Full Transforaminal Endoscopic Discectomy Versus Microlumbar Discectomy for Lumbar Disc Herniation: 2-Year Results

Manoj Sharma, Sanjay Chhawra, Raman Jain, Gaganpreet Singh
Department of Spine Services, Jaipur Golden Hospital, New Delhi, India

Abstract

Objective: Microlumbar discectomy (MLD) has been a gold standard surgical treatment of lumbar disc herniation (LDH); we have compared its results with full transforaminal endoscopic discectomy (FTED), which is a recent trend performed under local anesthesia. FTED and MLD are currently prevalent techniques for the surgical treatment of LDH. **Materials and Methods:** Patients were randomly assigned to the FTED or MLD groups in this single center study if they had clinical LDH with low back ache with radiculopathy confirmed with magnetic resonance imaging findings. The Oswestry disability index score was the primary outcome. 36-Item Short-Form Health Survey, Macnab, and visual analog scales for back pain and leg pain were used as secondary outcomes. **Results:** Over a follow-up of 2 years, both primary and secondary outcomes differed significantly according to the location of the discs; FTED was very successful in foraminal and extraforaminal herniated discs with many other benefits whereas MLD was better in central discs. **Conclusion:** FTED is superior in cosmesis, returning to work in 2 weeks, less surgical trauma, minimal bleeding, infection, hospital stay, and surgical scar compared with MLD. FTED was found to be less effective for median disc herniation, whereas MLD did not appear to be the best alternative for foraminal/extraforaminal disc herniation.

Keywords: Full transforaminal endoscopic lumbar discectomy (FTED), lumbar disc herniation (LDH), microlumbar discectomy (MLD)

Introduction

The prevalence of a herniated disc is approximately 5–20 cases per 1000 persons each year, with a male-to-female ratio of 2:1. It most frequently affects people in their third to fifth decades of life. About 1%–3% of patients have a symptomatic herniated disc in the lumbar spine. Caspar[1] and Yasargil[2] performed open microdiscectomy after the invention of the microscope, which transformed the surgical treatment of lumbar disc herniation (LDH). Microendoscopic discectomy (MED) was introduced by Foley and Smith[3] for the treatment of LDH. Since then, a range of minimally invasive (MI) techniques have been developed in collaboration with competent surgeons in response to the high demand for MI procedures among patients. Microdiscectomy is a less invasive procedure that uses a microscope to provide a similar view with a little incision and better cosmetic results.[4,5]

In 1988, Kambin was the first to report intraoperative discoscopic pictures of a herniated nucleus pulposus. Kambin *et al*. went on to promote the value of discoscopic vision of the periannular space in later papers. The triangle working zone was first defined and illustrated by Kambin in 1990. The departing root, inferiorly to the endplate of the lower lumbar segment, posteriorly to the superior articular process of the inferior vertebra, and medially to

Received: 31-Mar-2023, **Revised:** 13-May-2023, **Accepted:** 30-May-2023, **Published:** 07-Feb-2024.

Access this article online

Quick Response Code:

Website: https://journals.lww.com/isoj

DOI: 10.4103/isj.isj_25_23

Address for correspondence: Dr. Sanjay Chhawra, Jaipur Golden Hospital, Institutional Area, Sector -III, Rohini, New Delhi 110085, India.
E-mail: sanjaychhawra@gmail.com

How to cite this article: Sharma M, Chhawra S, Jain R, Singh G. Full transforaminal endoscopic discectomy versus microlumbar discectomy for lumbar disc herniation 2-year results. Indian Spine J 2024;7:50-8.

the traversing nerve root, defines the safe zone. Before the discovery of this safe zone, the tools placed posterolaterally were very small to avoid iatrogenic nerve root injury. This allowed for the introduction of larger devices without harming the departing nerve, and it also allowed for the development of more sophisticated instruments.[6-8]

Transforaminal endoscopic surgery for LDH was pioneered by Mathews[8] in 1996 and Ditsworth[9] in 1998. Kambin and Zhou[10] published in 1996 a surgical endoscopic procedure that uses mechanical tools to release nerve roots that have been compressed by lateral recess stenosis (forceps and trephines) with 0° and 30° scopes.[9-11]

In 2003, Yeung and Tsou[12] created the Yeung Endoscopic Spine System as a standardized approach for transforaminal endoscopic surgery. Endoscopic foraminoplasty, accessing the epidural space in the axilla between the exiting and traversing nerve roots, and partially resecting the posterior annulus to access the underside of the herniated mass if needed are all part of the protocol. Schubert and Hoogland[13] presented an endoscopic transforaminal nucleotomy with foraminoplasty employing reamers in 2005 to remove a sequestrated lumbar disc. They had a 95.3% success rate. Choi *et al*.[14] reported a 92% success rate in a cohort of 41 patients with a soft extraforaminal disc herniation treated with their innovative extraforaminal targeted fragmentectomy approach in 2007. Their technique used a steeper angle to medialize the skin entry point.[14]

Full transforaminal endoscopic discectomy (FTED) has become more mature, and complete access to the spinal canal laterally for transforaminal endoscopic discectomy under continuous vision has been created. FTED is a safe and MI alternative technique for the removal of LDH.

Materials and Methods

Study description

This prospective study was conducted at a single center, comparing the efficacy and cost-effectiveness of MLD with FTED.

Data collection

A total of 440 individuals with LDH were recruited between November 2017 and October 2019 with a follow-up of two years till 2021 with simple randomization with stratification. We compared the efficacy and safety of FTED and MLD in patients with LDH who needed surgery in a single center. Age, sex, duration of lower back pain, leg pain, the section of lower disc herniation, and straight leg raising test were all recorded as demographic features of the patients.

Inclusion and exclusion criteria

Inclusion criteria were as follows: (1) failed conservative treatment for at least 6 weeks; (2) age 25–50 years at the time of the procedure; (3) preoperative magnetic resonance imaging (MRI) and computed tomography scan revealed disc protrusion; (4) neurological signs such as motor weakness, sensory changes, radiculopathy, positive Lasegue's sign with unilateral radicular pain, and the presence of abnormal reflex due to migrated discs; (5) no previous lumbar surgery on the same disc level; and (6) low iliac crest and normal lumbar lordosis.

Exclusion criteria were as follows: (1) patients were excluded from the study if they were younger than 25 years or older than 50 years; (2) if their conservative treatment was insufficient (6 weeks); (3) calcified disc (4) if they had cauda equina syndrome or a developing neurological deficit that necessitated immediate surgical intervention; (5) if they had LDH in conjunction with other spinal illnesses that necessitated surgery other than discectomy; (6) instability; (7) central spinal canal stenosis or lateral recess stenosis; and narrowing foramen; (8) if they had a high-grade migratory disc herniation, (it was located below or above the middle of the pedicle of the lower vertebral body) (9) diabetes, obesity, cardiovascular disease, a spinal tumor or fracture, infection, and concomitant somatic or psychiatric conditions; (10) two levels; (11) if they have undergone spinal surgery before; and (12) pregnancy. In this study, both FTED and MLD were inpatient procedures performed by one experienced spine surgeon.

Data extraction

The following data were recorded by two authors separately. Any disputes among the reviewers were handled through conversation. Study characteristics, types of therapies, follow-up time, and outcome indicators were among the data gathered from the studies.

Surgical techniques

1. MLD: cases were positioned prone after the induction of general anesthesia. The affected level in the MRI of the spine [Figure 1] was verified and rechecked using C-arm fluoroscopy. A 2.5-cm posterior midline incision was made to expose the lamina and ligament flavum with the help of a tubular retractor with a diameter of 2.2 cm on the affected level [Figure 2]. Through the interlaminar window, the central canal or subarticular zones was approached. Laminotomy was done on the undersurface of the cephalad lamina with minimal medial facetectomy to preserve at least 5mm of the lateral pars interarticularis and at least 50% of the medial facet, which preserves the ligamentum flavum as a complete barrier to minimize scar formation. The lateral edge of the traversing nerve root was then identified and mobilized medially, allowing exposure to the herniated disc, and later discectomy was done [Figure 3]. After annulotomy, a pulsatile central dural sac and nerve root that was mobile was considered an adequate decompression surgery.

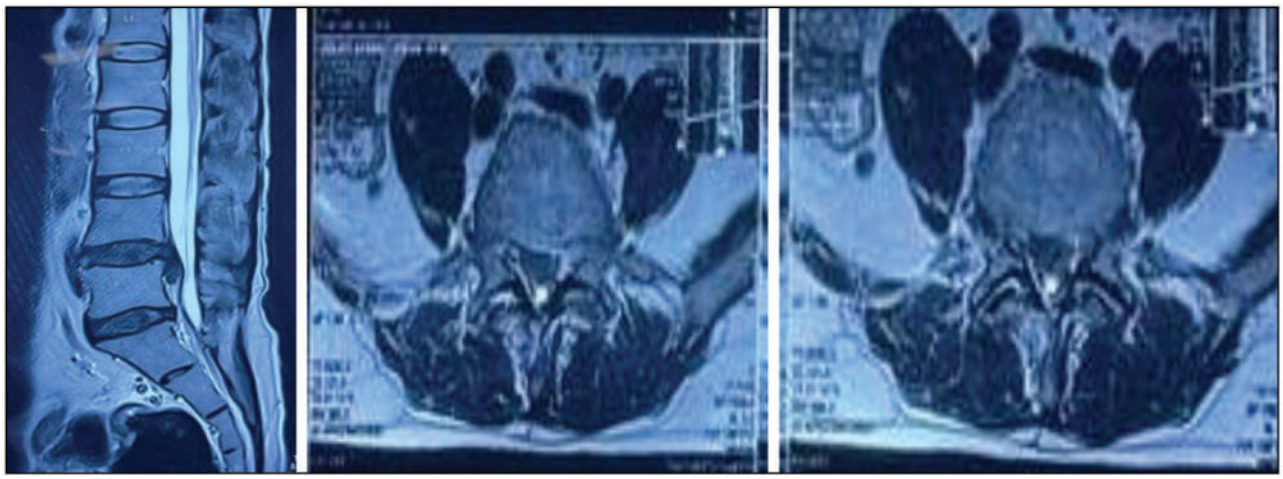

Figure 1: Magnetic resonance imaging sagittal and axial images showing a central disc. Microlumbar discectomy was performed

Figure 2: Microlumbar discectomy surgical procedure

Figure 3: Microlumbar discectomy disc

2. FTED: FTED (the endoscopic system used was with the working channel of 7 mm and an endoscope diameter of 6.5 mm with an angle of 15°) from the midline entry point was more lateral (8–14 cm from the midline). Under fluoroscopic supervision, an 18-gauge spinal needle was gently inserted laterally into the intervertebral disc through a triangular working zone (Kambin triangle) until it met the annular surface [Figure 4]. The superior facet joint was employed as an anatomic marker to minimize puncturing injuries and compressions to the exiting nerve root. The important step was inserting the spinal needle at a perfect location which is the base of the disc. It is medial to the mid-pedicular line in lateral recess disc herniation. The guide wire was inserted into the disc through this spinal needle. Over the guide wire goes dilator over which the working sleeve was inserted. This required little maneuvering and the use of an impactor as well. The perfect position of working sleeve opening is 50% in the disc and 50% in epidural space in the lateral view and medial to the mid-pedicular line in the AP view. One may have to do foraminoplasty by reviewing superior articular process to approach the disc more medially, removal of PLL, and sometimes collar of the annulus to reach herniated disc site [Figure 5]. The endpoint of surgery is the visibility of the pulsatile traversing nerve root after discectomy with sufficient excised disc [Figure 6].

Outcome assessment

Demographics, job status, smoking history, history of lower back pain, family history of sciatica, physical examination results, body mass index, herniated disc level, and physical examination results were recorded.

The Oswestry disability index (ODI) score was the primary outcome. The Medical Outcomes Study 36-Item Short-Form Health Survey body pain and physical

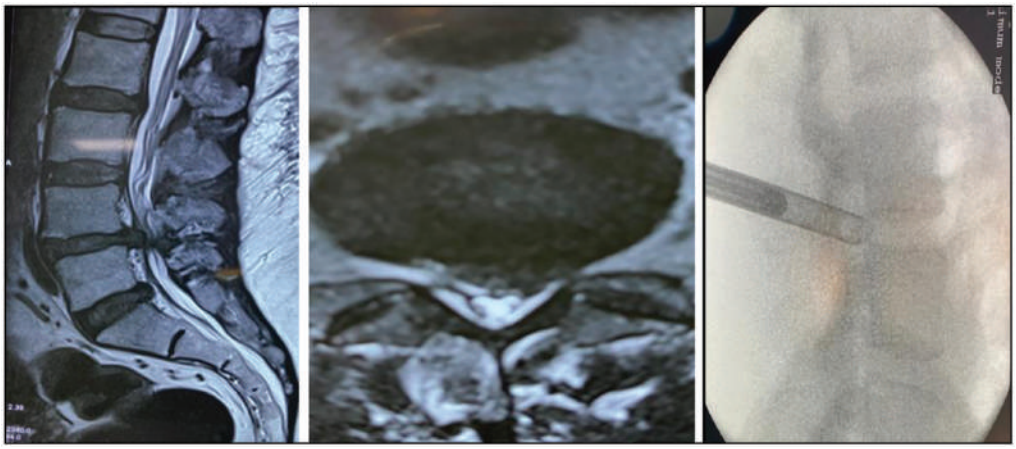

Figure 4: Magnetic resonance imaging showing a foraminal disc and endoscope positioned under fluoroscopy supervision

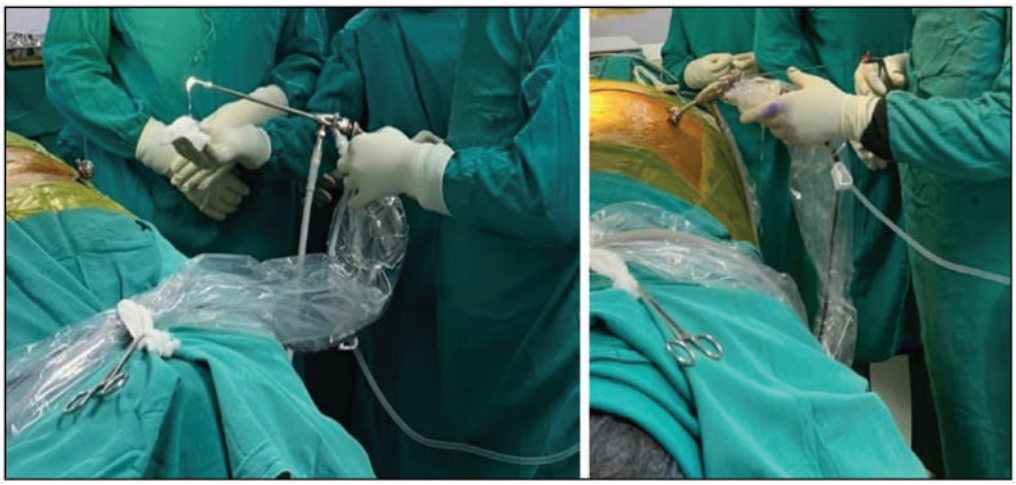

Figure 5: Full transforaminal endoscopic discectomy—surgical procedure

function scale modified Macnab, and visual analog scales (VASs) for back and leg pain were secondary outcomes. Participants were assessed preoperatively and at one week, 1 month, 3 months, 6 months, 1 year, and annually thereafter for 2 years postoperatively. Complications, postoperative in-bed time, length of hospital stay, duration of surgery, cost, and reoperations were all recorded.

Results

A total of 440 patients were recruited in the study and were then assigned to one of two groups at random (FTED group of 220 cases and MLD group of 220 cases). There were significant differences between the two groups in terms of surgery duration, intraoperative blood loss, return to work, and hospital stay.

The MLD group had 132 males and 88 females (220 patients), whereas the FTED group had 143 males and 77 females (a total of 220 patients). In the MLD group, the average age at the time of surgery was 38 years, whereas in the FTED group, it was 35 years (range, 25–50 years in both groups). In the MLD group, the most commonly seen LDH was L4-L5, which accounted for 55% of all cases, L3–L4 (10%), and L5–S1 (40%). In the FTED group, the most commonly seen LDH was L4-L5, which accounted for 50% of all cases, L3-L4 (15%), and L5–S1 (35%). Paramedian disc herniation was the most common kind of disc herniation, accounting for 68% of cases [Table 1].

The blood loss after FTED was estimated by the hematocrit method. The hematocrit was assessed prior to surgery, and the collected rinse solution (saline with the blood) of the FTED procedure was collected by suction in a container after the operation. The rinse solution hematocrit was examined, which was used to calculate the endoscopic blood loss.

Functional outcomes

ODI score was the primary outcome. Secondary outcomes include VAS, Rand Medical Outcomes Study—36-Item Short-Form Health Survey and last

Modified Macnab recorded for body pain and physical function scales.

P value of less than 0.05 was considered statistically significant.

Postoperative ODI and SF-36 was statistically significant with *P* value < 0.0001 [Table 2]. The FTED group had a 2% reoperation rate, whereas the MLD group had a 1% reoperation rate for recurrence and persistent pain. Mean operative time for FTED group was 50 min and MLD group was 65 min, difference being statistically significant (*P* value < 0.0001).

Figure 6: Full transforaminal endoscopic discectomy—disc

The mean length of hospital stay was significantly higher in the MLD group (5 days) compared with the FTED group (2 days). The hospital stay was prolonged because the preoperative patient was admitted for workup for surgery and postoperative physiotherapy and rehabilitation. Blood loss in the FTED group was 30 mL, but in the MLD group, it was 80 mL, and it was also statistically significant (*P* value < 0.0001) [Table 3].

Complication rate

The FTED group had a 3.18% complication rate whereas the MLD group had a 4.5% complication rate. In terms of outcome scores, the FTED group was better than the MLD group. Dura tear in the MLD group was repaired directly by 5.0 prolene suture and fibrin glue [Table 4].

Return to work on average was 2 weeks in FTED and 6 weeks in MLD. Biochemical outcomes were as follows: C-reactive protein and creatine kinase values were more in the MLD group compared with FTED to assess muscle tissue damage. Radiological outcome scarring was measured on postoperative MRIs and we found less scarring in the FTED group, but there was no correlation with clinical outcomes. The cost-effectiveness of surgery was determined by calculating the operating room's costs, hospitalization, endoscopes, and equipment sterilization. There was no statistically significant difference between the two groups. The rate of recurrence was higher in the FTED group.

Discussion

We compared the two procedures MLD and FTED for treating LDH in terms of efficacy and safety. In addition, assessed were complications and LDH recurrence in these two procedures.

Table 1: Comparison of age, duration of pain, and disc level

Variables	FTED (*n* = 220)	MLD (*n* = 220)	*P* value
Age, mean	35 ± 15.78 years	38 ± 17.49 years	0.06[a]
Duration of pain			
Less than 6 months	55 (25%)	75 (34.09%)	0.105[b]
6 months–2 years	150 (68.18%)	130 (59.09%)	
More than 2 years	15 (6.82%)	15 (6.82%)	
Disc level			
L3 L4	33 (15%)	22 (10%)	0.231[b]
L4 L5	110 (50%)	110 (50%)	
L5 S1	77 (35%)	88 (40%)	

[a]Independent *t* test

[b]Chi-square test

Table 2: Outcome measures recorded

Variables	FTED (n = 220)	MLD (n = 220)	P value
ODI			
Preoperative	50 ± 23.75	54 ± 25.86	0.09[a]
Postoperative	4 ± 1.73	6 ± 2.86	<0.0001[a]
VAS score leg pain			
Preoperative	7 ± 5.94	8 ± 5.42	0.07[a]
Postoperative	2 ± 1.34	4 ± 2.72	<0.001[a]
VAS Score back pain			
Preoperative	8 ± 5.96	7 ± 5.01	0.06[a]
Postoperative	2 ± 0.87	4 ± 1.38	<0.0001[a]
Modified Macnab score (postoperative)			
Poor	4 (1.82%)	7 (3.18%)	<0.0001[b]
Fair	18 (8.18%)	31 (14.09%)	
Good	110 (50%)	132 (60%)	
Excellent	88 (40%)	50 (22.73%)	
SF 36			
Preoperative	70 ± 22.34	66 ± 30.56	0.118[a]
Postoperative	10 ± 6.54	16 ± 8.37	<0.0001[a]

[a]Independent *t* test
[b]Chi-square test

Table 3: Comparison of hospital stay (days), surgery duration (min), intraoperative blood loss, incision (cm), return to work weeks cost, recurrence, and reoperation rate

Variables	FTED (n = 220)	MLD (n = 220)	P value
Hospital stay (days)	2 ± 1.5	5 ± 1.9	<0.0001[a]
Surgery duration (min)	50 ± 12.46	65 ± 14.83	<0.0001[a]
Intraoperative blood loss	30 ± 20.78	80 ± 38.76	<0.0001[a]
Incision (cm)	2.5 ± 1.83	2.86 ± 2.36	0.07[a]
Return to work in weeks	2 ± 1.32	6 ± 3.21	<0.0001[a]
Cost	Not significant	Not significant	-
Recurrence	3 (1.36%)	1 (0.45%)	0.623[b]
Reoperation rate	4 (1.82%)	2 (0.91%)	0.685[b]

[a]Independent *t* test
[b]Fisher's exact test

Table 4: Data of complications

Variables	FTED (n = 220)	MLD (n = 220)	P value
Neural injury	2 (0.91%)	2 (0.91%)	1[a]
Dysesthesia	2 (0.91%)	1 (0.45%)	1[a]
Poor wound healing	0 (0%)	2 (0.91%)	0.499[a]
CSF leak/Dura tear	1 (0.45%)	2 (0.91%)	1[a]
Residue/recurrence	3 (1.36%)	1 (0.45%)	0.623[a]
Persistent aggravated pain	1 (0.45%)	2 (0.91%)	1[a]
Infection (SSI)	1 (0.45%)	2 (0.91%)	1[a]
Discitis	0 (0%)	1 (0.45%)	1[a]
Hematoma	0 (0%)	1 (0.45%)	1[a]

CSF = cerebrospinal fluid, SSI = surgical site infection
[a]Fisher's exact test

MLD magnifies the operative field with an advanced camera system so that the surgeon can identify and protect nerve tissue more easily, with the advantages of less paraspinal muscle dissection, less bone, joint destruction, less spinal stability breach, less blood loss, and quicker postoperative recovery; it is essentially MI over conventional surgery but has risk of intraspinal adhesions.

MLD is effective in treating central disc herniation, although it has inferior clinical results in treating far-lateral disc herniation. A high degree of bone resection

(including the facet joint) was frequently necessary to gain proper exposure to the herniation, which may have led to postoperative segment instability. Limited bone removal prohibited a bright and clean surgical field, which may have resulted in poor results.

One of the most notable advantages was the ability to perform FTED under local anesthesia. The use of a modern camera system allows for intraoperative communication with patients, a low postoperative complication rate, the avoidance of nerve root damage, and quick mobilization.

Microsurgical treatments can be replaced with full-endoscopic surgery, which is a sufficient and safe option. FTED offers the advantage of avoiding cutting the lamina and causing less harm to the paravertebral muscles, ligaments, and intraspinal tissues, making it more in line with the MI surgical approach. In our study, we also demonstrated that FTED was superior to MLD with better immediate clinical outcomes and quicker recovery, less operative time, stay in a hospital, and rapid mobilization. In terms of outcome scores the FTED group was better than the MLD group.

FTED can be utilized to treat recurring and migrating disc herniations, as well as other types of herniations. It was difficult to completely remove enormous central disc herniation under the endoscope due to the thin neural foramen and short working cannula, resulting in poor clinical outcomes for the care of the median type of herniation. The bevel-ended cannula should be placed in the midline on an anteroposterior fluoroscopic view and between the epidural space and intra-annular region on a lateral view in cases with central disc herniation.

FTED, on the other hand, can directly remove foraminal and extraforaminal herniated disc materials without jeopardizing posterior column structures. As a result, it is regarded to be a better option for treating far-lateral disc herniation.[15-17]

In terms of complications, MLD had a higher complication rate of 6.36% compared to FTED with 4.54%. Complications of MLD were hematoma, persistent aggravated pain, infection, poor wound healing, cerebrospinal fluid leak, dura tear, discitis, and complications of FTED were dysesthesia, residue/recurrence disc. Neural injury was equal in both groups.

It should be noted that 16.7% of patients in the FTED group with median herniation had more residual or recurrent herniation than other types of herniation in the FTED group. This finding also explains why FTED showed less improvement in ODI scores for median herniation types.

A small endoscope's limited field of view and the limited operating space on a single work channel can contribute to incomplete herniation removal during the FTED procedure. According to a meta-analysis, the incidence of disc debris or incomplete decompression was higher in the FTED group than that in the MLD group.[18]

The average length of hospital stay for the MLD group was 5 days and for FTED was 2 days. Sometimes hospital stay of patients may extend where patients are hesitant to leave the hospital before complete recovery. The hospital stay is prolonged because the preoperative patient is admitted for workup for surgery and postoperative physiotherapy and rehabilitation. In terms of cost (expenses) no significant differences were seen between the two groups.

Ahn *et al*.[19] described that the selective discectomy approach offers the normal benefits of MI operations, such as a shorter operation time, hospital stay, and recovery time compared with open discectomy.

Liu *et al*.[20] stated that percutaneous endoscopic transforaminal discectomy, MED, and microdiscectomy methods effectively treated symptomatic LDH. After at least 2 years of follow-up and a restricted indication, PETD can lead to a quick recovery and better clinical outcomes.[20]

Ruan *et al*.[21] stated that despite the fact that the Percutaneous Endoscopic Lumbar Discectomy (PELD) surgical group has a shorter operation time and hospital stay than the open lumbar microdiscectomy (OLM) surgical group, the evidence suggests that there is no superiority between the two surgical approaches for the treatment of lumbar disc herniation in terms of functional outcome, complication rate, and reoperation rate.

Zhang *et al*.[16] described that in terms of length of hospital stay, transforaminal endoscopic discectomy is preferable to open microdiscectomy. However, there were no differences between FTED and MD in terms of leg pain, functional recovery, or the frequency of complications while treating LDH.[16] Although this approach has a learning curve, the lack of a need for general anesthesia and a typical duration of stay of less than one day make FTED a suitable procedure for use in day-care units.

In our study also, patients who underwent FTED recovered comparatively faster than those in the MLD group (shorter postoperative in-bed time, less bleeding and length of hospital stay) because FTED is performed under local anesthesia, and it can preserve the muscles and bony structure in the dorsal column. This allowed patients to have early ambulation, rehabilitation, and a quicker return to daily-life activities. Details of parameters measured in other studies for MLD & FTED are given in Tables 5 and 6.

Table 5: Details of parameters measured in other studies for microlumbar discectomy

Articles	Sinkemani *et al*.[15] Asian Spine J (2015)	Li *et al*.[22] Pain Physician (2015)	Jing *et al*.[23] Am J Transl Res (2021)	Chen *et al*.[24] Spine (2020)	Gibson *et al*.[25] Eur Spine J (2017)
Age	41.46±7.22	37.8±6.6	50.19±9.36	41.0±10.8	39 (9)
Disc level					
L1–L2			25.81%		
L2–L3			74.19%		
L3–L4	2.0%			0	3%
L4–L5	34.0%	36.7%		51.6%	30%
L5–S1	44.0%	67.3%		48.4%	67%
Hospital stay (days)	5.54±1.72	2.3±0.7	9.03±1.14	10.9±3.8	0–9
Surgery duration (min)	46.90±14.74	58.5±9	61.68±11.93	100.2±51.4	65
ODI score					
Before surgery	53.00±14.18	54.1±12.7	51.13±9.88	43.9±19.7	42
After surgery	4.96±10.34	9.1±6.1	5.39±2.26	3.4±7.5	22

Table 6: Details of parameters measured in other studies for full transforaminal endoscopic discectomy

Articles	Sinkemani *et al*.[15] Asian Spine J (2015)	Li *et al*.[22] Pain Physician (2015)	Jing *et al*.[23] Am J Transl Res (2021)	Chen *et al*.[24] Spine (2020)	Gibson *et al*.[25] Eur Spine J (2017)
Age	44.17±6.54	3 7.5±5.5	51.32±8.99	40.9±11.9	42 (9)
Disc level					
L1–L2			32.26%		
L2–L3			67.74%		
L3–L4	8.3%			4.2%	
L4–L5	36.1%	40%		50.4%	46%
L5–S1	44.4%	60%		45.4%	54%
Hospital stay (days)	5.05±2.20	1.5±0.6	5.03±0.98	8.2±4.2	0-2
Surgery duration (min)	93.89±32.33	102.9±12.3	49.94±13.70	97.7±41.9	61
ODI score					
Before surgery	48.72±11.55	56.1±14.0	51.10±8.17	46.3±20.5	44
After surgery	3.61±8.5	9.7±6.8	4.84±2.45	3.0±7.3	18

Conclusion

The goal of MLD and FTED treatment for LDH is to achieve optimal nerve root decompression with minimal tissue trauma and consequences. Our findings show that MLD and FTED provide satisfactory results, highlighting the benefits of being able to treat with a smaller incision, improved pain relief, and a lower risk of harm to the neural root and its tributaries. We found FTED to be superior to MLD in terms of bleeding, functional score, duration of surgery, surgical tissue damage, scarring in postoperative MRI, duration of hospital stay, and early return to work. FTED had inferior results for median disc herniation, and MLD had inferior results for far-lateral disc herniation.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent forms. In the form, the patient(s) has/have given his/her/their consent for his/her/their images and other clinical information to be reported in the journal. The patients understand that their names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

Ethical policy and institutional review board statement

Ethical approval for this study was provided by the Institutional Ethical Committee/Institutional Review Board.

Data availability statement

All collected data are available for this study. Data will be provided upon request.

Authors' contributions

MS, SC, RJ conceived the research idea, developed research design, and conducted the research. GS performed the statistical analysis. All authors contributed substantially to the write-up of the article. All authors reviewed and approved the final draft of the manuscript and all take responsibility of the content of the publication.

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