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RESEARCH

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The microendoscopic approach for far lateral lumbar disc herniation: a preliminary series of 33 patients

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Abstract

Background: Far lateral lumbar disc herniation (FLLDH) compresses the nerve root at the same level. The laterally herniated disc fragment typically could not be exposed by the standard posterior hemi-laminectomy technique, and a total facetectomy including wide bone removal is usually mandatory for good exposure and removal of the herniation but simultaneously increasing the risk of instability.

Objective: In the present study, the author presents his initial 4-year experience and surgical outcome in treatment of far lateral lumbar disc herniation with a posterior endoscopic approach.

Methods: This study was carried out in the period between February 2011 and January 2015, where 33 consecutive patients with symptomatic FLLDHs underwent a posterior endoscopic lateral approach for resection of the herniation. The mean age was 39.3 years, range 26–59 years. Patients were followed up for 4 years (mean follow-up was 19.9 months, range 3–47 months). Patients had their clinical outcomes reviewed and evaluated in terms of pain by visual analog scale (VAS) and in terms of functional outcome by modified Macnab criteria (MMC).

Results: Mean operative time was 91 min (range 55–166 min). At initial follow-up, according to MMC (3 months postoperative), 86% of patients were pain-free (28/33) and considered their postoperative status as excellent and 14% as good (5/33), and no patients reported a fair or poor outcome. There were no new postoperative neurological deficits or major complications. There were three cases of accidental medial facetectomy due to excess bony work, a single case of dural tear, and a single case that had a transient postoperative neuralgia that persisted for 2 weeks.

Conclusions: FLLDH can be treated adequately with the reported microendoscopic approach. The technique is associated with marked improvement in back pain and lower limb symptoms, as well as a short length of hospitalization and other benefits of minimal invasiveness. Although a transitory learning curve is necessary, the endoscope in general was safe in handling bimanually and allowed adequate mobility and visualization.

Keywords: Far lateral lumbar herniation, Microendoscopic discectomy, Extraforaminal disc herniation

Introduction

By virtue of computed tomography (CT) and magnetic resonance imaging (MRI), diagnosis of far lateral lumbar disc herniation (FLLDH) also known as extra-foraminal lumbar disc herniation came into existence decades after the emergence of surgical approaches for other entities of lumbar herniation. This could be attributable to diagnostic incapability of X-ray and myelographic studies [1, 2].

Extra-foraminal lumbar disc herniation comprises 7–12% of all lumbar disc herniations with the highest incidence at L4–L5 in the elderly population. It is described as lumbar disc herniation ensuing compression of the exiting nerve root at the same level external to the neural foramen/canal lateral or beneath the vertebral facet joint [3–5]. Symptomatic presentation varies between lumbar pain to severe lower limb radicular symptoms with frequently associated sensory deficit or motor weakness [3, 6]. Inherent technical difficulties in approaching the lateral compartment with no neural compromise or bony excess work exerted on facet joint that may induce further spinal instability with sequent

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necessary spinal fusion surgery render surgical treatment of FLLDH, a significant challenge to the spinal surgeon [1].

Variable surgical approaches have been proposed for treatment of FLLDH with variable success and complication rates. They encompass midline laminectomy with medial or total facetectomy, trans-pars technique with extra-foraminal approach, combined inter-transverse approach, and paramedian extra-foraminal and antero-lateral retroperitoneal approaches [7]. Moreover, minimally invasive procedures such as percutaneous far lateral endoscopic technique were introduced aiming to improve outcome and lessen the peri-procedural complications [5]. We hereby present our report illustrating efficacy represented by short-term surgical outcome, safety, and advantages of the lateral posterior microendoscopic approach in 33 patients presented with FLLDH.

Material and methods

Patient population

A total of 33 consecutive patients (20 males and 13 females) with FLLDH were included in the study in the period between February 2011 and January 2015. Median age at the time of surgery was 43 years, range 26–59 years. All patients included in the current study had symptoms of spontaneous radiculopathy that in some was aggravated by femoral stretch test while being refractory to 8 weeks of conservative therapy. Radicular leg pain could be escorted by motor weakness, sensory deficits, or lost deep tendon reflexes. Radiological examination inclusive of MRI or non-contrast lumbar CT assigned clinical findings into unilateral single-level extra-foraminal disc herniation compressing the nerve root responsible for symptoms experienced. Patients were excluded from our study when having (1) co-existing central spinal canal stenosis, (2) spinal instability evident on dynamic lumbar radiography, (3) prior history of lumbar disc surgery/intervention, and (4) multilevel or recurrent disc herniation.

Surgical procedure

Prior to the procedure, an informed consent is taken from all patients. Following general anesthesia, the patient is placed in a prone position on a lumbar frame. Under lateral fluoroscopic imaging obtained by fluoroscopic C-arm, the correct level is identified using a special endoscopic localizer.

An approximately 18-mm incision is then made just lateral to the midline on the ipsilateral side of disc herniation. Through the incision, after gentle stripping of the para-spinal musculature, a special endoscopic obturator of the Endospine® system (Karl Storz GmbH & Co., Tuttlingen, Germany) is inserted and directed by fluoroscopy till the bony junction of pars interarticularis with the transverse process of the same lumbar vertebrae. The obturator is then removed followed by insertion of the endoscopic insert and endoscope. Fluoroscopy is then repeated to ensure the exact working level and positioning.

Under endoscopic visualization, bipolar cautery and pituitary forceps are utilized to dissect any soft tissue remnant concealing the targeted bony field. Sequent to that, drilling is started at the lateral end of pars interarticularis-lamina junction. A high-speed microdrill is used to create a laminotomy through the lateral aspect of the pars interarticularis and lamina with exposure of the lateral part of the ligamentum flavum, followed by release and gradual resection of the lateral part of the ligament utilizing angled Kerrison rongeurs with careful attention to the underlying exiting nerve root. A small portion of the lateral margin of the corresponding superior or inferior articular process may be further removed to widen the field or if concurrent encumbering facetal hypertrophy existed. A comparison between the bony work in regular fenestration and in the described approach is depicted in Fig. 1, and intraoperative endoscopic views at the beginning and end of an operation are shown in Fig. 2a, b.

Thenceforth, the exiting nerve root is explored via micro-dissectors in a cephalo-lateral direction exposing the extra-foraminal herniated/sequestrated intervertebral disc fragment. Any venous bleeding is controlled using hemostatic agents and bipolar coagulation. Following satisfactory decompression, the field is scanned for any ancillary disc material. Complete hemostasis followed by closure in anatomic layers is then attained with no drainage applied. Patients are encouraged to mobilize as soon as they could whereas normal daily life activities were allowed 1 week following the procedure. There was no necessity for open conversion in any of our cases. Prophylactic antibiotics were given intraoperatively and continued for 5 days postoperatively. Post-procedural parental analgesics were administered.

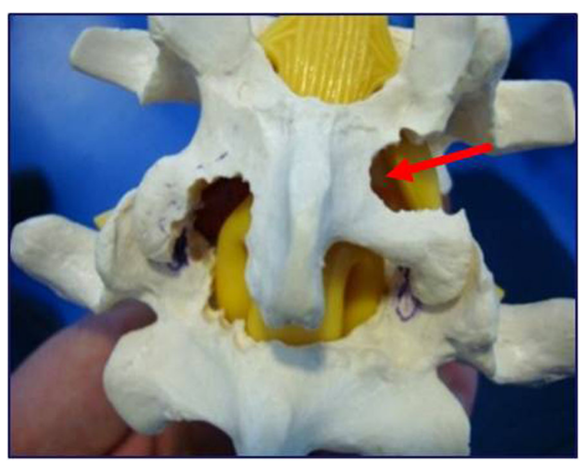

Fig. 1 Comparison between the bony work in regular fenestration and in the described approach (red arrow)

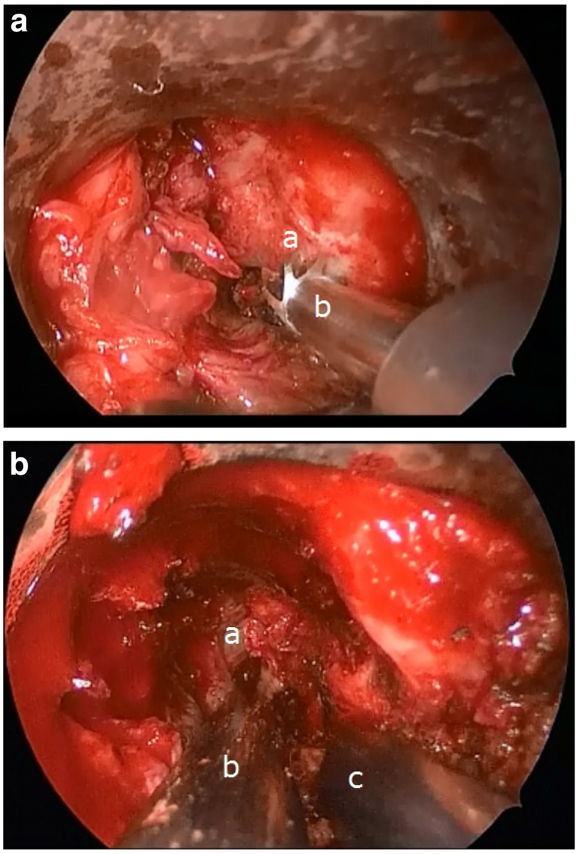

Fig. 2 a Intraoperative endoscopic view during the start of a left sided FLLDH excision. (a) Lateral edge of lamina. (b) Micro-drill burr at start point of drilling. **b** Endoscopic view at the end of operation for the same patient showing (a) lower aspect of exiting nerve root, (b) suction device in place after disc fragment removal, and (c) micro-dissector

Pre- and post-procedural evaluation

Following the surgery, all patients were regularly evaluated at preset clinical follow-up visits at 3 and 6 months. All patients' records were analyzed in terms of pre- and post-procedural symptomatic alteration, operative time, blood loss, operated levels as well as surgical complications, and outcome. Motor power in the initial assessment were compared to postoperative state grading from 0 to 5 where 0 indicating total paralysis with no active movement; 1, muscle contractile movement; 2, movement only aided by gravity; 3, movement against gravity; 4, movement against some resistance; and 5, normal muscle power.

Short-term outcome evaluation was performed utilizing the visual analog scale (VAS) for back and radicular leg pain (VAS score from 0 to 10 where 0 indicates no pain and 10 points out the worst possible pain) while long-term functional assessment was categorized into excellent (patient is free of pain and capable to resume normal life activities), good (occasional non-radicular pain with relief of presenting symptoms yet, patient tolerates only modified work), fair (some functional improvement render patient handicapped/unemployed), and poor (persistent postoperative root-related compressive symptoms necessitating revision surgery at the index level) based on modified Macnab criteria (Table 1).

Statistical analysis

IBM SPSS statistics (V. 24.0, IBM Corp., USA, 2016) was used for data analysis. Data were expressed as median and percentiles for quantitative non-parametric measures in addition to both number and percentage for categorized data. The following tests were done: (1) comparison between two independent groups for non-parametric data using Wilcoxon rank sum test, (2) Wilcoxon signed-rank test for comparison between two dependent groups for non-parametric data, and (3) chi-square test to study the association between each 2 variables or comparison between 2 independent groups as regards the categorized data. The probability of error at 0.05 was considered significant, while at 0.01 and 0.001 are highly significant.

Results

Thirty-three patients divided into 20 men (60.6%) and 13 women (39.4%) met the inclusion criteria and completed their follow-up visits. Three patients were lost to 6 months follow-up yielding a follow-up rate of 90.9%. The mean age was 39.3 years, ranging between 26 and 59 years. Of the 33 patients, 100% reported radiating leg pain while sensory deficits and lost deep tendon reflexes were encountered in 60.6% (n = 20) and 12.2% (n = 4), respectively. Femoral stretch test was positive in 63.6% (n = 21). Based on radiological assessment, all patients were diagnosed with FLLDH ranging between 6.1% (n = 2) at level L2–L3, 45.5% (n = 15) at L3–L4, and 48.5% (n = 16) at level L4–L5. In all patients the posterior micro-endoscopic approach successfully removed the herniated disc material, there was no recurrence or revision surgery necessitated. The median operative time was 91 (range 55–166) min, and the median intraoperative blood loss

Table 1 Modified MacNab Criteria assessing long-term functional outcome

Result	Criteria
Excellent	No pain, no restriction of mobility, able to return to normal work and activities
Good	Occasional non-radicular pain; relief of presenting symptoms; able to return to modified work
Fair	Some improved functional capacity; still handicapped and/or unemployed
Poor	Continued objective symptoms of root involvement; additional operative intervention needed at the index level, irrespective of length of postoperative follow-up.

was 30 (range 10–55) ml. The mean hospital stay was 1.6 ± 0.7 days.

Patients were followed up for a median of 30 months. Preoperative sensory deficits were prominent in 60.6% (n = 20) of our patient which were reduced into 12.1% (n = 4) at 3 months follow-up denoting a remarkable sensorineural betterment ($p < 0.001$). A highly significant ($p < 0.000$) post-procedural improvement was evident in muscle power as noted by the rise of median motor power grade from 3.0 (range, 1.0–4.0) preoperatively to 5.0 (range, 3.0–5.0) at the last follow-up visit.

Comparable to preoperative complaints at 3 and 6 months follow-up, a highly significant decrease of median VAS score for radiating leg pain ($p < 0.000$) from 8.0 (range7.0–9.0) into 1.0 (range 0.0–2.0) was depicted. Although, a statistical significance difference ($p = 0.038$) was noted between 1 month and 6 months follow-up yet with no clinical discernible symptomatic improvement. Among our cases based on Macnab criteria, the overall results were excellent in 84.8% (n = 28) of the patients and good in 15.2% (n = 5). No patients reported a fair or poor outcome (Table 2).

Despite the fact that no significant difference was seen in regards to preoperative median VAS score among patients eventually exhibiting excellent (median VAS score equal to 8.0 (25–75% percentile, 7.0–8.75)) or good (median VAS score equal to 9.0 (25–75% percentile, 8.0–9.5) functional results. However, after 6 months, patients demonstrating a highly significant decrease in VAS score were related to the excellent group (VAS score 0 (25–75% percentile, 0.0–1.0)) while others were related to the good category (VAS score 4 (25–75% percentile, 3.25–4.0). Through this, we assume that the median VAS pain score may be taken as a predictor of functional outcome prescribed by Macnab (Fig. 3a, b).

A total of 15.15% (n = 5) surgery-related complications were encountered. There were three cases of accidental medial facetectomy comparable to one case of dural tear showing no post-procedural CSF leakage. We had only one patient that experienced transient postoperative neuralgia continuing for 2 weeks yet did not affect the final clinical outcome. Neither de novo/persistent post-procedural neurological deficits nor major complications were depicted.

Table 2 Patients' characteristics and outcomes

Gender	
Male	20
Female	13
Level operated	
L2–3	2
L3–4	15
L4–5	16
Operative time (min)	Average 110 (range 55–166)
Blood loss (ml)	Average 33 (range 10–55)
Femoral stretch test	
Positive	21
Negative	12
Lost tendon reflexes	
Negative	29
Postive	4
Clinical improvement	
Radiating leg pain	
Proeperative VAS score	Average 8 (range 6–10)
Postoperative VAS score	Average 2.1 (range 1–4)
Postop. VAS score 6 months[a]	Average 1.8 (range 1–4)
Sensory deficit	
Preoperative	
Present	20
Absent	13
Last follow-up	
Present	4
Absent	29
Motor weakness (out of 5)	
Preop.	Average 3.3 (range 1–5)
Last follow-up	Average 4.7 (range 3–5)
Functional outcome (by modified Macnab criteria)	
Excellent	28
Good	5

[a]3 out of 33 patients were lost to follow-up before 6 months

Discussion

In a cadaveric study, Lindblom [8] firstly described far lateral disc prolapse as lumbar disc herniation outside the vertebral canal. As per Macnab 1971 [9], laminectomy failed in nerve root exploring in two cases with radicular symptoms attributable to lateral disc protrusion at L5–S1. Abdullah et al. [10] explicated the clinical entity of FLLDH on discography as infra-facetal extreme lateral herniation at the same level of lateral to intervertebral foramen. In opposition to postero-lateral disc protrusion, FLLDH encroaches on the nerve root at the same level ensuing intense radicular leg pain with L4–L5 being the most commonly involved [11].

FLLDH may adequately respond to conservative treatment composite of steroidal and non-steroidal anti-inflammatory drugs. However, failure of medical therapy, persistent pain, significant sensory deficit, or progressive motor weakness necessitates surgical intervention [12]. Many posterior surgical approaches such as medial facetectomy, inter-transverse technique, full facetectomy

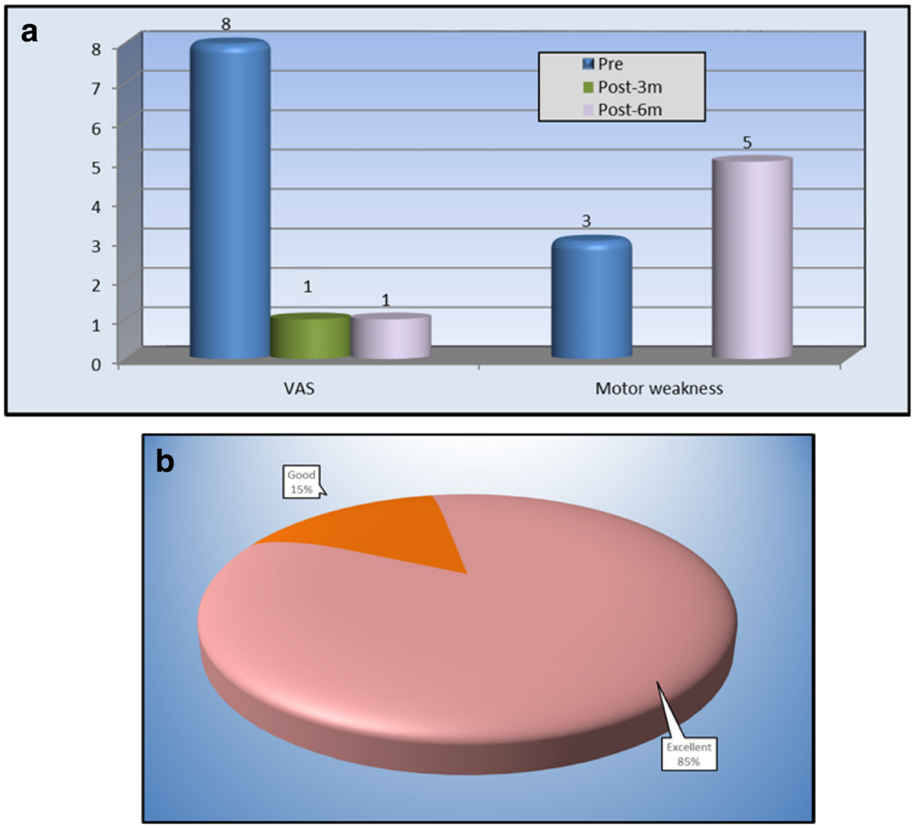

Fig. 3 **a** Clinical outcome based on visual Analog score (VAS) for leg pain. **b** Functional outcome by MMC

fusion, trans-pars technique, extra-foraminal technique have been advocated for treatment of FLLDH [13].

Medial facetectomy coupled with extended laminotomy or hemi-laminectomy could provide an access for dumbbell-shaped medial or foraminal sequestrated disc fragment with an extra-foraminal tail allowing its removal; however, it does not explore clearly the far lateral compartment making it a good choice for L5–S1 disc herniation where the pedicles are far apart [14]. In cases managed with total facetectomy, although the nerve root could be thoroughly visualized permitting adequate decompression, however, post-procedural low back pain and instability presupposing to fusion procedures have been reported. Nonetheless, Epstein [19] claimed low risk of instability with only 2% are in need for fusion [15–19]. Donaldson et al. [20] excised FLLDH with trans-pars extra-foraminal technique with 72% success rate, yet limited access to medial portion of the disc while accelerating risk of instability and recurrence rendered the technique ineffective by Epstein [21].

The inter-transverse technique permits direct visualization of the far lateral compartment while preserving stability in return for missing degenerative foraminal lesions increasing susceptibility for nerve root injury on blind attempts to remove residual disc fragments [22–24]. In 2 patients with FLLDH, Quaglietta et al. [25] emphasized the efficacy of a paramedian muscle-splitting inter-transverse approach awarding adequate nerve root and disc visualization with symptomatic sensorimotor betterment. Extreme lateral approach through a midline or paramedian muscle splitting technique was employed successfully in various reports [26–28] to remove far lateral fragments; however, it is flawed by postoperative recurrence since it has no access to the disk medially [6].

Towards minimally invasive 1-day surgeries with little post-procedural pain, different percutaneous, microscopic and endoscopic alternatives were introduced. Sasani et al. [29] reported advantages related to percutaneous endoscopic discectomy in 66 patients with foraminal and FLLDH yielding favorable results with reduced postoperative pain and minimized adhering and scarring. On the far side, the technique can not be employed in the setting of FLLDH at L5–S1 cause of impeding iliac wings as well as spinal degenerative process whether canal stenosis, degenerative spondylosis, or spondylolisthesis. Associated with preservation of the facet joint integrity and limited bone removal while providing direct access to the offending pathology, far lateral microdiscectomy was adopted heavily in the literature [5, 30–32]. Through microscopic-assisted technique, combining advantages of three-dimensional visual control with minimal surgical trauma reported with endoscopic procedures, Greiner-Perth et al. [32] managed 15 patients with FLLDH within 43 min as an average surgical time. A remarkable improvement of VAS leg pain from 7 to 3.6 as well as ODI reduction from 30.6 into 14.3 postoperatively was noticed. Patients were able to mobilize 4 h after the procedure with no reported complication exempting one case of recurrence that retreated in the same maneuver. In a similar retrospective study, Fuentes et al. [31] navigated tubular muscle retractor system combined with a microscope through a 12–15-mm paramedian incision to treat 26 patients with FLLDH ending in rapid rehabilitation and symptomatic improvement as denoted by VAS radicular pain reduction from 7.0 to 2.0 with no encountered complication.

A recent evolution is the reported microendoscopic discectomy technique coming up with several advantages: rapid rehabilitation, lower incidence of postoperative muscle pain and atrophy, and declined risk for iatrogenic instability since minimal bony resection is entailed [13, 33]. Beyond those advantages, the procedure is technically demanding with characteristic steep learning curve that was obvious through our results where the operating time was ranging from 166 min in the early operations; however, it was reduced lastly to 55 min. Yoshimoto et al. [11] declared that longer operative time in the early cases they operated were attributable to adopting the Foley et al [7] method where the exiting nerve is firstly identified then followed distally adding to difficulty approaching lesions at L5–S1; however, upon converting into a triangular working zone, the operative time reduced significantly to 60 min.

Many studies [7, 33, 34] emphasized the benefits following microendoscopic approaches to FLLDH encompassing less muscle, ligament damage; reduced operative time and blood loss; and rapid rehabilitation. Wu et al. [35] in a comparative retrospective study on 873 patients with lumbar disc herniation to assess long-term outcome between microendoscopic discectomy and open surgical groups found no statistically significant difference between the two groups concerning symptomatic improvement based on VAS scale; however, average length of hospital stay and time to return to normal activities were less in the microendoscopic cohort. In our study, the median intra-procedural EBL was 30 (range, 10–55) ml matching those who underwent minimally invasive discectomy in Wu et al [35]. where intra-procedural blood loss per level was approximately 44 ml.

We had satisfactory outcomes in all 33 patients who underwent minimally invasive described approach, including 28 (84.8%) excellent outcomes and 5 (15.2%) good outcomes with neither fair nor poor results. In Foley et al. [7], 10 cases reported excellent with only one good results out of 11 enrolled patients based on modified Macnab criteria while 9 out of 17 patients examined in Cervellini et al. [33] obtained excellent results. The remaining gave good results with neither fair nor poor outcome.

Our patients reported an overall symptomatic improvement denoted by resolution of sensory deficits in 80% (n = 16) out of 20 patients at 3 months follow-up as well as amelioration of median muscle power from free movement while eliminating gravity effect (grade 3.0) into normal motor power against full resistance (grade 5.0). In a similar study [7] after follow-up periods ranged from 12 to 27 months, the authors had not encountered any motor deficits in their series while four out of nine had residual motor deficits,

In line with Salame and Lidar [13] reporting significant progressive decrease of mean preoperative VAS score for radicular pain from 8.6 preoperatively to 3.8 on immediate post-procedural evaluation reaching from 1.3 after 6 months to finally 0.6 at the last follow-up visit, our patients proclaimed dramatic improvement of radicular leg symptoms at 6 months postoperatively from median score of 8.0 to 1.0 correlating closely to those rated as excellent on Macnab.

Potential complications met in minimally invasive approaches to FLLDH include nerve root damage, dural tear, CSF leakage, residual sequestered foraminal disc, and neuropathic pain resulting from manipulation of the dorsal root ganglion [36, 37]. In our study, we had only five minor complications in 15.2% of the cases with neither mortality nor a major morbid complication. One case experienced unintended dural tear yet with no subsequent CSF leakage or pseudo-meningocele formation. Salame and Lidar [13] described two incidents of dural tear management with tight fascial closure instead of primary suturing attributing it among drawbacks of their technique due to limited access; thence, dural violations may lead to CSF fistulas unless definitive management employed.

Excessive medial facetectomy was done unintentionally in three cases; however, no iatrogenic spinal instability was depicted in the current study. Postoperative neural complications in the form of transient dysesthesia were observed in one patient; however, dysesthesia was mild and resolved gradually over 2 weeks with no permanent complications. In Quaglietta et al. [25], three cases suffered from post-procedural same-level burning dysesthesia; however, it was transitory and disappeared 2–3 weeks sequent to medical treatment with indomethacin. Neuropathic pain was common in the series of Hodges et al. [6] which was theorized to be arising from intra-procedural dorsal root ganglion manipulation, yet it resolved 2–3 months following the surgery.

The incidence of recurrence in the case of FLLDH is 4% [38]. Within our cases, bearing in mind the limited follow-up period, we did not have any cases of recurrence at the final follow-up. Doi et al. [38], in their retrospective analysis of outcome following endoscopic decompression surgery intra -foraminal and extra-foraminal disc herniation, had 3 cases of late symptomatic recurrence on the ipsilateral side, and 2 patients on the contralateral side of the surgery which were speculated to be caused by the foraminal stenosis, thence the importance of precise interpretation of preoperative imaging [39].

Strengths and limitations

Although patients were followed up for 4 years (median follow-up was 30 months, range 3–47 months), however, long-term outcome cannot be deferred on this small cohort number of 33 patients while no control group for open surgical decompression existed. Moreover, we did not have any cases of L5–S1 lumbar disc herniation representing one of the main difficult situation and drawbacks for the aforementioned technique.

Conclusions

With adequate learning curve through familiarizing with the microendoscopic equipment, the reported approach is a safe efficacious minimally invasive technique for the management of FLLDH with clinical and functional outcome comparable to other operative approaches. It enables direct visualization of the involved exiting nerve root with minimal bony resection, less trauma to lumbar musculature, while potentially harboring no risk of postoperative spinal instability sequent to facet joint disruption. Furthermore, it has the advantages of reducing patients' hospital stay and perioperative morbidity.

Abbreviations

CT: Computed tomography; FLLDH: Far lateral lumbar disc herniation; MMC: Modified Macnab criteria; MRI: Magnetic resonance imaging; VAS: Visual analog score

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No other person contributed to this article

Authors' contribution

The single author performed all of the procedures, clinical assessment, follow-up of patients, collection of results, statistics, and final editing and is responsible for the study conception and design. The author read and approved the final manuscript.

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Nothing to disclose

Availability of data and materials

This is limited to the group preliminary study of a relatively novel surgical procedure. All data was recorded by the author and readers can find the supporting data within the study

Ethics approval and consent to participate

Retrospective ethics approval was obtained from the Faculty of Ain Shams University, General Surgery Department, research ethics committee, where the committee approved the study protocol form the ethical point of view. All patients signed an informed consent for the procedure and possible outcomes

Consent for publication

This study reported no personal data for any patients; informed consents were obtained for all patients included in this study for the publishing of results.
None of the patient involved in this study had declined the publication of study results.

Competing interests

The author declares he has no conflict of interests.

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