Percutaneous Full Endoscopic Posterior Decompression for Revision of Lumbar Spinal Dynamic Stabilization

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Technical note

Keywords: Transforaminal percutaneous endoscopic, Lateral stenosis, Recurrent herniation

Posted Date: August 30th, 2021

DOI: https://doi.org/10.21203/rs.3.rs-795033/v1

Abstract

Objective: The objective of this article was to analysis the efficacy of percutaneous full endoscopic posterior decompression for revision of lumbar spinal dynamic stabilization.

Methods: Twenty consecutive patients with failed lumbar spinal dynamic stabilization presenting with leg pain that had supporting imaging diagnosis of lateral stenosis and /or residual / recurrent disc herniation, or whose pain complaint was supported by relief from diagnostic and therapeutic injections, were offered percutaneous transforaminal endoscopic discectomy and foraminoplasty over a repeat open procedure. Each patient sought consultation following a transient successful, partially successful or unsuccessful open lumbar spinal dynamic stabilization surgery for disc herniation or spinal stenosis. Endoscopic foraminoplasty was also performed to either decompress the bony foramen for foraminal stenosis, or foraminoplasty to allow for endoscopic visual examination of the affected traversing and exiting nerve roots in the axilla. The average follow up time was, average 37.9 months, minimum 24 months. Outcome data at each visit included Macnab, VAS and ODI.

Results: The average leg Visual Analog Scale improved from 8.9 ± 2.6 to 1.08± 0.7 ($p < 0.005$). Fifteen patients had excellent outcomes, four had good outcomes, one had fair outcomes, and no had poor outcomes, according to the Macnab criteria (Table 2). Nineteen of 20 patients had excellent or good outcomes, for an overall success rate of 95%. No patients required reoperation. There were no incidental durotomies, infections, vascular or visceral injuries. They were also relieved to be able to avoid "open" decompression.

Conclusion: The transforaminal endoscopic approach is effective for failed lumbar spinal dynamic stabilization surgery due to residual/recurrent nucleus pulposus and lateral stenosis. Failed initial index surgery may involve failure to recognize patho-anatomy in the axilla of the foramen housing the traversing and the exiting nerve. The transforaminal endoscopic approach effectively decompresses the foramen and does not further destabilize the spine needing stabilization. It also avoids going through the previous surgical site.

Introduction

In recent years, non fusion dynamic stabilization system has been used in the treatment of degenerative lumbar diseases. Some studies have shown good clinical and radiological results. Although theoretically superior to rigid fixation, the long-term effect of non-fusion dynamic stability is still controversial. With the increase of the number of lumbar dynamic stabilization surgery, especially in elderly patients with a variety of diseases, it is the best way for doctors to develop new minimally invasive strategies in revision

The most effective treatment for patients with low back and leg pain after dynamic stabilization of lumbar non-fusion depends on the accurate and precise judgment of pathological physiology and anatomical pathological characteristics.Due to detailed medical history, physical examination, imaging examination, psychological evaluation and diagnostic puncture, more than 90% of patients can be diagnosed at one time.(1) More accurate diagnosis, including nerve block, may be needed to determine where the pain comes from and why the pain persists.

The most common diagnoses are foraminal stenosis, discogenic pain and recurrent disc herniation. Once the etiology is determined, multidisciplinary treatment is the most effective. Therapists should use specific diagnostic methods, including pain block or joint injection, to try to determine the specific site of pain; recognizing that additional surgery with shotgun method has a negative impact on prognosis; avoid "exploratory surgery"(2)

The challenge of postoperative pain after lumbar non-fusion dynamic stabilization is to determine the operation time and how to complete the operation. Repeated interlaminar approach may have several limitations. One reason for the failure of the first operation is "root compression syndrome" and arachnoiditis, which may be limited or insufficient inter-laminar exposure. Even if it is fully exposed to the lamina, it is difficult to stop bleeding if the patient's posture is not performed before operation. Bleeding can blur the operative region and the surgeon’s vision and deal with immediate problems.

The current study evaluated 20 consecutive patients with low back and leg pain after lumbar non-fusion dynamic surgery. The patient only needs decompression and does not need stability. All operations were performed by operators proficient in percutaneous transforaminal endoscopic discectomy and decompression in a operation center. Percutaneous endoscopic discectomy is performed via a visual approach.

Method

Patient Population

With the approval of the institutional review committee, 20 consecutive patients who failed lumbar dynamic stabilization surgery were included in the study from January 2016 to June 2019. There were 7 male and 13 female. The mean age at the beginning of diagnosis and treatment was 40.2 years (range 32–65 years). All patients who failed lumbar dynamic stabilization surgery received non-steroidal anti-inflammatory drugs and steroids combined with bed rest. The symptoms did not improve after 6 months of treatment. The average follow-up time during the study period was at least 24 months, with an average of 37.9 months. All patients received percutaneous endoscopic discectomy, including 3 cases of L3-L4 segment, 12 cases of L4-L5 segment and 5 cases of L5-S1 segment(Table 1).

Preoperative

All patients with pain after lumbar dynamic surgery underwent percutaneous endoscopic discectomy. All patients underwent lumbar preoperative magnetic resonance imaging (MRI) and computed tomography (CT). Plain film (anterior and posterior lateral position) was performed before and 1 year after operation. Clinical outcome data (back and leg visual analogue scale [VAS] and macnab criteria) were collected preoperatively and postoperatively (6 weeks, 6 months and 12 months). The clinical evaluation data of exercise intensity (grade 0–5), touch, pain, reflex and proprioception were collected. All operations were performed by the same doctor in the same unit. Local anesthesia was used. Patients are told that they may feel discomfort and pain during the operation. Transparent operating table and C-arm X-ray were used. Prepare 3000 ml of normal saline and 0.5 mg of adrenaline solution for continuous intraoperative flushing through endoscope.

Operative

All patients were placed on the operating bed in the lateral position. The design of the route from the skin to the herniated disc and appropriate patient position are important for clinical effect. All cases were given lidocaine as selective local anesthesia with different concentrations according to the level. Aspiration localization was determined based on pathological level; for example, when performing an operation at the L4-5 level, the entering point should be 11 to 13 cm from the posterior midline at the L4 spinous process level. Under direct fluoroscopic visualization, a #16 spinal needle is used to infiltrate the local anesthetic to the facet joint, such that the spinal needle is left in place as a guide. The correct position of the needle tip is confirmed using both anteroposterior and lateral projections. The needle is parallel to the disc space, midway between the endplates, proximal to annulus, with the tip lateral to the medial border of the pedicles. A 3- to 5-mm stab incision is made at the entry site of the needle. A hemostat is used to dilate a tract through the lumbodorsal fascia. The flexible trocar is then placed through the tract adjacent and parallel to the spinal needle (double- needle technique). The correct position of the trocar is confirmed using fluoroscopy, and the spinal needle is withdrawn. Under continuous fluoroscopic visualization, the flexible trocar is advanced to the posterior central aspect of the disc. The outer cannula with dilator is then advanced down the trocar to the annular wall. The dilator is removed and the irrigation/aspiration cannula is advanced 1 to 2 mm against the annular wall as the 3.0-mm trephine is introduced and advanced to create the annulotomy. A working tube which the diameter was 7.5 mm was inserted into the target disc tissue, and an endoscope was placed in the working one. Various tissues were identified under continuous irrigation, and partial decompression was performed. The residual nucleus pulposus was found, and the exiting nerve root was protected. The nerve root was fended off with the working tube. The nerve root was explored and released. Finally, ablation decompression and annuloplasty were performed using bipolar radiofrequency (Figs. 1, 2).

All patients were placed on the operating table in a lateral position. The path design from the skin to the herniated disc and the appropriate patient location are very important for clinical results. All cases were given selective local anesthesia with different concentrations of lidocaine. The suction site was determined according to the pathological level. For example, when performing surgery at the L4-5 segment, the entry point should be 11 to 13 cm from the posterior midline of the L4 spinous process segment. Under direct fluoroscopy, a #16 spinal needle is used to penetrate the local anesthetic into the facet so that the spinal needle can remain in place as a guide. The correct position of the needle tip is confirmed by anteroposterior and lateral fluoroscopy. The needle is parallel to the intervertebral disc space, located in the middle between the endplates, close to the intervertebral ring, and the needle tip is located outside the medial edge of the pedicle. Make a 3 to 5 mm puncture incision at the entry site of the needle. The hemostat is used to dilate a passage through the fascia of the low back. The elastic trocar is then passed through the spinal canal adjacent to and parallel to the spinal needle (double needle technique). Use fluoroscopy to confirm the correct position of the trocar and pull out the spinal needle. Under continuous fluoroscopy, the flexible trocar was pushed to the posterior center of the intervertebral disc. Then, the outer sleeve with expander is pushed down the trocar to the annular wall. Remove the expander and push the irrigation / suction sleeve forward 1 to 2 mm against the annular wall, while introducing and pushing the 3.0 mm annular drill to form an annular incision. A working tube with a diameter of 7.5mm was inserted into the target intervertebral disc tissue, and an endoscope was placed in the working tube. Various tissues were identified under continuous flushing and partial decompression was performed. Residual nucleus pulposus was found to protect the existing nerve roots. The nerve root is blocked by the working tube. Nerve roots were explored and released. Finally, bipolar radiofrequency ablation decompression and annuloplasty were performed.

Result

The average leg Visual Analog Scale improved from 8.9 ± 2.6 to 1.08 ± 0.7 ($p < 0.005$). Fifteen patients had excellent outcomes, four had good outcomes, one had fair outcomes, and no had poor outcomes, according to the Macnab criteria (Table 2). Nineteen of 20 patients had excellent or good outcomes, for an overall success rate of 95%. No patients required reoperation. There were no incidental durotomies, infections, vascular or visceral injuries. They were also relieved to be able to avoid "open" decompression.

Discussion

In the past 10 years, the number of lumbar dynamic surgery has increased significantly. Dynamic stabilization without fusion can be advocated to many advantages, with less trauma, short operation time and less bleeding. Considering the year of our case, more and more operations are performed in elderly patients and patients with various diseases, both of which are associated with a higher incidence of complications. In addition, the incidence of complications was positively correlated with the increase of device complexity. In recent years, the number of patients who need to revision surgery is close to 10%. This challenge is exacerbated by the significant increase in the number of complex lumbar dynamic surgery in the elderly(3, 4).

The most effective treatment of patients with low back and leg pain after lumbar dynamic surgery depends on the accurate diagnosis of anatomical and physiological changes. The most common diagnosis is foraminal stenosis, discogenic pain, or recurrent disc herniation. Hypertrophy of the superior articular process of the lower vertebral body leads to compression of the nerve root at the outlet of the lateral foramen, which is a consensus on the causes of nerve root symptoms, especially for patients who have failed previous lumbar dynamic surgery (5). These lesions have characteristic physical manifestations and imaging studies, which can distinguish them from other etiologies of radiculopathy. We propose a lesion-specific, facet-sparing surgical technique (6).

After the first recognition of spinal canal stenosis in 1802, the understanding of spinal canal stenosis gradually formed in the next 150 years. In traditional surgery, lateral canal stenosis is most often missed or undertreated. The structure of the nerve root canal is semi tubular, and the nerve root goes from the sheath to the intervertebral foramen. The proximal part of the nerve root canal, also known as the intervertebral or subarticular part, is limited by the superior articular process and facets on the posterolateral side and by the intervertebral disc on the anterolateral side. The distal end of the nerve root canal is equivalent to the lateral recess, that is, the lateral angle of the pedicle level intervertebral foramen. The inlet and outlet of intervertebral foramen are located at the lateral and medial edges of pedicle. Hypertrophy of the inferior articular process may only lead to stenosis of the central part of the spinal canal. The superior articular process leads to the deformity of the medial, subarticular and lateral parts of the nerve root canal. According to our experience of percutaneous endoscopy through intervertebral foramen, in many cases of failed lumbar dynamic surgery, the lateral recess often leads to residual unrecognized stenosis. Hypertrophy of ligaments or bone in the superior articular process leads to intervertebral foramen stenosis, and any degree or additional disc herniation in the protruding area, including the inflatable ring, can also affect the nerves in the sheath capsule and intervertebral foramen (7–9)

Endoscopic foraminoplasty was performed to either decompress the bony foramen for foraminal stenosis, or to be convenient for endoscopic visual verification of the decompressed exiting and traversing nerve in residual/recurrent patients with continued leg and/ or back pain after lumbar spinal dynamic surgery. The annulus is often inflated and expands with the unloading and loading of spinal segments, resulting in the compression of intervertebral foramen. No foramen nerve from the existing nerve branches was found to come from the dorsal branch. They have a diameter of 1–2 mm, no pain in palpation, and will not cause postoperative sensory disturbance during transection. The nerve walks below the superior articular process along the ligamentum of the intervertebral foramen, which can reduce axial back pain during ablation. However, resection of larger nerves in the foramen may lead to postoperative sensory impairment. At present, we cannot confirm the cause of color vision after operation, because color vision may occur even if the nerve is not affected. We tell the patient that this is a risk that cannot be eliminated. Fortunately, this is usually temporary and can be alleviated by postoperative transforaminal and sympathetic block. The axilla, accessed through foraminoplasty, is the location that is often under appreciated as a area for pathological anatomy causing FBSS. The pathological anatomy is considered as foraminal osteophytosis, foraminal stenosis, compressive foraminal fibrosis, or recurrent or residual patients presenting with back and leg pain.The axilla includes hidden pathoanatomy, such as intervertebral foramen herniation and synovial cyst. The dorsal branch can easily be mistaken for pathological anatomy. In a parallel study of dorsal rhizotomy for axial back pain, it was determined that facet pain was also relieved by dorsal endoscopic (visual) rhizotomy rather than fusion (10–12).

Conclusion

Transforaminal endoscopic surgery is an effective method for the treatment of persistent low back and leg pain due to residual / recurrent nucleus pulposus and foraminal stenosis after lumbar dynamic surgery. Failed index surgery may include failure to identify the patho-anatomy in the axilla of the foramen housing the traversing and the exiting nerve. The transforaminal percutaneous endoscopic approach decompresses the foraminal nerves and does not cause to labilize the spine requiring stabilization. It also avoids passing through the last surgical position.

Abbreviations

1. magnetic resonance imaging (MRI)
2. computed tomography (CT)
3. visual analog scale (VAS)
4. Failed back surgery syndrom (FBSS)
5. The Oswestry Disability Index (ODI)

Declarations

Ethics approval and consent to participate:

Not applicable

Consent for publication:

All authors consent for publication

Availability of data and materials:

All data and materials are available

Competing interests:

Not applicable

Funding:

Not applicable

Authors' contributions:

Changkun zheng: Supervision

Zhong liao: Writing - Original Draf

Weiliang cui: Data analysis

Acknowledgements:

Not applicable

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Tables

Table 1
Characteristics of 20 patients with revision of lumbar spinal fusion surgery.

Characteristic	No. of Patients (%)
Male/female	1:1.85(7/13)
Age	
<40	11 (19)
40–59	7 (56)
>60	2 (25)
Level	
L3-4	3 (15)
L4-5	12(60)
L5-S1	5 (25)
Location of pathology	
Foraminal stenosis	3(15)
Residual disc	14 (70)
Recurrent disc	3 (15)
Location of pain	
Back pain	2 (10)
Back and leg pain	8 (40)
Leg pain	10 (50)

Table 2
Outcome after endoscopic discectomy.

Outcome	No. of Patients (%)
MacNab criteria	
Excellent	15 (75)
Good	4 (20)
Fair	1 (5)
Poor	0 (0)

Figures

Figure 1

Lateral radiograph showing placement of the working tube.

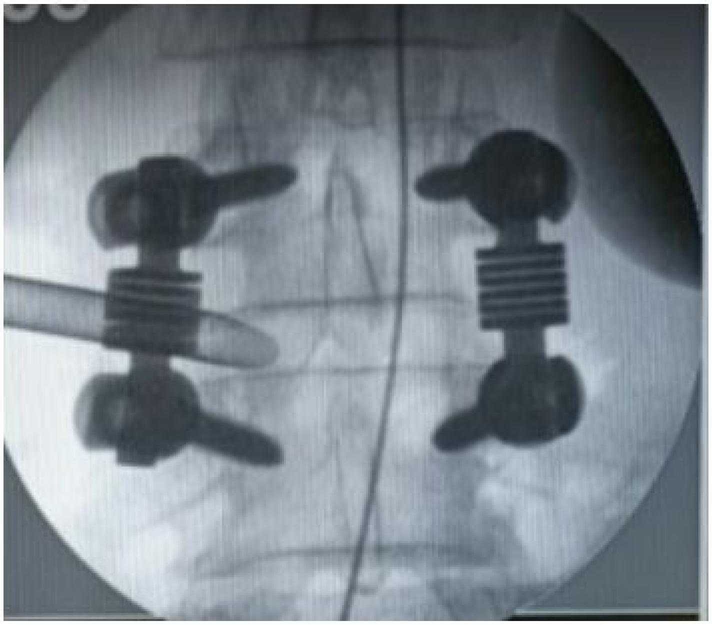

Figure 2

Anterior-posterior fluoroscopic images showing placement of the working tube.