# Surgical Outcomes of Extraforaminal Microdiskectomy by Midline Incision for Far-Lateral Lumbar Disk Herniation

Ismail Yüce[1] Okan Kahyaoğlu[2] Halit Çavuşoğlu[1] Yunus Aydın[2]

[1] Vocational School of Health Services, Acibadem Mehmet Ali Aydinlar Universitesi, Istanbul, Turkey
[2] Acibadem Healthcare Group, Fulya Hospital, Istanbul, Turkey

**Address for correspondence** Ismail Yüce, MD, Vocational School of Health Services, Acibadem Mehmet Ali Aydinlar Universitesi, Istanbul, Turkey (e-mail: dr.ismailyuce@gmail.com).

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## Abstract

**Background** Far-lateral lumbar disk herniation (FLDH) is defined as a disk herniation located laterally to the medial wall of the pedicle. The aim of our study is to describe the extraforaminal microdiskectomy by midline incision for FLDH, which does not include laminotomy–partial facetectomy, and to evaluate mid-term surgical outcomes.

**Methods** 107 patients who underwent surgery for FLDH by midline incision for the first time between 2012 and 2017 were included in our study. The assessment of neurological status of the patients was done by physical examination, preoperative Oswestry Disability Index (ODI), Visual Analog Scala (VAS) scores, and magnetic resonance images. They were then followed-up postoperatively and at 12 months with VAS and ODI tests.

**Result** 58 (54.2%) patients were male and 49 (45.8%) were female. The mean age at the time of surgery was $55.0 \pm 8.6$ years. The mean ODI scale score was $32.4 \pm 6.2$ preoperatively, $11.4 \pm 2.1$ early postoperatively, and $9.7 \pm 2.2$ in late postoperative follow-up (statistically significant, $p = 0.001$). The average VAS was $7.51 \pm 1.1$ preoperatively, $2.74 \pm 0.7$ early postoperatively, and $0.68 \pm 0.08$ in late postoperative follow-up (statistically significant, $p = 0.001$). The average operative time was $41 \pm 7$ (37 to 58) minutes.

**Conclusions** The extraforaminal microdiskectomy without laminotomy by midline incision is a minimally invasive approach for FLDH. Our technique allows a sufficient and safe decompression of the neural structures, and thus results in a significant reduction of the symptoms and disability

**Keywords**
- Far-Lateral Lumbar Disk Herniation
- minimally invasive approach
- microdiskectomy
- midline incision
- surgical outcomes

## Introduction

Far-lateral lumbar disk herniation (FLDH) is defined as a disk herniation located laterally to the medial wall of the pedicle and constitutes ~6.5–10% of all lumbar disk herniations (LDHs).[1–6] Minimal lumbar pain, predominant leg pain, and compressed nerve root localized by magnetic resonance imaging (MRI) with or without sensory or motor deficit are symptoms of FLDH.[7,8] The conventional midline approach, which includes large laminotomy–partial facetectomy and paramedian approaches, is used for the surgical treatment of FLDH.[9] Recently, modified paramedian approaches which intend to protect the lamina and the facet have been commonly used.[10–13] The aim of our study is to describe the extraforaminal microdiskectomy for FLDH by midline incision, which does not include laminotomy–partial facetectomy or damaging of the paravertebral muscles, and to share our experiences and mid-term surgical outcome of FLDH.

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## Materials and Methods

In our clinic, 1,073 patients were treated by microdiskectomy for LDH for the first time between 2012 and 2017. Over the time interval, 327 of 1,073 patients were treated for F LDH and 121 of them were treated by extraforaminal microdiskectomy by midline incision. A total of 107 patients who met the inclusion criteria were included in our study. All of the patients were operated by the senior author (YA). The patients who were operated for other lumbar pathologies were not included in the present study. All the patients who had the following criteria were included in this study: (1) symptoms of back pain and radicular symptoms attributable to FLDH, (2) MRI evidence of FLDH (neurologic compression by disk herniation), (3) failure of conservative measures for a minimum 3 months, (4) absence of associated pathology such as instability, inflammation, or malignancy, and (5) no history of surgery for lumbar stenosis, disk herniations, or lumbar fusion. The assessment of neurological status of the patients was done by physical examination, preoperative Oswestry Disability Index (ODI), Visual Analog Scala (VAS) scores, and MRI (►**Fig. 1**). Our study was designed with followed-up criteria. Therefore, all patients were admitted to our neurosurgery department with VAS and ODI tests for this study. Questions were asked to all patients via face-to-face assessment or questions were addressed to family members if the patients had communication problems owing to regional dialect, and the data were collected by the medical secretary in our clinic. They were then followed-up postoperatively at 12 months with VAS and ODI tests which were planned into the study design. The features evaluated after

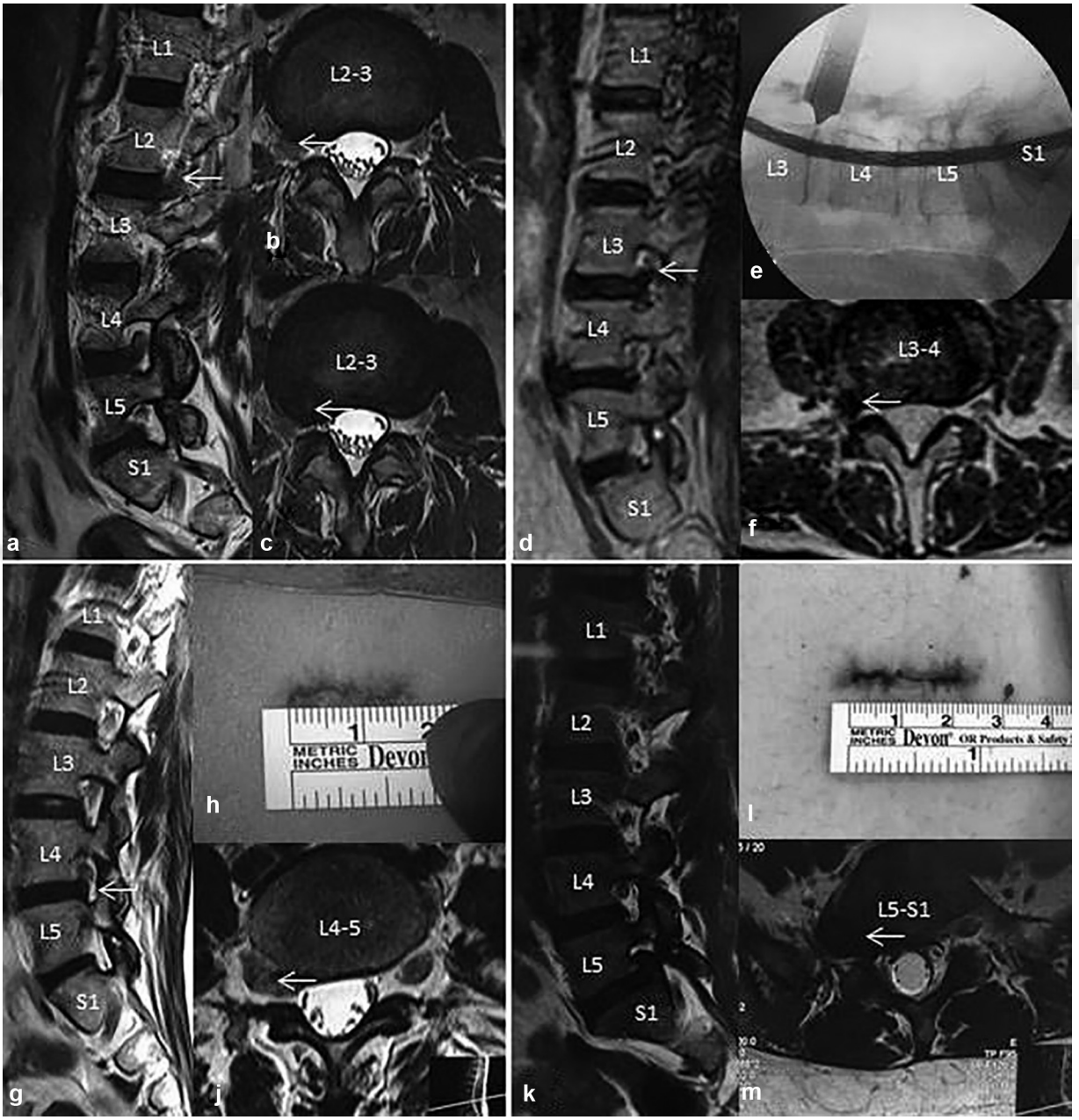


**Fig. 1** Preoperative T2-weighted magnetic resonance imaging (MRI) of L2–L3, L3–L4, L4–L5, L5–S1 far-lateral lumbar disk herniation (FLDH), sagittal images (*A*, *D*, *G*, *K*) and axial images (B, C, E, F, H, J, L, M).

surgery included neurological status, disability of the patients, and average operative time. Informed consent was obtained from all individual participants included in the study.

### Surgical Procedures

After midline skin incision, paramedian opening of the fascia, and subperiosteal dissection of the paravertebral muscles, a retractor—which was redesigned from a classic Taylor retractor—is placed. A portable c-arm flouroscopy is used to verify the disk level. Using microscope, the transverse process–facet joint is exposed from the lateral side of the upper lamina. The superior border of the transverse process and the lateral aspect of the isthmus and facet are landmarks of extraforaminal microdiskectomy for FLDH. Bone is removed by a high-speed drill between the upper side of the transverse process–facet joint and the intertransverse ligament. The lateral part of facet joint is not removed. For L5–S1 FLDH, a part of the iliac crest is removed by a high-speed drill. To expose the lateral border of the facet joint, the mesial part of the transverse ligament is removed using a Kerrison rongeur. Using an angled curette, the junction of medial distal part of transverse ligament is freed from the upper side of the transverse process. The fenestration and exposure of the exiting nerve root are completed. The nerve root is transposed laterally by micro retractor before diskectomy. The disk is removed extensively with pituitary rongeurs and curettes. Then, the nerve root is wrapped with the mesial part of the transverse ligament (►**Figs. 2** and **3**).

The patient is allowed out of bed without a lumbosacral orthesis 4–5 hours after surgery and is discharged within 24 hours. An exercise program is started after 2 weeks to strengthen the paravertebral muscles and the patient is advised to return to daily activities.

### Statistical Analysis

The data obtained from the cases were recorded using Microsoft Excel-2013. SPSS 21 (Statistical Package for Social Sciences) for Windows Software was used for the evaluation of the findings (mean and standard deviation). Statistical significance was set at a probability value of less than 0.05 (Confidence Interval [CI] 95%). The statistical analysis was performed with Paired Sample Test and analysis of variance (ANOVA). The clinically significant change is considered to be a change of 12.8 points on the ODI. Changes greater than 12.8 points are reported to be "responders" and the changes less than 12.8 are reported to be "non-responders" on the ODI scale.[14]

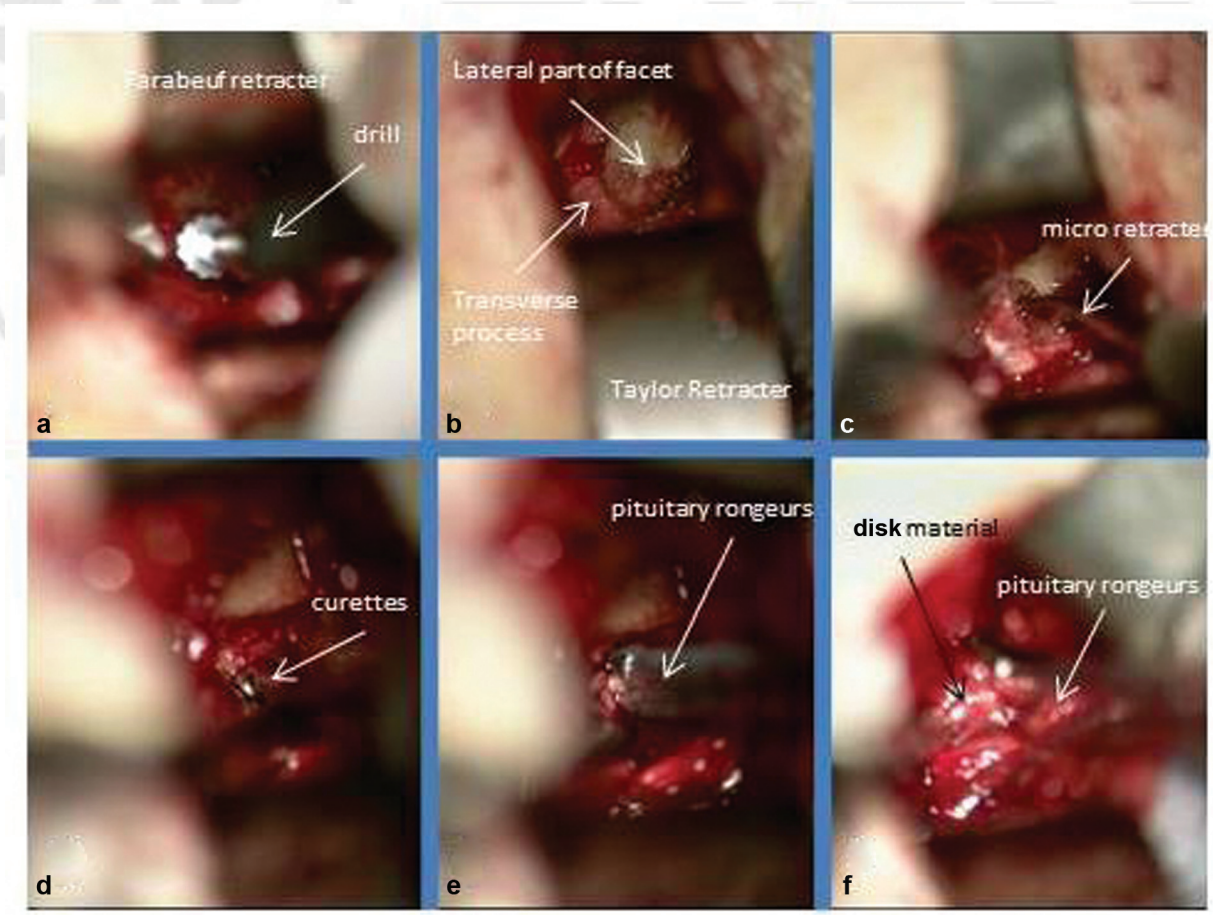


**Fig. 2** L4–L5 right-side far-lateral lumbar disk herniation (FLDH) operation images. (**a**) Drilling the bone by high-speed drill. (**b**) Removed bone area between upper side of the transvers process–facet joint and intertransverse ligament. (**c**) Exposing the lateral border of the facet, the mesial part of the transvers ligament. (**d**) Exposure of the exiting nerve root. (**e**) Removing the disk with pituitary rongeurs. (f) Wrapping the nerve root with fat tissue.

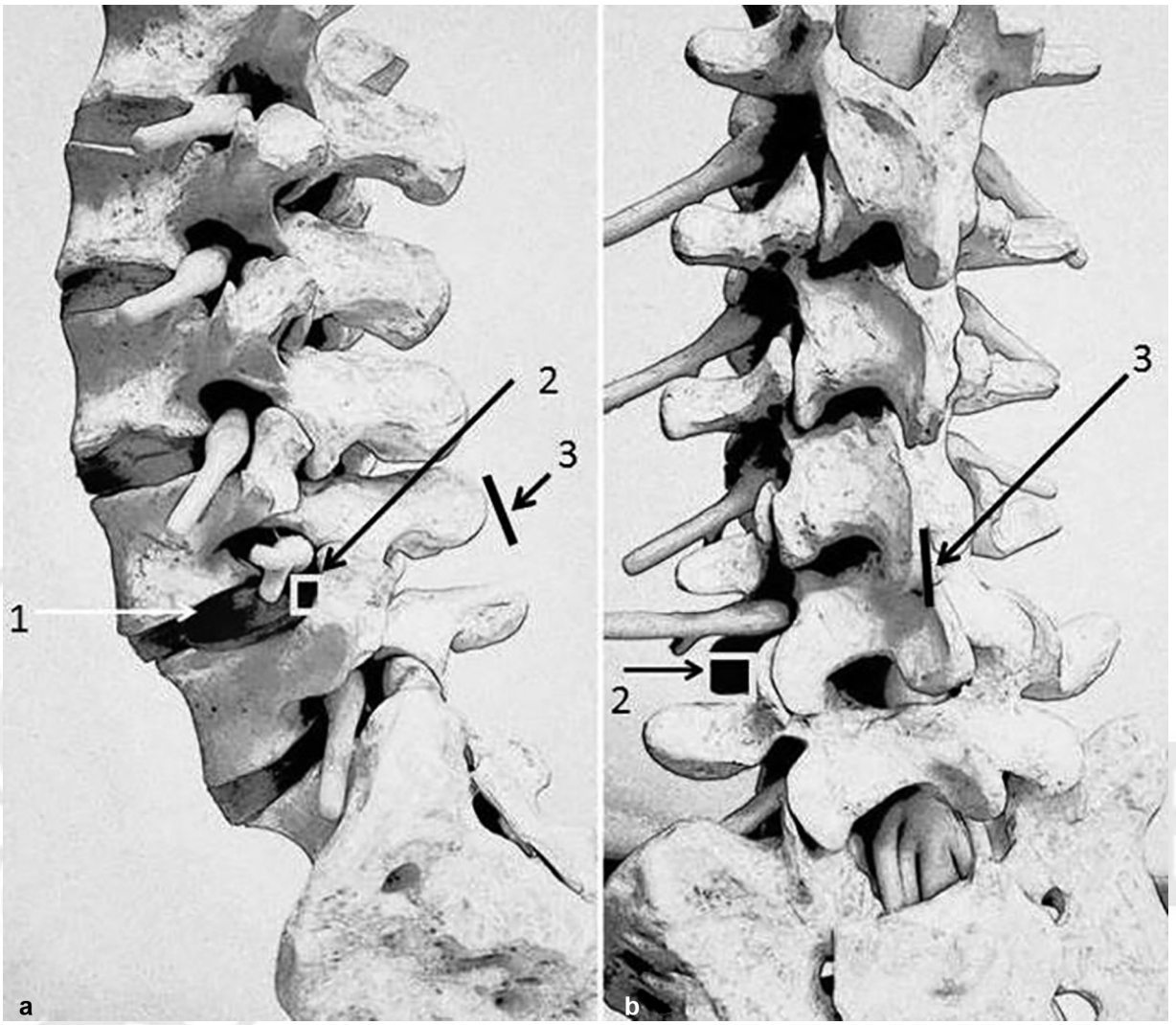


**Fig. 3** Lumbar spinal column with L4–L5 left-side far-lateral lumbar disk herniation (FLDH) images, (**a**) lateral, (**b**) oblique, 1-Left-side FLDH, 2-Surgical area, and 3-Skin incision.

## Result

Out of 121 patients who were treated with extraforaminal microdiskectomy by midline incision over the time interval, 14 were excluded because of refusal to follow-up or due to missing data such as ODI or VAS forms (9 patients refused to follow-up and 5 patients had insufficient ODI and VAS forms). The average postoperative follow-up period was 15.4 months (ranging from 15 to 29 months). Among the remaining patients, 58 (54.2%) were male and 49 (45.8%) were female. The mean age at the time of surgery was $55.0 \pm 8.6$ years (ranging from 39 to 71 years). Eleven patients were operated for L2–L3 FLDH, 35 for L3–L4 FLDH, 44 for L4–L5 FLDH, and 17 for L5–S1 FLDH (►**Table 1**).

The mean ODI was $32.4 \pm 6.2$ preoperatively, $11.4 \pm 2.1$ early postoperatively, and $9.7 \pm 2.2$ during late postoperative follow-up. None of the patients' ODI got worse early postoperatively. The changes of preoperative and early postoperative ODI was $20.99 \pm 6.7$ and the changes of preoperative to late postoperative (12 months) ODI was $22.69 \pm 7.2$. The differences between preoperative to early postoperative and preoperative to late postoperative ODI were statistically significant ($p = 0.001$) (►**Table 2**). Based on the ODI, 101 (94.3%) patients were found to have responded positively to surgery at the early and late follow-up periods. The change was clinically significant.

**Table 1** Demography of patients

| Parameters | | *n* | % |
|---|---|---|---|
| Mean Age (yrs) | 55.0 | | |
| Average follow-up (mths) | 15.4 | | |
| Gender | | | |
| Female | | 49 | 45.8 |
| Male | | 58 | 54.2 |
| Level of FLDH | | | |
| L2–L3 | | 11 | 10.3 |
| L3–L4 | | 35 | 32.7 |
| L4–L5 | | 44 | 41.1 |
| L5–S1 | | 17 | 15.9 |

Abbreviation: FLDH, far-lateral lumbar disk herniation.

**Table 2** Outcome of surgical treatment

| Parameters | Average | *p* |
|---|---|---|
| Operation time (minutes) | 41 ± 7 | |
| ODI | | |
| Preoperatively | 32.4 ± 6.2 | |
| Early postoperatively | 11.4 ± 2.1 | |
| Late postoperatively | 9.7 ± 2.2 | |
| Changes of ODI | | |
| Preoperative/early postoperative | 20.99 ± 6.7 | 0.001 |
| Preoperative/late postoperative | 22.69 ± 7.2 | 0.001 |
| VAS | | |
| Preoperatively | 7.51 ± 1.1 | |
| Early postoperatively | 2.74 ± 0.7 | |
| Late postoperatively | 0.68 ± .08 | |
| Changes of VAS | | |
| Preoperative/early postoperative | 4.76 ± 1.3 | 0.001 |
| Preoperative/late postoperative | 6.83 ± 1.2 | 0.001 |

Abbreviations: ODI, Oswestry Disability Index; VAS, Visual Analog Scala.

The average VAS was 7.51 ± 1.1 preoperatively, 2.74 ± 0.7 early postoperatively, and 0.68 ± 0.08 during late postoperative follow-up. The changes of preoperative to early postoperative VAS was 4.76 ± 1.3 and the changes of preoperative to late postoperative (12 months) VAS was 6.83 ± 1.2. The differences between preoperative to early postoperative and preoperative to late postoperative VAS were statistically significant ($p = 0.001$) (►**Table 2**).

Five patients returned 6 months after operation due to low back pain and they were investigated with lumbar MRI, computed tomography (CT), and radiography (lateral neutral-hyperflexion- hyperextension) and were treated by medical therapy (►**Figs. 4** and **5**).

The changes of preoperative to early postoperative ODI and VAS and of preoperative to late postoperative ODI and VAS for levels L2–L3, L3–L4, L4–L5, and L5–S1 of FLDH were not statistically significant ($p > 0.05$).

The average operative time was 41 ± 7 (37 to 58) minutes. The patients were mobilized 4 or 5 hour after surgery and were usually discharged 1 day after operation. There were no perioperative deaths. Neural injury or accidental durotomy were not observed during operation. No revision surgery was

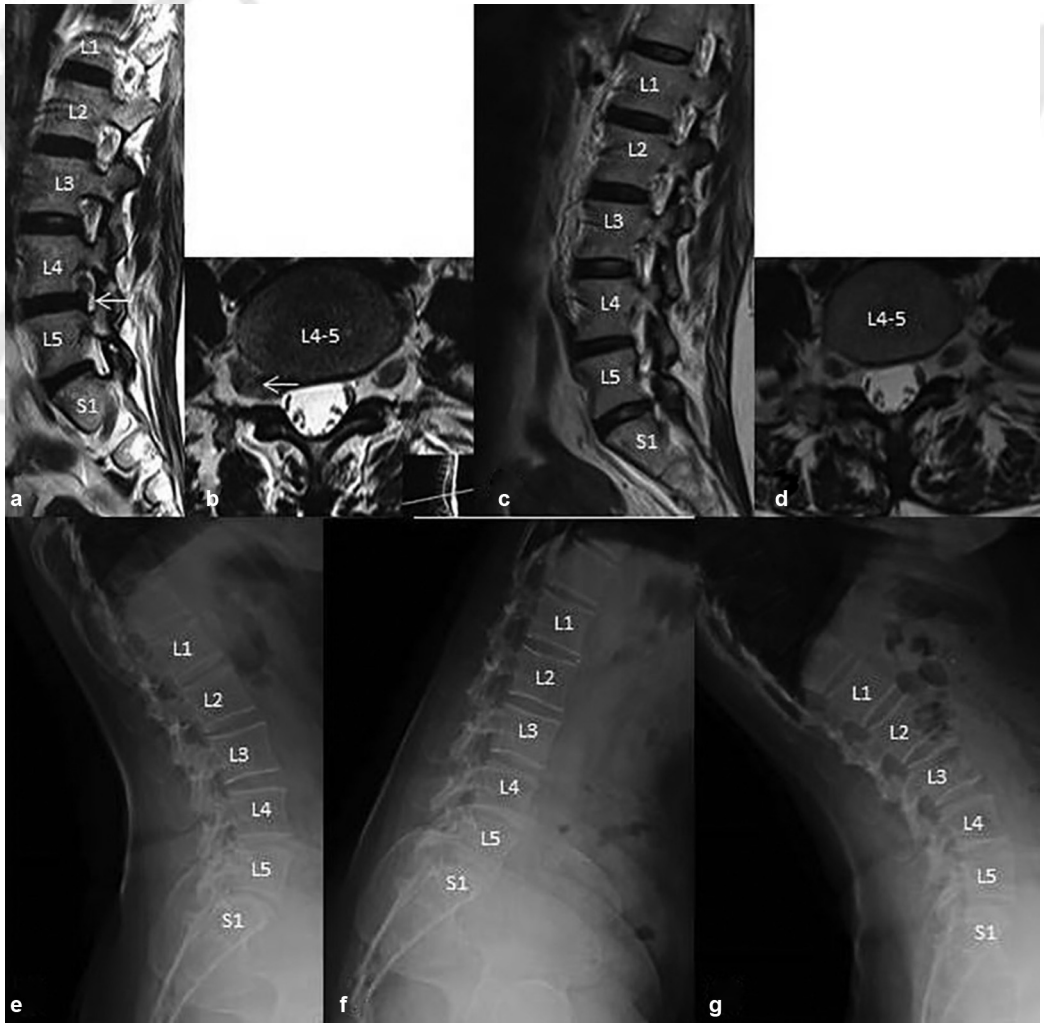


**Fig. 4** Preoperative (A-sagittal, B-axial) and postoperative (C-sagittal, D-axial) T2-weighted magnetic resonance imaging (MRI) of L4–L5 right-side far-lateral lumbar disk herniation (FLDH), and postoperative lateral radiographs (E-neutral, F-hyperflexion, G-hyperextension).

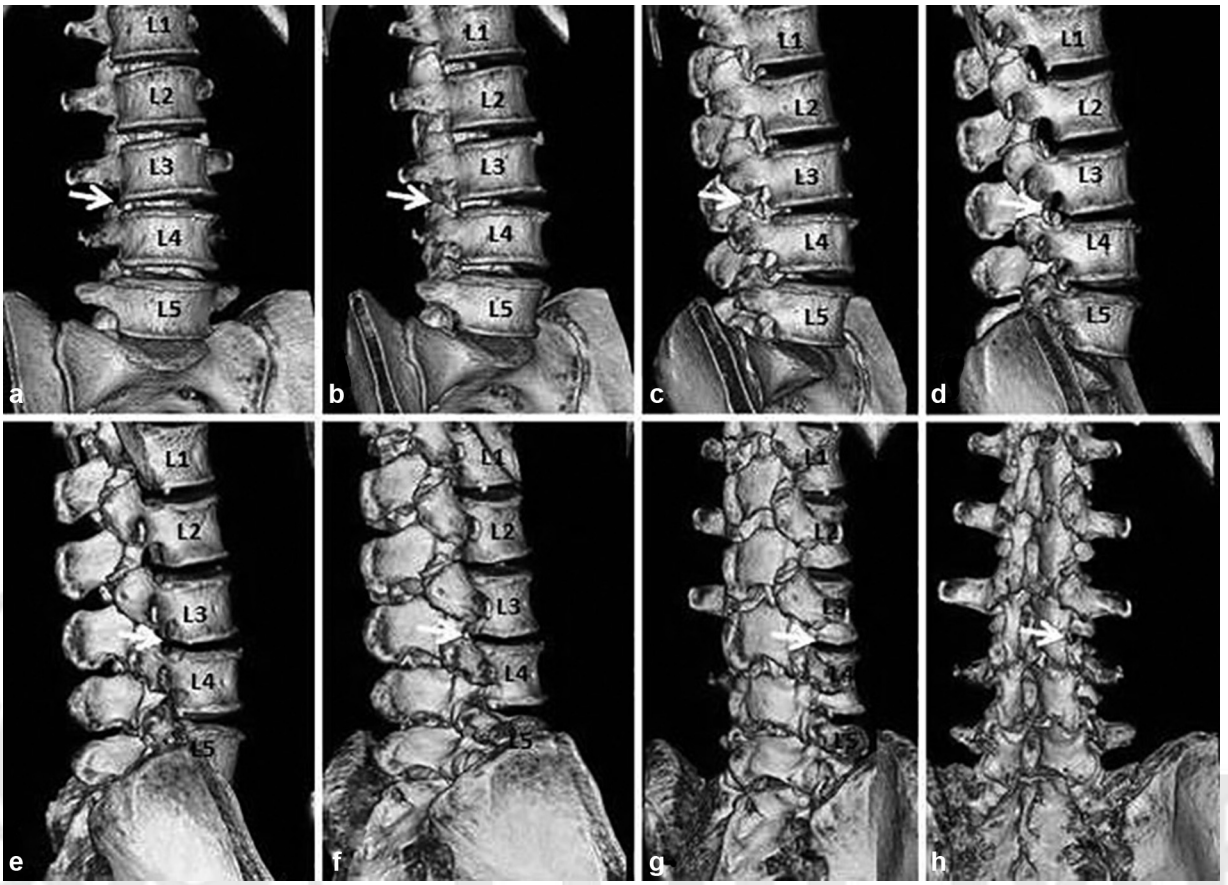


**Fig. 5** Postoperative three-dimensional computed tomography (3D CT) images of L3–L4 right-side far-lateral lumbar disk herniation (FLDH) (**a–h**) Turn through anterior to posterior.

required in the early postoperative period. Two patients were discharged after 2 days due to incisional problems and minimally subcutaneous hematoma (1.8% = complication rate).

## Discussion

The surgical approach for FLDH is important to maintain spinal stability. The paraspinal muscles, facets, and posterior ligaments are mainly responsible for the spinal stability.[15] Many studies have described different surgical approaches and varying techniques for the treatment of FLDH.[16,17] One important aspect of our technique is that it additionally allows treatment of other degenerative pathologies such as lumbar stenosis or median disk herniation in adjacent level by a single incision. The other is that the approach protects the facet joints and paravertebral muscles thus preserving spinal stability.

Initially, the most common surgical approach was hemilaminectomy which includes destruction of the facet joint by a midline incision. Later, microdiskectomy with paramedian muscle splitting approach was preferred to avoid facetectomy.[10,18,19] Our technique protects the facet joint, lamina, ligamentum flavum, and intertransverse ligament

Diskectomy with midline incision via the assistance of microscope which allows a three-dimensional vision was first described by Caspar.[20] Although the endoscopic technique allows only a two-dimensional vision which is often blurred due to bleeding, some authors considered endoscopy as the preferred method for treating FLDH .[21,22]

In 2004, Tessitore and Tribolet described the microsurgical transmuscular approach for FLDH.[23] They mentioned that the muscle-splitting approach allows surgeons to reach the far-lateral disk herniation without any facet bone removal. The skin incision is ~5 to 7 cm long and 8 to 10 cm from the midline in their technique. Similarly, our technique allows surgeons to reach the far-lateral disk herniation without any facet bone removal without muscle-splitting. The incision is midline and it is 2 or 3 cm in our technique.

LDHs are common between the ages of 30 and 50 years while FLDH present predominantly in older patients.[24–26] In the present study, the mean age is 55.0 ± 8.6 years. Excellent and good outcomes have been reported in the literature.[3,8,19,24,25,27] The outcomes of our technique for FLDH are similar to the others. The conservative treatment can occasionally be effective for FLDH, but surgery is usually required.[28] The operative time of posterior midline approach for LDH reported in the literature ranges between 40 and 120 minutes.[3,29] In our clinic, it varies between 30 and 55 minutes for LDH. The average operative time for FLDH in the present study is 41 ± 7 minutes, and it is similar to others.

## Conclusions

The extraforaminal microdiskectomy by midline incision as described in the present study is a minimally invasive approach for FLDH. Our technique allows a sufficient and safe decompression of the neural structures and thus results in a significant reduction of the symptoms and disability. Additionally, it does not require an endoscope. The paramedian muscle of the spine is not damaged. The main conclusion is that our technique allows surgical treatment of FLDH by single median incision as in spinal stenosis and/or median LDHs.

### Informed Consent

Informed consent was obtained from all individual participants included in the study.

### Ethical Approval

This study was performed with clinical data collected from patient files collected retrospectively. For this type of study, formal consent is not required. All patients were informed for the procedure and the study.

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This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

### Conflict of Interest

The authors report no conflict of interest concerning the materials or methods used in this study or the findings specified in this paper.

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