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Modified Lateral Approach for Foraminal/Extraforaminal Lumbar Disc Herniation at L5-S1 Level

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ABSTRACT

Background: Rarely can a herniated disc in the far-lateral extraforaminal area of the lumbar spine cause compression of a nerve root.

Objective: To focus on L5-S1 foraminal/extraforaminal lumbar disc as well as to analyze the outcome of surgical management via the lateral approach.

Patients and Methods: From March 2016 to July 2020, 42 patients with L5-S1 foraminal or extraforaminal disc herniations were included in this study after they received unilateral L5-S1 paraspinal decompression at Benha University Hospitals and Brüder Hospital Trier. All medical charts of the included patients were reviewed and analyzed regarding clinical presentation, complete neurological examination, operative findings, complications, and short-term outcome. MacNab scale of excellent (no pain), good (some pain), fair (moderate pain), and poor was used to assess patients' subjective levels of postoperative satisfaction (unchanged or worse).

Results: Preoperative sensory and motor deficits showed obvious improvement in the majority of patients. Motor weakness showed significant improvement in 24 patients out of 30 patients (80%). Pain scoring (Visual Analogue Score; VAS) after surgery before discharge of the patients from the hospital revealed that 23 patients had no pain, 16 patients had mild to moderate pain (VAS 1-3) and 3 patients had significant pain (VAS >4).

Conclusions: Orientation of the pathology, proper diagnostic imaging as well as familiarity of the approach are significant factors for patient's improvement. We have found that our modified lateral approach is a safe, minimally invasive option with little complications.

Keywords: Extraforaminal disc herniation, Far-lateral disc herniation, Paraspinal approach, Lateral approach.

INTRODUCTION

Foraminal or extraforaminal lumbar disc herniation can cause compression of the L5 nerve root at the L5/S1 lumbosacral level [(1)]. The term "extraforaminal lumbar disc herniation" (EFLDH) refers to a herniated disc in the lumbar spine that occurs outside of the spinal canal. Other names for this condition include "far-lateral," "extreme-lateral," and "extracanalicular"[(2)]. Comparatively, a foraminal lumbar disc herniation (FLDH) is a herniated disc that occurs within the neural foramen, whereas an extraforaminal lumbar disc herniation (EFLDH) occurs outside of the foramen[(3)]. An appreciable number of patients will have both foraminal and extraforaminal manifestations at the same time[(4)].

Only 1-12% of all lumbar disc herniations are due to EFLDH, or far-lateral disc herniation. While EFLDH at the L5 to S1 level is considered an uncommon disease accounting for roughly 2 percent - 4 percent of all lumbar disc herniations [(5)]. EFLDH, on the other hand, is more common among the elderly, especially at the L4/5 level [(6)].

As diagnostic radiology, especially MRI, has improved, the proportion of cases in which L5/S1 EFLDH is initially suspected has increased to between 6.5% and 25% of all cases[(7)]. Foraminal stenosis is another possible site of injury to the L5-nerve exiting root [(8-9)].

The purpose of this study was to focus on L5-S1 foraminal/extraforaminal lumbar disc as well as to analyze the outcome of surgical management via the lateral approach.

PATIENTS AND METHODS

From March 2016 to July 2020, 42 patients with L5-S1 foraminal or extraforaminal disc herniations were included in this study after they received unilateral L5-S1 paraspinal decompression at Benha University Hospitals and Brüder Hospital Trier.

We looked at the demographics of these patients by going through their medical records; there were 27 men and 15 women, with a 64/36 male/female ratio and a median age of 50.2 years (range 43- 86 years). In order to determine the cause of each patient's L5-root compression, their medical records were reviewed (herniated disc or foraminal stenosis); clinical symptoms before and after surgery, as well as during surgery, intraoperative findings, complications, and quick recovery time. Foraminal and extraforaminal lesions were confirmed by CT and MRI before surgery.

Extraforaminal disc was located lateral to the foramen with no foraminal affection. While foraminal disc herniation or stenosis were confined to the foramen causing direct root compression.

All patients underwent a preoperative, postoperative, and final follow-up evaluation to evaluate pain and neurological function. The Visual Analogue Scale for Pain was utilized to evaluate cases of back pain and/or sciatica (VAS score 0 = when there is absence of pain, score ten indicating higher level of

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pain). Subjective evaluations of surgical outcomes focused on the patient's ability to return to normal daily activities, the extent to which those activities were limited, and whether or not they were able to return to work. according to the MacNab categorization system, patients' progress was ranked as outstanding (no pain), good (minimal discomfort), fair (moderate pain), or poor (no improvement or worsening)[10].

Surgical Technique:

General anesthetic was used during surgery. Cefazolin, a prophylactic antibiotic, was given to the patient before the incision was made in the skin. A Wilson frame was used to position the patient prone.

When the L5/S1 disc level needed to be pinpointed, X-ray fluoroscopy was employed. The next step was making a 2.5 cm long skin incision in the midline, with the point of origin being at the disc space. In standard lumbar disc surgery, paravertebral muscle separation follows incising the deep fascia. The paraspinal muscle was displaced as far as possible from the surgical site with the use of a long unilateral self-retractor whose distal end was advanced at the extraforaminal fat plane. Preoperative planning should angle the cranial end of the retractor away from the sacral ala.

Under microscopic view, the lateral surface of the L5/S1 facet joint was exposed, then the lateral edge of the lamina immediately above the facet joint was carefully exposed. Thereafter, fluoroscopy was used to double-check the spinal level. A high-speed diamond-tipped burr was used to delicately drill a hole in the lateral L5 lamina and the surrounding periosteum, located just 2–3 mm from the lateral inferior articular facet of L5. Next, the facet joint was opened, and the medial portion of the superior articular facet of S1 was excised. The L5 nerve root and the dorsal root ganglion were then exposed by cutting through the ligamentum flavum at the foramen. If the extraforaminal wi\ndow was blocked by the sacral alar inferiorly, it was usually not necessary to shave away the superior portion of the sacral alar to increase access to the disc region. The next steps of surgery were tailored to the underlying pathology; for example, in the case of a sequestrated disc, the nerve root was located and retracted cranially with the use of a dissector; next, the disc fragment was mobilized using a hook; and last, it was removed. Manipulation of the L5 nerve root as well as the dorsal root ganglion was avoided. Sometimes partial discectomy was necessary if the herniated fragment was in continuity with an additional fragment in the intervertebral space. Foraminal stenosis called for bone decompression, which involved drilling the osteophyte and expanding the bony borders. Nerve hooks with different lengths were introduced both medially and laterally to palpate residual disc material or other compressing bony structure, in order to achieve adequate decompression of the nerve root.

Ethical consent:

The study was authorized by the Academic and Ethical Committee of Benha University. Everyone who agreed to take part in the study did so after signing an informed written consent form. All procedures involving human subjects in this study have been performed in conformity with the principles outlined in the World Medical Association's Declaration of Helsinki on the conduct of scientific research involving human subjects.

Statistical Analysis

SPSS (Statistical Package for the Social Sciences) for Windows® version 22 was used for coding, processing, and analysing the gathered data (IBM SPSS Inc, Chicago, IL, USA). Data were presented as frequency and percentage.

RESULTS

The study included 42 patients (27 males, 15 females). Age mean was 63.8 years (ranging from: 43-86 years). 30 patients had foraminal/extraforaminal disc prolapse, 10 patients had foraminal stenosis, 2 patients had foraminal/extraforaminal cyst at the L5-S1 level. So, patients were classified into stenosis group (10 patients) (Figs. 1 and 2), the disc prolapse group (30 patients) (Figs. 3, 4, and 5), and the synovial cyst group (2 patients) (Figs. 6 and 7).

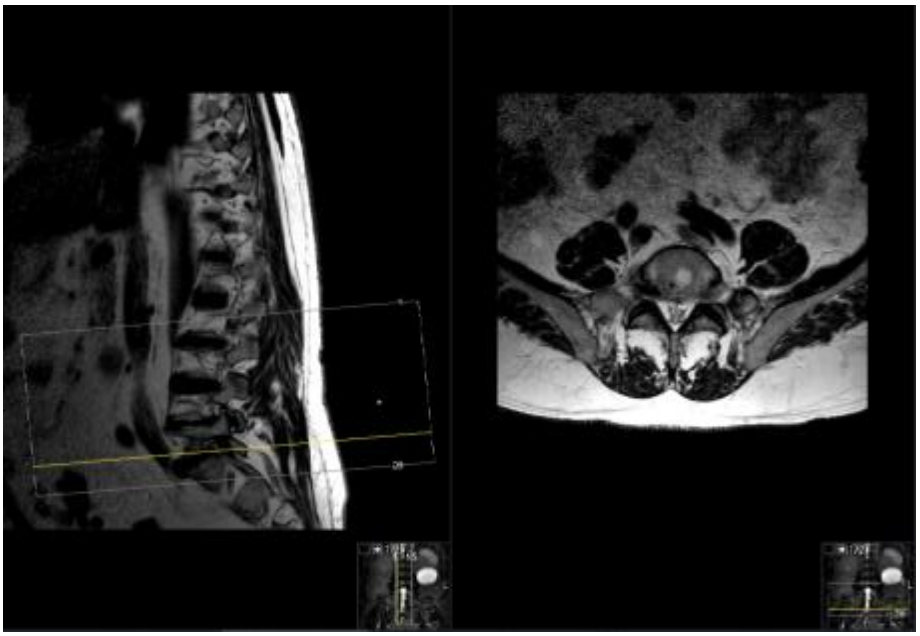


Figure (1): Preoperative T2WI-MRI sagittal and axial cuts show left side foraminal stenosis at the level of L5-S1

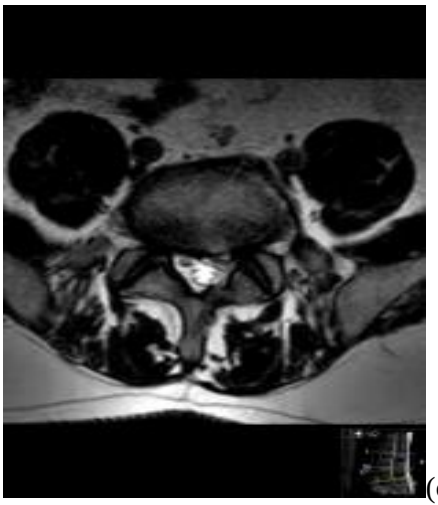
(a)  **(b)**  (c) 

Figure (2): Foraminal stenosis L5-S1. (a) preoperative T2WI-MRI sagittal cut shows left side foraminal stenosis at L5-S1 level. (b) preoperative T2WI-MRI axial cut shows left side foraminal stenosis at L5-S1 level. (c) preoperative T2WI-MRI axial cut shows left side foraminal stenosis at L5-S1 level

Figure (3): Preoperative T2WI-MRI sagittal and axial cuts show subligamental sequestrated disc with foraminal stenosis L5/S

(a) **(b)** **(c)**

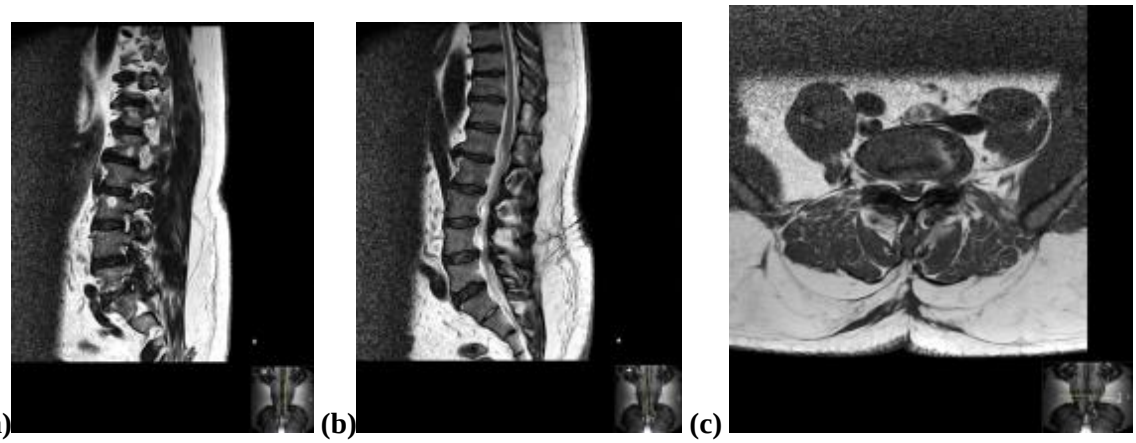


Figure (4): Preoperative T2WI-MRI sagittal (a+b) and axial (c) cuts show subligamental sequestrated disc with foraminal stenosis L5/S

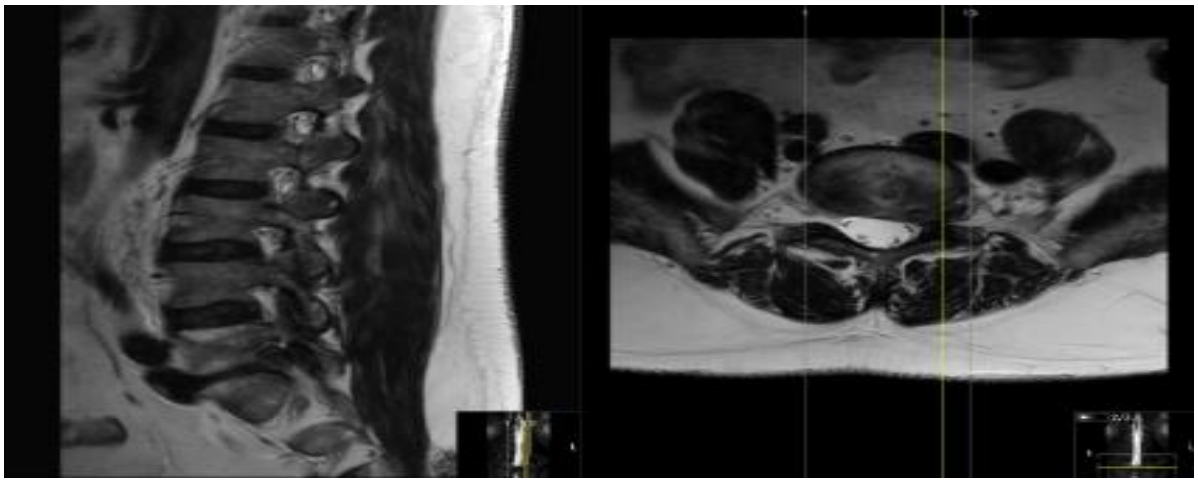


Figure (5): Preoperative T2WI-MRI sagittal and axial cuts show extruded sequester L5/S1 level

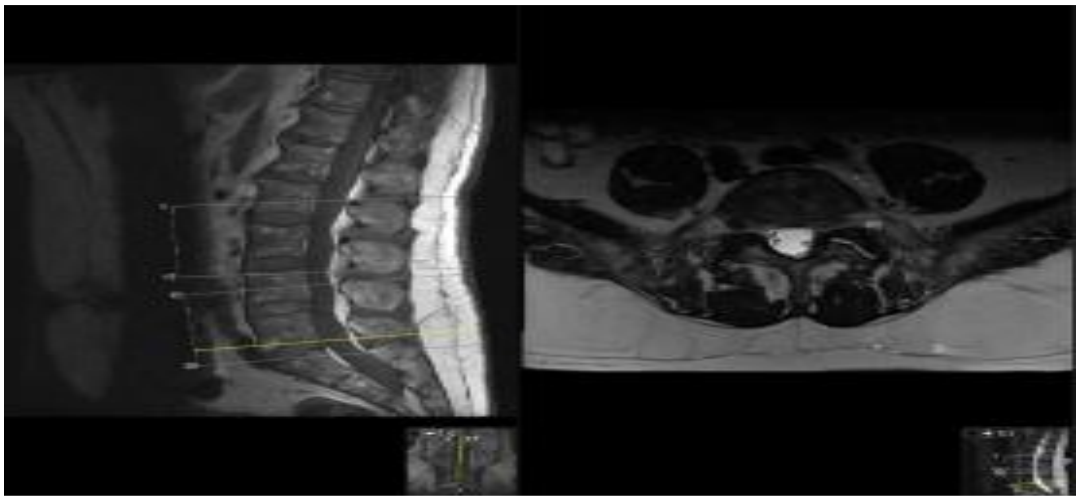


Figure (6): Preoperative T1WI-MRI sagittal and T2WI-MRI axial cuts show synovial cyst at L5/S1 level

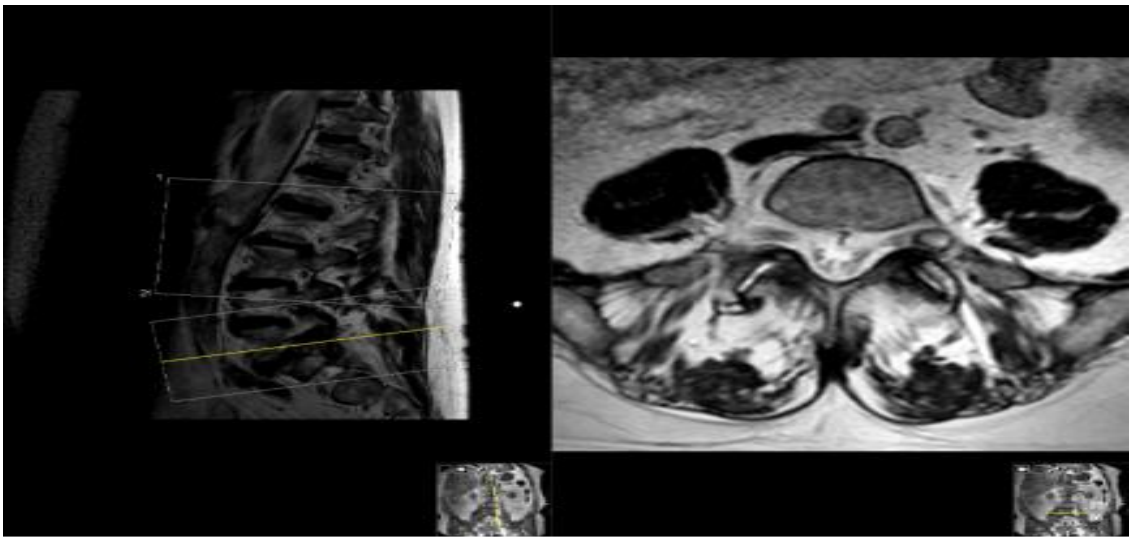


Figure (7): Preoperative T2WI-MRI sagittal and axial cuts show synovial cyst at L5/S1 level.

Right side affection was in 15 patients and left was in 27 patients. Duration of symptoms was 1-40 days (average 10 days). All cases were presented with radicular leg pain taking the distribution of L5-dermatom, however in one case there was associated S1 radiculopathy while 29 cases (69%), complained of low back pain. All patients were subjected to a complete neurological examination which revealed; no cauda equina, a sensory deficit in form of L5 hypoesthesia in 29 cases (69%), on the other hand, the motor deficit was documented in 30 cases (71.4%).

The rate of L5-hyposthesia was 62.5% (5/8 patients) in the cases of only foraminal stenosis, 68.8% (22/32 patients) in patients having lumbar disc prolapse either with or without additional foraminal stenosis, and in 100% of patients presented with cyst.

All patients presented with motor deficit had weakness of the Extensor Hallucis Muscle (EHM), the grade of weakness was Grade 4/5 in 20 patients, Grade 3/5 in 9 patients and Grade 2/5 in 1 patient. Additionally, 16 patients (38%) had in addition to the EHM-weakness an additional weakness in Gluteus Medius Muscle (GMM) with positive Trendelenburg sign. Only 12 patients (28.6%) did not have motor weakness at the presentation.

In the cases of only foraminal stenosis, muscle weakness was evident in 4 patients (50%), however in patients having lumbar disc prolapse either with or without additional foraminal stenosis the rate of muscle weakness was 75% (24/32 patients), and all patients presented with cyst presented with weakness.

The foraminal stenosis was associated with a cyst in 2 cases and associated with craniolateral extension in 8 patients.

Radiological scanning revealed other associated pathologies in form of; residual disc in 3 cases, L5-S1 spondylolisthesis in 2 patients, and L4-5 stenosis in 2 patients.

This study has no mortality and postoperative complications were superficial burning of the skin from the light of the microscope in one case and postoperative subcutaneous hematoma in another patient on oral anticoagulation. One patient underwent fixation 3 weeks after surgery due to persistent pain after foraminal decompression, this patient had already spondylolisthesis before surgery.

Pain scoring (Visual Analogue Score; VAS) after surgery before discharge of the patients from the hospital revealed that most of the patients had no pain **(Table 1).** Pain scoring according to patients' groups are detailed in **Table 2.**

During the period of follow up which ranged from 1 month to 15 months with mean 8.9 months we did not document any recurrence of the pathology, However, reoperation was done for 5 patients; 2 of them were operated upon for the other side of the same level L5-S1 and 3 were operated upon for other level L4-5. It is important to notice that 8 patients were lost at follow-up.

Table (1): Pain scoring (Visual Analogue Score; VAS) after surgery

VAS	Number of Patients
No pain	23
Mild to moderate (VAS 1-3)	16
Significant pain (VAS >4).	3

Table (2): Pain scoring (Visual Analogue Score; VAS) after surgery according to patients' groups

	Disc prolapse group (n:30)	Stenosis group (n:10)	Synovial cyst group (n:2)
VAS 0 (No pain)	18 cases	4 cases	1 case
VAS 1-2	7 cases	5 cases	1 case
VAS 2-3	3 cases	-	-
VAS 3-4	1 case	-	-
VAS >5	1 case	1 case	-

Postoperative weakness showed total improvement in 7 patients, better than preoperative in 17 patients, and no improvement in 6 patients. Postoperative total improvement of sensory deficit was documented in 7 patients, was better than preoperative in 19 patients, no improvement in 3 patients, and only one patient was deteriorated after surgery.

The functional outcome according to McNab criteria was documented. 16 patients showed excellent outcome **(Table 3)**.

Table (3): The MacNab criteria at the last follow-up in 34 patients.

McNab criteria	Number of Patients
Excellent (no pain)	16
Good (some pain)	12
Fair (moderate pain)	6

Ten patients out of a total of 42 during short-term follow-up reported some degree of postoperative leg pain. Thus, the incidence of major and moderate leg pain decreased from 100% to 24%, while 3 patients out of 29 patients reported some postoperative low back pain. Thus, the incidence of low back pain decreased from 69% to 7 %. On the other hand, motor weakness showed significant improvement in 24 patients out of 30 patients (80%).

No fixation was performed in all other cases except in one patient of the stenosis group, where we documented no improvement of the pain after extraforaminal decompression, and therefore Posterior Lumbar Interbody Fusion (PLIF) was performed 10 days later after the surgery.

Intraoperative findings:

Sixty percent of the cases (n = 25) had a frank extrusion with free fragments of disc material, and twelve percent had a subligamentous disc herniation (n =5), stenosis in 24 % (n =10), and synovial cyst in 5 % (n =2).

DISCUSSION

Due to the lumbosacral junction's distinct structure, L5-S1 EFLDH is completely distinct from EFLDH at higher lumbar levels[11-16]. As the lumbosacral region is a special junction with a unique anatomy characterized by long foraminal zone as well as L5-S1 prominent foraminal crowding. These anatomical features can stand behind the higher incidence of remnant FLDH after microdiscectomy for EFLDH at the L5-S1 level[8].

Degenerative changes at the lumbosacral junction, i.e., osteophytes formation, facet hypertrophy, disc degeneration can associate foraminal stenosis in such patients. So, significant facet joint removal to decompress both the intra- and extraforaminal space in these cases is always required, which in turn accelerate the process of the degeneration causing secondary instability and chronic lumbar pain [12].

The L5-S1 level has the longest "lumbosacral tunnel" because the length of the departing root, from the beginning of the foramen to the end of the extraforaminal, is the longest of any of the lumbar levels. The dorsal root ganglion (DRG) of exiting root, which is extraordinarily pain-sensitive structure usually locates within the foramen[13]. Direct compression of both the nerve root as well as the spinal ganglion by FELDH can evoke often particularly severe and sometimes excruciating pain[14]. That's why it is advised to manipulate carefully the DRG during microdecompression to avoid postoperative dysesthesia [2, 5].

Wiltse and Spencer were the first surgeons who described the transmuscular paramedian surgery to approach the extraforaminal space with less bone removal [15]. This approach was used as an effective surgical method for EFLDH, though which the facet joints can be preserved to avoid postoperative instability. Despite relatively good surgical outcomes of microdecompression of EFLDH at the L5-S1 level, it is worthy to note that the narrow operative corridor makes the approach extremely difficult [5].

Cervellini *et al.* [16], introduced the far lateral microdiscectomy technique to approach the nerve root

lateral to the foramen via a small paramedian incision, which offers direct straight route with better exposure of the pathology, less extensive muscle dissection as well as much preservation of the integrity of the facet joint. On the other hand, the iliac crests can obscure the exposure of L5/S1 level, which limits its applicability to somehow. 2 This is due to the special anatomical features in lumbosacral region, such as ala, the iliolumbar ligament, and the broad pedicle at the L5-S1 level which facilitate compression of the L5 root in the long extraforaminal zone by the herniated disc[17]. That's why we did not prefer to use the lateral approach for L5/S1, however we performed the surgeries through an approach just lateral to and partially through the inferior articulating facet of L5.

Why we performed our approach and we think it is better

We approach these patients through a midline skin incision with muscular separation beginning in the midline and then we approach the foramen and the extraforaminal space through the lateral part of the facet joint with removal of part of the lamina laterally without disrupting the pars interarticularis or the facet joint completely.

This approach is easy because the anatomical bony landmarks are clear and all spine surgeons are familiar with this region, in comparison to the transmuscular lateral approach [15].

With this approach we can expose the L5-foramen completely in order to avoid remnant foraminal fragments. At the same time the extraforaminal compartment could be exposed by following the nerve root from medial to lateral. The approach could be tailored according to the preoperative assessment of the extension of the pathology.

An important point in the anatomy of L5/S1 foramen is the longer foraminal zone at this level in comparison to higher lumbar levels, this may be a possible cause of remnant foraminal disc especially after a lateral transmuscular approach.

Another advantage in the approach we used is that the DRG is not manipulated extensively, because the nerve root was exposed at the beginning in its medial portion then the root is followed carefully from medial to lateral.

According to **Ryang and coworkers[18],** 95 percent of lateral approaches are successful, while just 57 percent of medial approaches are successful, and complications are reportedly more than twice as common with medial procedures. After a mean follow-up of 38.4 months, 78.3 percent of **Chang**'s 184 patients who underwent lateral approach surgery reported excellent or good outcomes [3]. **Vogelsang and Maier [19]** documented comparable outcomes using the same approach.

Porchet *et al.* [4], in their large series after long follow up period of 4.2 years for 202 patients operated via lateral approach, they documented excellent and good results in 73% patients with 1.5% minor complications related to surgery. On the other hand, **Garrido and Connaughton [20]** reported comparable results for the medial approach with 92% excellent and good outcome after nearly 2 years follow up. They had to fuse the spine in one of their 41 patients after doing complete facetectomy.

Foraminal and/or far lateral lumbar disc herniation can be approached via combined paraspinal and midline approach where total facetectomy followed by spinal fusion are recommended when microdecompression techniques is used to expose FLDH in the medial foraminal zone. **Ozveren *et al.* [21]** found among 18 patients with far-lateral disc herniation were treated with a combined approach, and all reported excellent outcomes with no symptoms of instability throughout the follow-up period.

CONCLUSION

Orientation of the pathology, proper diagnostic imaging as well as familiarity of the approach are significant factors for patient's improvement. We have found that our modified lateral approach is a safe, minimally invasive option with little complications.

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