. Manchikanti L, Drive L, Soin A, et al. Systematic review effectiveness of percutaneous adhesiolysis in post lumbar surgery syndrome: a systematic analysis of findings of systematic reviews. http://www.painphysicianjournal.com. Accessed Jan 10, 2024.

11 Manchikanti L, Knezevic E, Knezevic NN, et al. The role of percutaneous neurolysis in lumbar disc herniation: systematic review and meta-analysis. Korean J Pain. 2021. https://doi.org/10.3344/KJP.2021.34.3.346.

12. Hong Park C, Park CH, Ho Lee S. Prospective evaluation effectiveness of percutaneous transforaminal adhesiolysis in patients with lumbar neuroforaminal spinal stenosis. http://www.painphysicianjournal.com. Accessed Jan 10, 2024.

13. Kim DH, Ji GY, Kwon HJ, et al. Contrast dispersion on epidurography may be associated with clinical outcomes after percutaneous epidural neuroplasty using an inflatable balloon catheter. Pain Med. 2020;21(4):677–85. https://doi.org/10.1093/PM/PNZ225.

14. Kim JH, Jung HJ, Nahm FS, Lee PB. Does improvement in epidurography following percutaneous epidural neuroplasty correspond to patient outcome? Pain Pract. 2015;15(5):407–13. https://doi.org/10.1111/PAPR.12197.

15 Kim CS, Moon YJ, Kim JW, et al. Transforaminal epidural balloon adhesiolysis via a contralateral interlaminar retrograde foraminal approach: a retrospective analysis and technical considerations. J Clin Med. 2020. https://doi.org/10.3390/JCM9040981.

16. Salem HH, Akbas M, Elawamy AR, Fouad AZ, Abbas NA, Dagistan G. Comparison of 3 approaches to percutaneous epidural adhesiolysis and neuroplasty in post lumbar surgery syndrome. http://www.painphysicianjournal.com. Accessed Jan 10, 2024.