Retrospective Study

Transforaminal Percutaneous Endoscopic Discectomy and Foraminoplasty after Lumbar Spinal Fusion Surgery

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Background: The most common causes of pain following lumbar spinal fusions are residual herniation, or foraminal fibrosis and foraminal stenosis that is ignored, untreated, or undertreated. The original surgeon may advise his patient that nothing more can be done in his opinion that the nerve was visually decompressed by the original surgery. Post-operative imaging or electrophysiological assessment may be inadequate to explain all the reasons for residual or recurrent symptoms. Treatment of failed lumbar spinal fusions by repeat traditional open revision surgery usually incorporates more extensive decompression causing increased instability and back pain. The authors, having limited their practice to endoscopic surgery over the last 10 years, report on their experience gained during that period to relieve pain by transforaminal percutaneous endoscopic revision of lumbar spinal fusions.

Objective: To assess the effectiveness of transforaminal percutaneous endoscopic discectomy and foraminoplasty in patients with pain after lumbar spinal fusion.

Study Design: Retrospective study.

Setting: Inpatient surgery center.

Methods: Sixteen consecutive patients with pain after lumbar spinal fusions presenting with back and leg pain that had supporting imaging diagnosis of foraminal 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 fusions treatment for disc herniation or spinal stenosis. Endoscopic foraminoplasty was also performed to either decompress the bony foramen in the case of foraminal stenosis, or to allow for endoscopic visual examination of the affected traversing and exiting nerve roots in the axilla. The average follow-up time was 30.3 months, minimum 12 months. Outcome data at each visit included MacNab criteria, visual analog scale (VAS), and Oswestry Disability Index (ODI).

Results: The average leg VAS improved from 9.1 ± 2.0 to 2.0 ± 0.8 ($P < 0.005$). Ten patients had excellent outcomes, 5 had good outcomes, one had a fair outcome, and none had poor outcomes, according to the MacNab criteria. Fifteen of 16 patients had excellent or good outcomes, for an overall success rate of 93.7%. No patients required reoperation. There were no incidental durotomies, infections, vascular, or visceral injuries. There was one complication, a case of leg numbness caused by dorsal root ganglion injury. The numbness improved after 2 weeks. After 3 months, physical exam showed that the total area of numbness in the legs had decreased. At last follow-up, the patient had no pain, and only a few areas with numbness remained that did not affect the patient's activities of daily living. The patient was relieved to be able to avoid open decompression.

Limitations: This is a retrospective study.

Conclusion: The transforaminal endoscopic approach is effective for patients with back or leg pain after lumbar spinal fusions due to residual/recurrent nucleus pulposus and foraminal 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.

Key words: Full-endoscopic, foraminal stenosis, recurrent herniation, surgical treatment, fusion

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With the growth of the quantity of lumbar spinal fusion surgeries, especially in geriatric patients with a variety of diseases, it is the best way for the doctor to develop new minimally invasive strategies in revision. The most effective treatment of patients after lumbar spinal fusions presenting with back and leg pain hinges on an accurate and precise judgment of the pathological physiology and anatomical pathology features. As a detailed history, physical test, imaging studies, psychological assessment and diagnostic puncture, a diagnosis can achieve more than 90% of patients (1). More accurate diagnosis including nerve blocks may be needed to determine where the pain is coming from and why it is persisting.

The most common diagnoses are foraminal stenosis, discogenic pain, and recurrent disc herniation. Once an etiology is determined, a multidisciplinary approach to treatment is most effective. Treating physicians should adopt specific diagnostic method including pain blocks or joint injections, attempting to determine peculiar position of pain; recognize that prognosis is negative influence by a shotgun approach to additional surgery; and refrain from "exploratory surgery" (2).

The challenge of pain after lumbar spinal fusions is in the decision of the time of the surgery and how to do operate completely. There may be several limitations for repeat interlaminar approach. One source of failure in the first surgery is a "battered root syndrome" and arachnoiditis, which may be limited or inadequate interlaminar exposure. Even though sufficient interlaminar exposure, it is difficult to achieve hemostasis if the position of the patient before operation has not been performed. Bleeding can obscure the operative region and the surgeon's vision and handle the problem at hand.

The current study evaluates 16 consecutive patients with back or leg pain after a lumbar spinal fusion surgery. The patients only required decompression without stabilization. All procedures were performed at an operating center associated with the spine group's training center, by operators all proficient in the percutaneous, transforaminal endoscopic discectomy decompressive approach. Percutaneous endoscopic discectomy is through the transforaminal visual path.

Patient Population

After Institutional Review Board approval, from January 2013 to June 2015, 16 consecutive patients with failed lumbar spinal fusion surgery were enrolled in the study. There were 7 men and 9 women. The average age at the diagnosis time and treatment initiation was 62.6 years (range, 51 – 76 years). All patients with failed lumbar spinal fusion surgery were treated with non-steroidal anti-inflammatory medications, steroid combined with bed rest, and there was no improvement in symptoms after treatment for 6 months. The average follow-up time in the study period was a minimum of 12 months, an average 30.3 months. All patients were treated with transforaminal percutaneous endoscopic discectomy and foraminoplasty, including one in segments L3-L4, 10 in segments L4-L5, and 5 in segments L5-S1 (Table 1).

Preoperative

All patients with pain after lumbar spinal fusion surgery underwent transforaminal percutaneous endoscopic discectomy. All patients underwent preoperative magnetic resonance imaging (MRI) and computed tomography (CT) of the lumbar spine. Plain x-rays (standing antero-posterior, lateral views) were get before the operation and one year postoperatively. The clinical outcome data of preoperative and postoperative (6 week, 6 months and 12 months) (back and leg visual analog scale [VAS] and MacNab criteria) was collected. The clinical assessments data of motor strength (graded 0 – 5), light touch, pain, reflexes, and proprioception was collected. All the procedures were operated by the same doctor at the same unit. Local anesthesia was used. Patients were informed that they may feel discomfort and pain during surgery. A radiolucent operating bed and C-arm x-ray were used. A solution of 3000 mL normal saline plus 0.5 mg epinephrine was prepared for intraoperative continuous irrigation through the 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).

Results

The average leg VAS improved from 9.1 ± 2.0 to 2.0 ± 0.8 ($P < 0.005$). Ten patients had excellent outcomes, 5 had good outcomes, one had a fair outcome, and none had poor outcomes, on the basis of the MacNab criteria (Table 2). Fifteen of 16 patients had excellent or good outcomes, for an overall success rate of 93.7%. No patients need to surgery again. All patients had no infections, incidental durotomies, or visceral or vascular injuries. There was one complication, a case of leg numbness caused by dorsal root ganglion injury. The sensory deficit ameliorated after 14 days. It was clearly that the total region of numbness in the leg had become smaller after 3 months. After the last follow-up, the patient had no pain, and only left a few areas with numbness that did not affect the patient's activities of daily living. The patient was also relieved to be able to avoid open decompression.

Discussion

The number of lumbar spinal fusion surgeries has increased substantially during the last 10 years. Consid-

Table 1. *Characteristics of 16 patients with revision of lumbar spinal fusion surgery.*

Characteristic	No. of Patients (%)
Male/female	1:1.3 (7/9)
Age	
50-59	3 (19)
60-69	9 (56)
70-79	4 (25)
Level	
L3-4	1 (16)
L4-5	10 (16)
L5-S1	5 (16)
Location of pathology	
Foraminal stenosis	9 (56)
Residual disc	5 (31)
Recurrent disc	2 (13)
Location of pain	
Back pain	5 (31)
Back and leg pain	8 (50)
Leg pain	3 (19)

Fig. 1. *Lateral radiograph showing placement of the working tube.*

Fig. 2. *Anterior-posterior fluoroscopic images showing placement of the working tube*

Table 2. *Outcome after endoscopic discectomy.*

Outcome	No. of Patients (%)
MacNab criteria	
Excellent	10 (62.5)
Good	5 (31.2)
Fair	1 (6.3)
Poor	0 (0)

ering the year of our cases, more and more procedures are carried out in patients of advanced in years and with various diseases, which have both been revealed to be relative to higher complication rates. Moreover, the rate of complication show to associate positively with increased complexity of instrumentation. The number of patients requiring revision surgery with extension of fusion constructs approached 10% in recent years. The challenge is exacerbated by the large increase in the quatity of complex lumbar spinal fusion surgeries being carried out in the elderly (3,4).

The most effective treatment of patients' status post lumbar spinal fusions presenting with back and leg pain depends on a precise and accurate diagnosis of the altered anatomy and physiology. The most common diagnoses are foraminal stenosis, discogenic pain, or recurrent disc herniation. Hypertrophy of the superior articular process of the inferior vertebra, leading to compress the nerve root at the lateral foraminal exit, is a consensus on cause of radicular symptoms, particularly in patients in whom previous lumbar spinal fusion surgeries have failed (5). These lesions present with characteristic physical findings and imaging studies can distinguish them from other causes of radiculopathy. We propose a lesion-specific, facet-sparing surgical technique (6).

After initial recognition of spinal stenosis in 1802, a gradual understanding evolved over the next 150 years. Lateral canal stenosis is most often missed or undertreated in traditional surgeries. The structure of the nerve-root canal is semi-tubular which the nerve root walks from the thecal sac to the intervertebral foramen. The proximal part of the nerve-root canal, also named the intervertebral or subarticular portion, is limited posterolaterally by the superior articular process and the facet joint and anteriorly by the intervertebral disc. The distal part of the nerve-root canal amounts to the lateral recess which means the lateral corner of the intervertebral foramen at the level of the pedicle. The exit and entrance of the intervertebral foramen lie at the lateral and medial borders of the pedicle. The hypertrophy of inferior articular process may result in stenosis of only the central portion of the spinal canal. The superior articular process results in the malformation of the medial, sub articular, and lateral portions of the nerve-root canal. From our transforaminal percutaneous endoscopic experience, the lateral recess contributes frequently to residual unrecognized stenosis in many cases of failed lumbar spinal fusion surgery. Ligamentous or bony hypertrophy of the superior articular process makes stenosis of the intervertebral foramen, and additional disc protrusion of any degree or region of herniation, including a flatulent annulus, will also affect the nerves in the thecal sac and 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 fusion surgery. The annulus was often flatulent, swellng with unloading and loading of the spinal segment, thus resulting in foraminal compression. Foramal nerves not seen branching from the exiting nerve were found to be from the dor-

sal ramus. They were 1 – 2 mm in diameter, not painful to palpation, and did not give rise to post-operative dysesthesia when transected. The nerve walk under the superior articular process along the foraminal ligament, and brought axial back pain relief when ablated. Ablation of larger nerves in the foramen, however, can be responsible for postoperative dysesthesia. We have not been able to confirm at this time the reason of post-operative dyesthesia as it can happen even when the nerve is left alone. We inform the patients that this is a risk that cannot be removed. Fortunately, this is usually temporary, and can be relieved by postoperative transforaminal and sympathetic blocks. 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 pathological anatomy such as foraminal disc protrusions and synovial cysts. The dorsal ramus is easily mistaken for patho-anatomy. In a parallel study of dorsal radicotomy for axial back pain, it was determined that facet pain was also mitigated by dorsal endoscopic (visualized) radicotomy instead of fusion (10-12).

Conclusion

The transforaminal endoscopic approach is effective for treating patients with continued back and leg pain after lumbar spinal fusions due to residual/recurrent nucleus pulposus and foraminal stenosis. Failed index surgery may involve failure to recognize 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 going through the last surgical location.

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