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척추관 협착이 동반된 요추 추간판 탈출에 대한 경피적 내시경을 이용한 추간판 제거술

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의학과

주 창 일

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Percutaneous Endoscopic Discectomy for Lumbar Disc Herniation Combined with Spinal Stenosis

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조선대학교 대학원

의학과

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목 차

표목차

도 목 차

국문 초록

척추관 협착이 동반된 요추 추간판 탈출 환자에 대한 경피적 내시경을 이용한 추간판 제거술

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Objective. 요추 척추관 협착증이 동반된 추간판 탈출 환자에 대하여 경피적 내시경 추간판 제거술은 수술중 신경손상 위험성이 높아 아직까지 수술금기증이다., 본 연구는 척추관 협착증이 동반된 추간판 탈출 환자에서 일측성 하지 방사통이 저명한 환자에 대하여 경피적 내시경을 통한 추간판 제거 수술을 시행하여 좋은 결과를 얻을 수 있어 이에 대하여 문헌 고찰과 함께 보고하고자 한다.

Materials and Methods. 본원에서 2007년 10월부터 2010년 12월까지 요추 척추관 협착증이 동반된 추간판 탈출환자 총 26명 환자에 대하여 수술을 시행하여 후향적 분석을 시행하였다. 모든 환자는 추간판 탈출로 인한 신경근 압박으로 인하여 일측성으로 심한 하지 신경병증성 방사통을 호소하였다. 수술 전 촬영한 T2 강조 Magnetic Resonance Image(MRI) 단면 영상에서 황색인대가 4mm 이상의 소견이 관찰되었고, 주증상은 주행신경근(traversing nerve root)이 외측 함요부분에서 심하게 압박을 받아 발생하고 있었다. 경피적 내시경을 이용한 추간공 경유 접근법(transforaminal approach)를 시행하여 주행신경근 (traversing nerve root)를 감압하였고, 탈출된 추간판을 제거하기 위하여 척추경상방 접근법(suprapedicular approch)와 반고형 구부러지는 탐침(semi-rigid curved probe)를 이용하였다.

Results. 총 34명의 환자중 남성이 7명, 여성이 19명이었고, 20대가 1명, 30대가 1명, 40대가 4명, 50대가 7명, 60대가 8명, 70대가 5명이었다. 수술 후 평균 추적관찰기간은 18개월이었다. 수술 전 하지 통증은 평균 Visual Analog Scale(VAS)이 8.08 이었고, 수술 후 하지 통증은 평균 VAS가 2.08 였다. Macnab's criteria에 따른 평가에서는 완전 호전(excellent result)가 6례, 호전(good result)가 17례, 보통

(fair result)가 2례, 악화(poor result)가 1례 였으며, 88.46%에서 만족스러운 결과를 얻을 수 있었다.

Conclusion. 일반적으로 척추관 협착증이 동반된 요추 추간판 탈출에서는 경피적 내시경 수술은 금기시 되어 왔으나, 만약 주증상이 요추 척추관 협착증이 아닌 추간판 탈출에 의한 외측함요에서 신경근 압박으로 발생한 경우 경피적 내시경을 이용한 transforaminal approach로 접근하여 신경근 감압을 하는 방법은 매우 효과적인 최소 침습적 수술법이 될 수 있다.

Key Words : Endoscopic Discectomy, Suprapedicular Approach, Lumar Disc Heriation and Spinal Stenosis

I. Introduction

Percutaneous endoscopic lumbar discectomy is becoming increasingly important in the treatment of patients with incapacitating sciatica.

In the surgical treatment for lumbar disc disease, a microscopic discectomy has generally been performed;[1,3-5] However, endoscopic discectomy techniques have been greatly improved[6-12,17-20]and are now used to treat a variety of conditions.

Usually, lumbar disc herniation with spinal stenosis has not been an indication for endoscopic lumbar discectomy because the space of the safety zone is narrowed by hypertrophied yellow ligament and the facet joint, and the room to manipulate an endoscopic device in the epidural space is not sufficient through which to extract disc materials safely. For this anatomic reason, it is difficult to reach to the lesions located in the narrowed epidural space. Thus, the possibility of disc material remaining is high and the success rate of surgery noticeably reduced.[10,12,18] In Chosun University hospital, in cases involving lumbar disc herniation with spinal stenosis and symptoms of severe radiculopathic leg pain, with or without back pain caused by compression of the traversing nerve root in the lateral recess, by using a rigid endoscope and a semi-rigid flexible curved probe, a posterolateral lumbar endoscopic discectomy has been performed using the transforaminal suprapedicular approach, and satisfactory results have been obtained. We therefore report our clinical experience with a review of the literature.

II. Materials and methods

The subjects

Twenty-six cases of lumbar disc herniation with spinal stenosis having severe unilateral radiculopathy were included in this study.

The patients included in this study met the following inclusion criteria: 1) the major symptom was unilateral radiating leg pain that was more prominent than back pain with a positive straight leg raising test; 2) radiologic investigations (computed tomographic [CT] and magnetic resonance imaging [MRI] scans) suggesting a single level posterolateral disc herniation with spinal stenosis and a preoperative magnetic resonance axial image showing that anterior posterior spinal canal diameter was less than 10mm and the ligamentum flavum was thicker than 4 mm with lateral recess stenosis, 3) neurogenic intermittent claudication was not evident before the radiating leg pain developed; 4) traversing root compression confirmed by both 3D CT scan and MRI, 5) failure of appropriate conservative treatment for 8 weeks, and 6) no calcified disc herniation.

Patients were excluded from this study based on the following criteria: 1) severely narrowed diameter of spinal canal (< 8 mm) on CT and MRI scans, 2) neurogenic intermittent claudication symptoms were prominent, 3) severe disc space narrowing and facet hypertrophy with lateral recess stenosis, 4) calcified disc herniation; 5) recurrent disc herniation with adhesions at the same level, 6) patients with significant motor neurodeficits, and 7) associated spondylolisthesis.

Procedure

There is generally a trend in favor of a local anesthetic procedure for nerve root injury monitoring during surgery and for the early assessment of surgical results[18,25,27,30,41,43,45], nevertheless, at our hospital, epidural anesthesia was performed in all cases. Either 100 μg fentanyl and 0.5 % pucain were diluted by 1/2 and prepared 0.25 % solution and approximately 15-20 cc was injected to the epidural space or 15-20 cc 0.5 % pucain stock solution was injected to the epidural space, anesthesia was assessed by checking the sensory level, and surgery was performed.[23,25-27] During surgery, this procedure is not enough to block the nerve root completely, so we could detect the patient's sensory and motor changes.

The sequence of surgery was identical to the general endoscopic posterolateral procedure.[12,18-20] The skin entry point was approximately 8-10cm off the midline. Prior to the procedure, using indigo-carmine dye, evocative chromodiscography was performed.[10,18] A guide wire was inserted through the needle channel into the annulus, then a 1 cm skin incision was made at the entry needle site. An operative sheath (YESS System; Wolf, Knittlingen, Germany) was introduced into the disc space through the transforaminal safety working zone. Disc decompression was performed in a manner identical to the percutaneous endoscopic posterolateral transforaminal procedure,[12,18-20] and after completing the decompression, the cannula was removed carefully from the foraminal space and moved to the upper margin of the lower vertebral pedicle. The pedicle is surrounded by abundant soft tissues, fat, and blood vessels. The superior margin of the pedicle was secured by removing these structures completely using a high voltage bipolar probe (Ellman Innovation, Newyork,USA) and forceps. During the transforaminal suprapedicular approach, in the case of inferior migrated disc herniation, the transverse nerve root may by protected by disc material. However, in the case of disc herniation combined with stenosis, a narrowed lateral recess as well as less protective structures may expose the traversing nerve root to injury. Therefore, it is very important to identify the nerve root during the transforaminal suprapedicular approach (i.e., twitching of the involved leg by high voltage bipolar probe stimulation).

If the pedicle and upper margin of the lower vertebra are prepared properly, a sufficient space to perform the suprapedicular approach is obtained (Figures 1C and D, and Figures 2B and C), the traversing nerve root can be visualized, and careful manipulation to decompress the space of the ventral and lateral parts of the nerve root can be attempted.

If the space of lateral recess was decompressed enough to free the nerve root by the transforamina suprapedicular approach, additional decompression of the epidural space was performed from the direction of the lateral recess to the disc space.

Occasionally, due to the presence of spondylosis in the upper margin of the lower vertebra, the space may be not sufficient or covered to the level, thus impeding surgery. In such cases, the upper margin of the lower vertebra was removed using a punch. Upon performing the procedure, the epidural space and the traversing root are exposed, and occasionally, the ruptured disc material is exposed first and thus it can be readily removed. However, the inferior migrated ruptured disc material is present below the traversing root in most cases, thus care must be exercised not to injure the traversing root. Even if the ruptured disc material is seen, a probe may not reach the area in many cases, and for such cases if a semi-rigid flexible curved probe is used, it can be approached sufficiently and removed (Figure 2). The ruptured disc material is removed using a curved probe. If the disc material is extracted and root decompression is sufficient, massive bleeding can obscure the structural findings on the endoscopic view, but can be controlled with a bipolar coagulator and the mobile traversing root can be assessed. After observing such findings, if blue-stained material is not detected, sufficient disc material extraction and root decompression has occurred and the procedure can be terminated.

Evaluation

Based on MRI and 3D CT with discogram images taken prior to surgery, the migration level, lesion type, and the relationship with adjacent anatomic structures were analyzed. Approximately 1 – 4 hours after surgery, the remnant disc was assessed by checking with MRI. Approximately 1 week after surgery, the improvement of the patient was evaluated by the Visual Analogue Pain Score (VAS), Oswestry Disability Scores (ODI), and neurologic tests.

Outcomes were categorized using Macnab criteria[27], as follows: excellent (no pain and no restriction of activity), good (occasional back or leg pain of sufficient severity to interfere with normal work or leisure activities), fair(handicapped by intermittent pain of sufficient severity to curtail work or leisure activities, but improved functional capacity), and poor (unimproved symptoms, insufficient improvement to allow increased activity, or requirement of reoperation at the same level). Data were collected by a registered nurse employed by the operating surgeon.

The functional outcome was measured by the change in preoperative and postoperative VAS. A change of 7.5 points was deemed excellent, 5 points was good, 2.5 points was fair, and < 2.5 points was considered poor.

III. Results

Twenty-six patients were operated on between October 2007 and December 2010 for lumbar disc herniation with spinal stenosis with the transforaminal suprapedicular endoscopic technique. There were 7 male and 19 female patients. The age distribution of patients was as follows: 20-29 y (1), 30-39 y (1), 40-49 y (4), 50-59 y (7), 60-69 y (8), and 70-79 y (5).

The L3-4 level was involved in two patients, while the L4-5 level was involved in 24 patients. The preoperative MRI and 3D CT with discogram images showed that 3 cases were non-contained type disc herniations and 23 cases were contained-type disc herniations; in all 23 cases, satisfactory results were obtained.

There were no patients who required conversion to an open procedure after abandonment of the transforaminal suprapedicular endoscopic discectomy.

Five patients (19%) developed lower extremity paresthesias in a dermatomal distribution that was different from the preoperative radiating pain, but the dysesthesias were transient and improved over 4 weeks. Two patients (7.7%) developed transient motor weakness, but recovered fully after 2 weeks.

The mean follow-up was 18 months. The mean VAS of the patients prior to surgery was 8.08, and the mean postoperative VAS was 2.08. According to Macnab's criteria, 6 patients had excellent results, 17 patients had good results, 2 patients had fair results, and 1 patient had a poor result; satisfactory results were obtained in 88.46 % of the cases.

There were no infections, discitis, paresis, dural tears, vascular injuries, or systemic complications. At the final follow-up, there were no patients with unsatisfactory outcomes requiring revision surgery.

IV. Discussion

Acute lumbar disc herniation with spinal stenosis, even if it is relatively small, may precipitate severe neural compression and increased neurologic deficits, which is characterized by cauda equina syndromes when central or radiculopathic.[16,56] Neurologic findings are often located unilaterally, with compression occurring along the nerve root toward the exit from the thecal sac, over the caudal disc space, beneath the superior articular facet, around the pedicle, and through the neural foramen into the far-lateral compartment. Narrowing maybe further exacerbated by spondylosis, with hypertrophy of the ligamentum flavum and facet joints.

Disc herniation accompanied lumbar stenosis in 15% of Hall's patients,33% of Heath's patients, and 45% of Epstein's 857 patients.[13-15,21,24]Disc herniation accompanied degenerative spondylolisthesis in 4.3% of patients in Tsou and Hopp's series and in up to 20% of patients in the Alexanderetal.study.[2,53]

Generally, The choice of surgical treatments for lumbar disc diseases accompanied by stenosis have been conventional laminectomies and discectomies [1,3-5]and endoscopic surgery has been limited and relatively contraindicated . However, recently numerous studies and results of endoscopic discectomies have been reported, and the outcomes are gradually improving.[6,7-12,17-22,34]

Percutaneous endoscopic surgery for removal of disc herniations and for decompression of compromised nerve roots via the transforaminal suprapedicular approach requires an understanding of the endoscopic anatomy of the periannular structures and the foramina. In the clinical setting, lumbar disc herniation with spinal stenosis is commonly seen in association with lateral recess stenosis compressing the transverse nerve root. Intraoperative visualization of the foraminal contents makes it possible to protect the exiting root during endoscopic decompression of the lateral recess. The nerve root canal begins at the point of origin of the nerve root sheath and terminates when the spinal nerve emerges from the foramina. The superior facet and ligamentum flavum form the roof of the lateral recess; the annulus, an expansion of the posterior longitudinal ligament, and the vertebral bodies form the floor of the lateral recess.

The percutaneous endoscopic transforaminal suprapedicular approach to the disc space and lateral recess is gained via a 1 cm posterolateral incision. The muscle fibers are not severed, but are separated with the aid of a cannulated obturator, thus preventing denervation of the musculature and scar formation, and promoting rapid recovery and return of function. Interference with normal flow of epidural and neural venous systems by intraoperative application of traction on the dura and the nerve root, excessive electrocoagulation, and sustained external pressure by osteophytes or bulging discs may promote neural venous stasis, causing chronic edema, fibrosis, decrease of oxygen supply to the nerve root, and leading to the development of chronic pain and failed-back syndrome.[6,18,20] Posterolateral endoscopic foraminal decompression does not require entry into the spinal canal and therefore minimizes the occurrence of the latter complication. In our limited experience, percutaneous endoscopic access to the lateral recess of the lumbar spine for the decompression of the exiting root is a minimally invasive procedure that appears to be safe and effective.

The incidence of complications after endoscopic lumbar discectomies is low,[8,35,36] and it has many advantages over minimally invasive procedures; specifically, with endoscopic lumbar discectomies, the possibility of resection of bone and ligament is dispensed and by performing thes elective evacuation of the intervertebral space, surgery-induced instability can be prevented.[37-43] In addition, endoscopic lumbar discectomy is less traumatic, has a shorter operating time, less scarring, and conserves the intact intra-epidural lubricant structure, such as epidural fat and yellow ligaments. Post-discectomy syndrome or other surgery-associated deterioration does not develop, revision is not more difficult, and destabilization induced by surgery does not readily develop. As general anesthesia is not required, not only are the complications developing in the elderly or the increase in morbidity less, but also the hospital stay is shortened and rehabilitation is quicker. In comparison with microscopic discectomy, return to work or sports activities is more rapid, and thus it is accepted by patients more readily with a high patient acceptance.[32,44] More important points are that epidural scarring develops in more than 10 % of patients after conventional laminectomy and discectomy,[45-50] and in posterolateral endoscopic discectomy, such scars have not been detected by MRI or during revision surgery.[22] Therefore, subsequent endoscopic or conventional procedures are possible.[51,52]

Despite such numerous advantages, endoscopic discectomy is not universally accepted because to acquire endoscopic procedural skills is difficult and thus it has a flattened and lengthy learning curve, and in comparison with microscopic discectomy, surgical outcomes after endoscopic discectomy are not considered superior and its indications are limited. Lateral approach endoscopic discectomy has many restrictions due to anatomic limitations; the approach is through the iliac wing, and thus the iliac wing and the height of the working disc space should be adequate.[19] One has to approach the working disc space through the foraminal space, which is difficult,[8] and because a rigid endoscope is used, the approach in cases with high grade migration and high canal compromised is difficult.[11]

According to Ditsworth,[11] it has been reported that despite endoscopic transforaminal lumbar discectomy having numerous advantages and showing good surgical results, it has several short comings; surgical manipulation is not easy, and thus it is possible to remove only a portion of the extruded disc, resulting in a lower success rate (83 %).

To overcome such limitations, it is important to understand the anatomic relationship of the lesion disc and adjacent structures prior to surgery.[54,55,57] In endoscopic discectomy by the lateral approach, to solve such problem, it is required to understand the location in relationship to the stalk of the ruptured disc and the rest of the particles, to understand the fragment level of the ruptured disc, and to obtain the volume of the lesion site and information on 3D imaging. At our hospital, such problems were solved by performing a discogram with 3D reconstruction CT (Figure1B).[8]

Even if a precise diagnosis were made prior to surgery, in the high grade inferior migration type, it is difficult to approach the lesion, and the success rate of endoscopic discectomy is lowered,[10,11] the reason is due to anatomic structures, a rigid endoscope, and a probe that does not reach the lesion. An extreme lateral access,[17]an epiduroscopic approach,[10] and a flexible working channel scope could solve such problems.[8] A suprapedicular approach is a method to the remove the migrated disc using the narrowing space immediately above the pedicle of the lower vertebra. The suprapedicular approach has several advantages in that manipulation is performed at the foraminal level and thus it could have a sufficient angle to reach the migrated disc, the epidural space could be approached readily, and sufficient assessment of root decompression and disc extraction is feasible (Figure 2). If a working cannula were installed in the disc space and subsequently the cannula were moved to the upper margin of the lower vertebral pedicle, and arranged clearly by a bipolar coagulator (Ellman Innovation, Newyork, USA), forceps, and laser, the suprapedicular entry point appears (Figures 1C and D). Through this route, by performing an epiduroscopic approach and subsequently using a semi-rigid flexible curved probe, the inferior migrated disc material could be extracted sufficiently.

A satisfactory outcome with resolution of sciatic pain was observed in 88.46% of patients. Of 26 self-employed patients, 6 patients had an excellent recovery and 20 patients had good recovery and returned to their previous work and activities. We have not encountered any neurovascular complications following this operative procedure. Although the outcome in this limited group of 26 patients who underwent endoscopic discectomy with decompression of lateral recess stenosis has been encouraging, a larger number of patients and a longer follow-up period are required to confirm these early results.

V. Conclusion

Lumbar disc herniation combined with spinal stenosis is difficult to resect properly by a percutaneous endoscopic lumbar discectomy using a rigid endoscope. Nevertheless, if endoscopic lumbar discectomy is performed by applying transforaminal suprapedicular approach, good results can be obtained.

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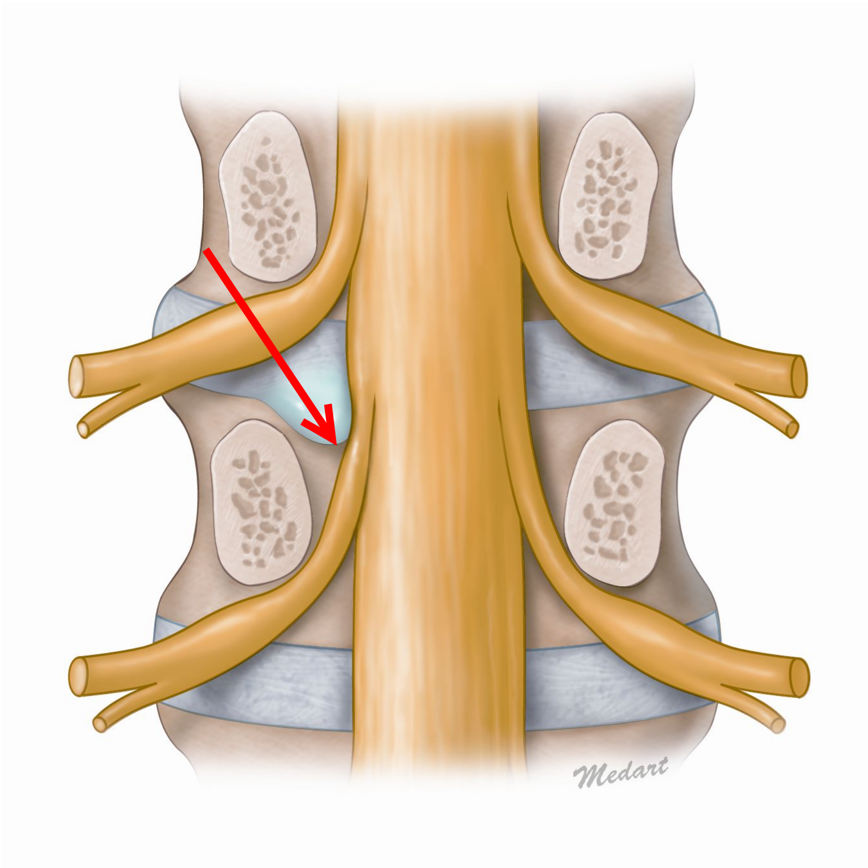

Figure 1. Schematic drawing showing the posterior aspect view of the route of the transforaminal suprapedicular approach for root decompression access to the disc herniation combined with spinal stenosis compressing the dominant root.

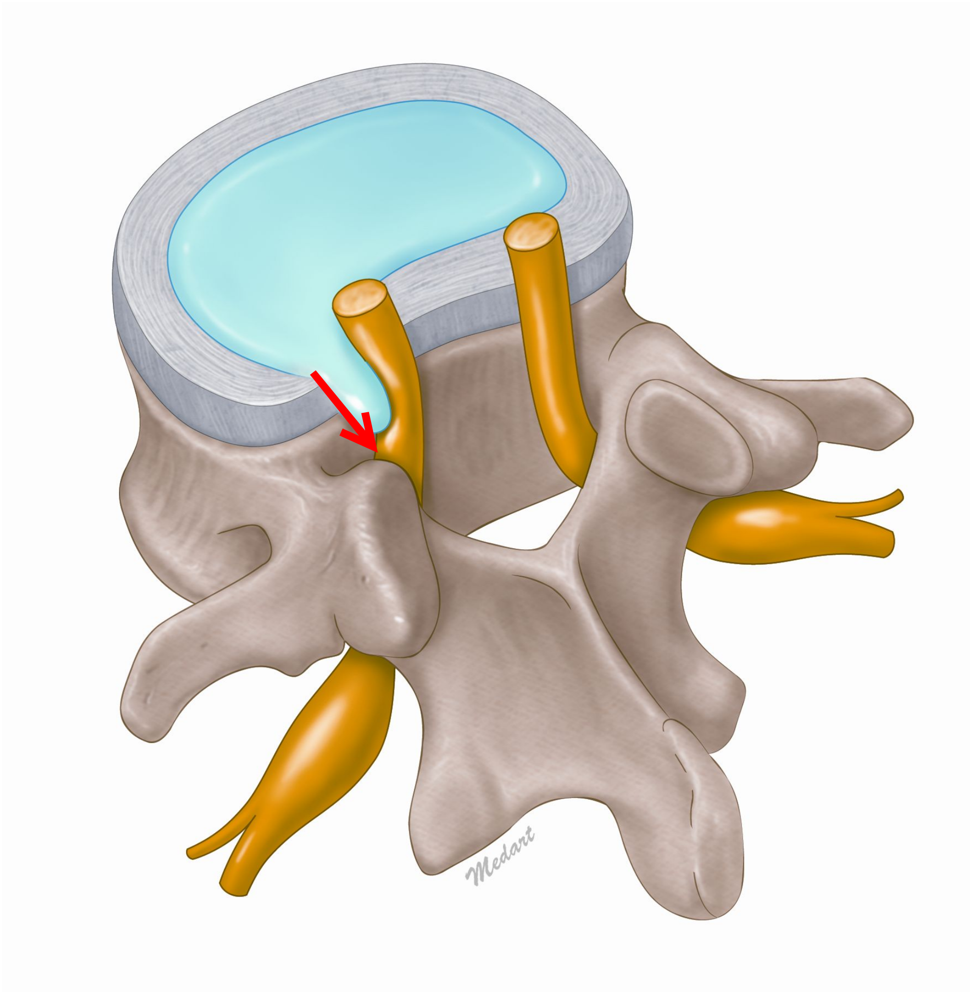

Figure 2. Schematic drawing showing the lateral aspect view of the route of the transforaminal suprapedicular approach for root decompression access to the disc herniation combined with spinal stenosis compressing the dominant root.

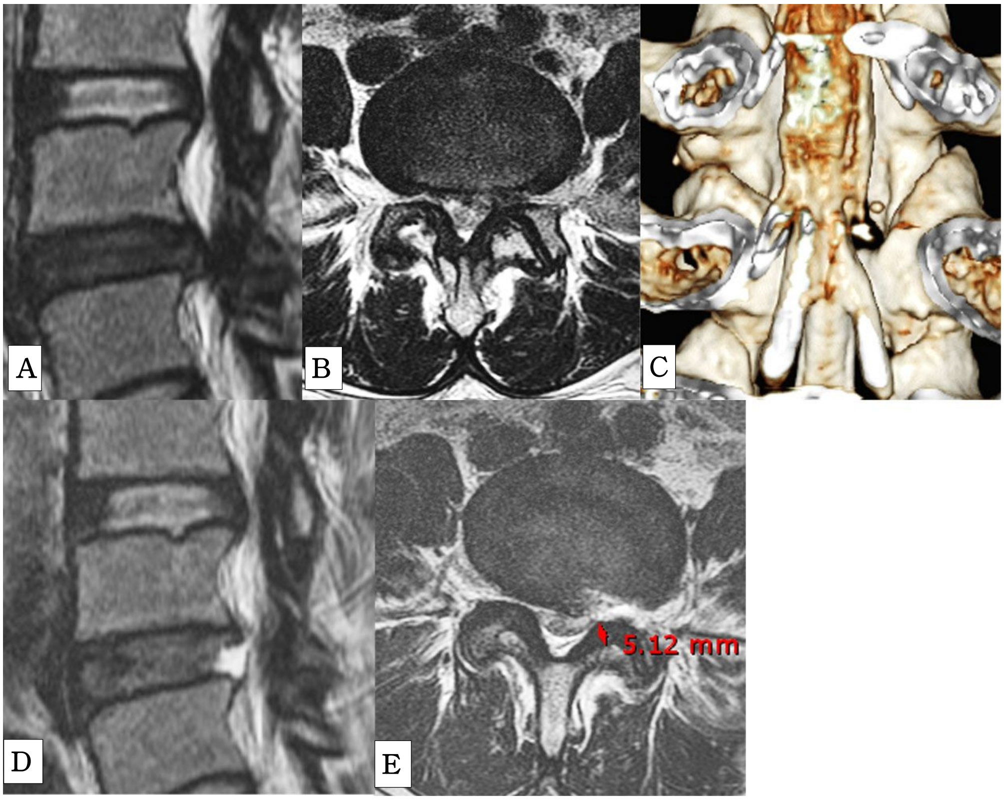

Figure 3. Preoperative MR images shows L4-5 disc herniation combined with spinal stenosis compressing the dominant root (A,B). Postoperative myelogram with 3D reconstruction CT shows decompressed traverse nerve root (C). Postoperative MR images shows herniated disc material successfully removed and nerve root decompressed at the lateral recess with thickened ligament flavum (>5 mm; D,E).

Table1. Surgical outcomes of PELD for Lumbar disc herniation combined with spinal stenosis

Case	Age / Gender	Level	C/C	Preop VAS	Postop VAS	Macnab's Criteria	Complications
1	43/F	L4-5	LBP, Lt. leg pain	8	3	good	
2	53/M	L4-5	Rt. leg pain	9	2	excellent	
3	66/F	L3-4	LBP, Rt. leg pain	7	2	good	
4	35/M	L4-5	LBP, Lt. leg pain	8	3	good	
5	44/F	L4-5	Lt. leg pain	7	1	excellent	
6	55/F	L3-4	LBP, Lt. leg pain	8	2	good	transient paresthesia
7	73/F	L4-5	Rt. leg pain	7	3	good	
8	62/M	L4-5	Rt. leg pain	8	5	fair	
9	59/F	L2-3	Lt. inguinal pain	9	2	good	
10	27/M	L4-5	LBP, Lt. leg pain	8	1	excellent	
11	68/M	L3-4	LBP, Rt. leg pain	8	3	good	transient paresthesia
12	59/F	L4-5	LBP, Rt. leg pain	8	2	good	
13	60/F	L4-5	LBP, Lt. leg pain	9	1	excellent	
14	77/F	L4-5	Lt. leg pain	9	3	good	
15	45/F	L4-5	LBP, Rt. leg pain	9	3	good	
16	71/F	L4-5	LBP, Lt. leg pain	8	1	excellent	transient paresthesia
17	46/M	L3-4	LBP, Rt. leg pain	8	2	good	
18	55/F	L4-5	LBP, Rt. leg pain	8	2	good	transient motor weakness
19	63/F	L3-4	LBP, Rt. leg pain	7	3	good	
20	66/F	L4-5	LBP, Rt. leg pain	8	1	excellent	
21	72/M	L4-5	Lt. leg pain	9	3	good	transient paresthesia
22	58/F	L4-5	LBP, Rt. leg pain	8	6	fair	
23	53/F	L4-5	LBP, Lt. leg pain	8	2	good	transient motor weakness
24	71/F	L3-4	LBP, Lt. leg pain	9	7	poor	
25	65/F	L3-4	LBP, Lt. leg pain	8	3	good	transient paresthesia
26	62/F	L4-5	LBP, Rt. leg pain	9	2	good	