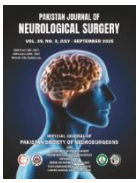

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Original Research

Clinical Outcomes of Transforaminal Full Endoscopic Discectomy in the Management of Upper Lumbar Disc Herniation: A Prospective Study

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ABSTRACT

Objective: This study analyzes the clinical effects and possible adverse events that occur after performing Full Endoscopic Lumbar Spine Surgery (FELSS) through the transforaminal approach when treating upper lumbar disc herniation.

Materials & Methods: This prospective study recruited patients with Upper Lumbar Disc Herniation (ULDH) who underwent transforaminal full Endoscopic Lumbar Spine Surgery at the Farooq Endoscopic Spine Institute, Afridi Medical Complex, from February 2020 to January 2023, with a 1-year follow-up. Those patients who have Symptoms refractory to at least six weeks of conservative management, including physiotherapy, analgesics, and epidural steroid injections, were included. Visual analogue scale and Oswestry disability index were the main outcome measures used, along with reporting the complications.

Results: During postoperative months 1, 6, and 12, the patients experienced significant VAS and ODI score enhancements, which reached 1.5 ± 0.6 VAS and 12.5 ± 5.0 ODI ($p < 0.001$). Of the patients, 83.1% managed to return to work, and daily activities were resumed by 89.2% of the population. Three patients (6.38%) showed drastic improvements as they were pain-free and achieved standing position, while preoperatively they were brought on a wheelchair. The surgical procedures resulted in four complications affecting 2.4% of patients through dural tear, as well as 4.2% developing epidural hematomas.

Conclusion: The transforaminal FELSS surgical method represents a reliable and protected strategy to treat upper lumbar disc herniation while producing considerable positive treatment results. Surgeons can expect better patient recovery when medical treatment occurs soon after symptoms start and the patient has no neurological issues**.**

Keywords: Endoscopic, herniation, discectomy, radiculopathy, neuropathy.

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INTRODUCTION

Lumbar disc herniation (LDH) is a ubiquitous degenerative state responsible for most cases of low back pain and radiculopathy, subsequently causing functional impairment and compromised quality of life.[1] Although most herniations take place at the lower lumbar levels (L4-L5 and L5-S1), the upper lumbar disc herniations (ULDH) at the L1-L2, L2-L3, and L3-L4 levels are responsible for about 5%% % of all lumbar disc herniations.[2] Because of its specific clinical, anatomical, and biomechanical manifestations, ULDH is a unique clinical entity.[3] It often leads to compression of the exiting nerve roots or the conus medullaris, causing a range of symptoms, including radiating pain, neurogenic claudication, and motor paralysis.[4]

Upper lumbar disc herniation (ULDH) is a comparatively scarce but clinically substantial condition that arises mainly from degenerative disc disease, continuous mechanical stress, or traumatic injury to the spine.[5] A wide range of symptoms, from localised pain and radiculopathy to severe motor deficits, abnormalities in gait, or even bowel and bladder dysfunction in more advanced cases, can be caused by ULDH as it compresses the conus medullaris or the exiting nerve roots.[6] Due to the complexity of neural structures in the upper lumbar region and the proximity of the herniated disc material to critical neural pathways, neurological consequences tend to be worse compared to lower lumbar disc herniations.[7] Untreated ULDH can cause progressive neurological degeneration, functional impairment, and a major drop in the patient's quality of life, therefore stressing the need for prompt and efficient management.[8]

Symptomatic ULDH resistant to conservative treatment has been mainly treated using traditional surgical methods like open discectomy and microdiscectomy. These methods, meanwhile, are linked to notable muscular dissection, blood loss, and protracted recovery times.[9] Therefore, Full endoscopic lumbar spine surgery (FELSS) has become more popular in recent years as a minimally invasive option because it is possible to minimise soft tissue damage, lower postoperative pain, and speed recovery.[10] FELSS entails high-definition endoscopic visualization, enabling decompression of neural structures to be both precise and targeted.[11]

The application of FELSS in the treatment of ULDH is underscored by the complicating anatomical factors at these levels, such as smaller interlaminar spaces, increased nerve roots, and differences in the proximity of neural structures. Newer trends in endoscopic tools and techniques have overcome these obstacles, and FELSs can now be applied to more complicated conditions such as ULDH.

The current research intends to assess the clinical results of transforaminal FELSS in the treatment of ULDH, considering parameters like pain relief, functional recovery, rate of complications, and recurrence.

MATERIALS AND METHODS

Study Design/Study Setting/Sample Size

This prospective study recruited 47 (95% confidence interval with a 5% margin of error) patients with Upper Lumbar Disc Herniation (ULDH) who underwent Full Endoscopic Lumbar Spine Surgery at the Farooq Endoscopic Spine Institute, Afridi Medical Complex, from February 2020 to January 2023, with a 1-year follow-up. The sample was calculated through the OpenEpi calculator. Ethical approval was obtained from the institutional review board (Ref No 703/DME/AMC).

Inclusion/Exclusion Criteria

The current study included both male and female patients diagnosed with single-level ULDH (L1-L2,

L2-L3, or L3-L4) confirmed by magnetic resonance imaging (MRI) and clinical correlation, with an age range from 35 to 72 years. Further, those patients who have Symptoms refractory to conservative treatment for a minimum of six weeks, which included physiotherapy, pain relief medications, and epidural steroid injections. Those patients who were below 35 and above 72 years and suffering from Multilevel disc herniations, coexisting spinal instability, infections, or tumors, Prior spine surgery at the affected level, and Significant medical comorbidities contraindicated surgery.

Surgical Technique

The transforaminal approach was selected based on the disc herniation level and location, and the procedure was performed under local anaesthesia with sedation or general anaesthesia, depending on patient preference and clinical considerations.

Outcome Measures

In this study, pain relief was evaluated on the Visual Analog Scale (VAS) of both leg and back pain, a quantifiable measurement of symptom decreases with time. Functional improvement was measured on the Oswestry Disability Index (ODI), which is the standard tool for assessment of ADLs. Patient satisfaction was measured with the Macnab criteria, which classify outcomes as excellent, good, fair, or poor according to the patient's subjective recovery experience. Complications during and after surgery were noted carefully, with special emphasis on the occurrences of dural tear, neurological deficits, and epidural hematoma. Recurrence was also defined as the reappearance of symptoms necessitating further medical or surgical treatment during follow-up in outpatient clinics at regular intervals. These parameters were determined preoperatively and then again at follow-up periods of 1st, 6th, and 12th months. MRI scans were obtained in cases of persistent or recurrent symptoms to confirm the integrity of the surgical repair, offering a complete understanding of the patient and the ultimate surgical outcomes

Statistical Analysis

Version 26 of SPSS software was incorporated into data analysis. Numerical data were expressed as mean ± standard deviation, while categorical variables were presented as frequencies and percentages. Paired t-tests and chi-square tests were used to compare preoperative and postoperative outcomes. A p-value of <0.05 was considered statistically significant. Further results were represented in tabular form.

RESULTS

Patient Demographics and Baseline Characteristics

A total of 47 patients, comprising 29 (61.2%) and 18 (38.8%), with a mean age of 57.4 ± 9.6 years, underwent full endoscopic lumbar spine surgery for upper lumbar disc herniation. The mean duration of symptom onset was 8.3 ± 2.4 months, and patients were suffering from the most common complaints, such as radicular pain 39 (82.4%), followed by motor weakness 17(36.5%) and sensory disturbances 13(28.2%), as shown in Table 1

Preoperative Clinical Findings

Table 2 illustrates that the average preoperative Visual Analog Scale (VAS) score of leg pain was 7.6 ± 1.2, and the mean Oswestry Disability Index (ODI) score was 52.3 ± 9.4, indicating moderate to severe disability in the majority of patients.

20 (42.4%) cases showed neurological deficits,

consisting of 11 patients (23.5%) having motor weakness and 9 patients (18.8%) with sensory deficits.

Surgical Details

Table 3 displays the outcome of the study of (FELSS) for upper lumbar disc herniation in 47 patients, demonstrating significant findings regarding clinical outcomes and complications.

Table 2: *Preoperative Clinical Findings.*

Variable	Mean ± SD / n (%)
VAS Score	7.6 ± 1.2
ODI Score (%)	52.3 ± 9.4
Neurological Deficits	20 (42.4%)
- Motor Weakness	11 (23.5%)
- Sensory Deficits	9 (18.8%)

VAS: Visual Analogue Scale ODI: Oswestry Disability Index

The most frequently involved lumbar levels were L1-L2, involving 22 patients (45.9%), followed by L2-L3, comprising 18 patients (39.4%), and the least involved level was L3-L4, with 7 patients (14.9%). All patients were operated through a transforaminal approach. The average surgery

Table 3: *Surgical Details*

Variable		Value
Approach Used	Transforaminal	47(100%)
Mean Surgical Time (minutes)	-	74.2 ± 12.8
Intraoperative Complications	Incidental Dural Tear	1 (2.1%)
	Epidural Hematoma	2(4.2%)
Postoperative Complications	Discitis	1 (2.1%)
	Transient Dysesthesia	2 (4.2%)
Mean blood loss (mL)	-	23.6 ± 7.1

time was 74.2 minutes ± 12.8, while the average intraoperative blood loss was negligible, i.e., 23.6 ± 7.1. Further intraoperative complications were

Table 1: *Patient Demographics and Baseline Characteristics.*

Variable	Categories	Value
Gender	Male	29 (61.2%)
	Female	18 (38.8%)
Mean Age (years)	35-72	57.4 ± 9.6
Presenting Symptoms	Radicular Pain	39 (82.4%)
	Motor Weakness	17 (36.5%)
	Sensory Disturbances	13 (28.2%)
Mean Symptom Duration (months)	-	8.3 ± 2.4

also observed, including an incidental dural tear (durotomy) in 1(2.4%) patient, epidural hematomas in 2(4.2%) patients, and discitis in one patient. Further details are given in Table 3.

Postoperative Outcomes

Table 4 shows postoperative outcomes from 1 month to 12 months prospectively. The mean VAS score enhanced significantly from 7.6 ± 1.2 to 3.1 ± 1.0 at first month, 1.9 ± 0.8 at 6th month, and 1.5 ± 0.6 at 12th month ($p<0.001$), reflecting substantial pain relief post operatively and the mean ODI score dropped from 52.3 ± 9.4 to 28.4 ± 7.9 at 1st month, 16.2 ± 6.4 at 6th month and 12.5 ± 5.0 at 12th month ($p < 0.001$), indicating considerable functional recovery. Three patients (6.38%) showed drastic improvements as they were pain-free and achieved standing position, while preoperatively they were brought on a wheelchair. Additionally, 42 (83.1%) patients had returned to work, while 45 (89.2%) patients resumed normal activities of daily life without limitations ($p < 0.05$), demonstrating long-term postoperative success as shown in Table 4.

Association of Patient Characteristics with Outcomes

Table 5 demonstrates the association of patient characteristics with postoperative outcomes, and the findings indicate that the clinical results of Full Endoscopic Lumbar Spine Surgery (FELSS) were

Table 4: *Postoperative Outcomes.*

Variable	Preoperative	1-Month Postoperative	6-Month Postoperative	12-Month Postoperative	p-Value
VAS Score	7.6 ± 1.2	3.1 ± 1.0	1.9 ± 0.8	1.5 ± 0.6	< 0.001
ODI Score (%)	52.3 ± 9.4	28.4 ± 7.9	16.2 ± 6.4	12.5 ± 5.0	< 0.001
Return to Work (%)	N/A	31 (65.9%)	37 (78.8%)	42 (83.1%)	< 0.05
Resumption of Normal Activities (%)	N/A	34 (71.8%)	41 (85.9%)	45 (89.2%)	< 0.05

VAS: Visual Analogue Scale ODI: Oswestry Disability Index

Table 5: *Association of Patient Characteristics with Postoperative Outcomes*

Variable	Mean VAS Score (12 Months)	Mean ODI Score (12 Months)	Return to Work (%)	p-Value
Age				
- ≤ 50 years (n=32)	1.3 ± 0.5	10.2 ± 4.1	90.6%	< 0.05
- > 50 years (n=53)	1.7 ± 0.6	14.3 ± 5.3	80.2%	< 0.05
Gender				
- Male (n=52)	1.4 ± 0.5	11.8 ± 4.7	85.4%	0.09
Female (n=33)	1.6 ± 0.6	13.7 ± 5.1	81.2%	0.08
Symptom Duration				
- ≤ 6 months (n=40)	1.3 ± 0.5	11.2 ± 4.2	89.5%	< 0.05
- > 6 months (n=45)	1.8 ± 0.7	14.8 ± 5.5	78.4%	< 0.05
Preoperative Neurological Deficits				
- Present (n=36)	1.9 ± 0.6	16.2 ± 5.8	74.3%	< 0.05
- Absent (n=49)	1.2 ± 0.5	10.9 ± 3.7	88.6%	< 0.05

assessed at 12 months postoperatively based on several patient and surgical parameters. Younger patients (≤50 years) had significantly more favourable outcomes in terms of pain, functional disability, return to work, and recurrence rate that showed a lower mean VAS value (1.3 ± 0.5) and ODI value (10.2 ± 4.1), as well as a higher return-to-work rate (90.6%) than those patients who were > 50 years of age. In terms of Gender, no statistically significant association had been found, although men did report slightly better improvement in pain, functional activities, and return to work than women.

Additionally, Patients operated within 6 months of the onset of symptoms showed better results as compared to patients with prolonged symptom duration. Such patients had decreased pain (VAS 1.3 ± 0.5 vs. 1.8 ± 0.7), lower disability (ODI 11.2 ± 4.2 vs. 14.8 ± 5.5), and improved work return rate (89.5% vs. 78.4%). All findings were statistically significant ($p<0.05$). The results also revealed that patients who did not have preoperative neurological deficits reported statistically significant improvement compared to those who presented with such deficits, as they reported reduced disability (1.2 ± 0.5, $p<0.05$)) and pain (10.9 ± 3.7, $p<0.05$)) scores, higher return-to-work rate (88.6% vs 74.3%, $p<0.05$). The detailed description is provided in Table 5.

DISCUSSION

Our study evaluated the clinical results of full endoscopic lumbar spine surgery (FELSS) for upper lumbar disc herniation (ULDH), representing significant postoperative pain relief, functional improvement, and improved return to work rate. The findings aligned with existing literature while providing valuable insights into patient selection, surgical approaches, and factors

influencing recovery.

The significant drop in mean VAS score from 7.6 ± 1.2 preoperatively to 1.5 ± 0.6 postoperatively at 12 months, and a decline in ODI from 52.3 ± 9.4 to 12.5 ± 5.0, which were aligned with previous study done by Wang et al, (2022), conducted on 22 patients, underwent underwent percutaneous transforaminal endoscopic discectomy (PTED) who reported a reduction in pain from 7.9 ± 1.2 to 2.1 ± 1.0 and functional disability from 59.8 ± 16.8 to 15.3 ± 8.2 using PETD for ULDH. This comparison underlines the effectiveness of endoscopic discectomy in achieving significant pain relief and functional recovery across different surgical approaches.[12]

Compared to Wu et al (2021), who conducted a retrospective evaluation of patients who had undergone FELD, found that the satisfaction rate for TELD was 87.8% (five unsatisfactory instances) and for IELD was 100% after five years of follow-up on 58 patients. Overall, 91.3% of patients (53/58 patients) had good to excellent results based on the modified MacNab criteria. In contrast to the findings of Wu et al., where two patients needed open discectomy for recurrent herniation, no recurrence was observed in our cohort of patients, suggesting durable results with endoscopic methods.[13]

The observed complications included incidental durotomy in one patient (2.4%) and emergent epidural hematoma in two patients (4.2%), which remained within the documented ranges of medical literature. According to a study by Chen et al (2020), 45 patients (8.6%) needed a second operation, while 31 patients (6.0%) had unsatisfactory surgical results (fair/bad MacNab score). Significant factors linked to poor outcomes in univariate analysis were higher disc degenerative grade (P = 0.047), longer preoperative symptoms (P < 0.001), prolapsed herniated disc (P < 0.001), and higher lumbar level.
(P = 0.026), and surgery performed before 2017 (outside-in approach, P = 0.020). Greater disc degenerative grade (P = 0.030), prolapsed herniated disc (P < 0.001), and greater lumbar level (P = 0.046) were statistically significant in multivariate analyses.[14] Our data established improved surgical results for patients younger than 50 years who underwent operations within six months of symptom appearance, along with those who did not experience preoperative neurological impairment. Patients who received early surgery reported VAS 1.3 ± 0.5 and ODI 11.2 ± 4.2, while those undergoing delayed surgery had VAS 1.8 ± 0.7 and ODI 14.8 ± 5.5.

Yuan et al (2024) investigated PTED in ULDH alongside L4–L5 LDH patients, which yielded an excellent/good outcome rate of 81.8% among ULDH participants, aligning with our study's findings on functional recovery. The studies detected substantial postoperative improvements in VAS scores, along with enhancements in functional measurements[15] which were consistent with our data that indicated that treatment success is higher for patients younger than 50 years old and without preoperative neurological deficits; however, Yuan et al noted no significant differences between patient groups. However, our study only included upper lumbar disc herniation cases and found a significant association of surgical outcome with patients' baseline characteristics.

CONCLUSION

The current study concluded that transforaminal Full Endoscopic Lumbar Spine Surgery (FELSS) treatment of upper lumbar disc herniation led to sustained clinical success with reduced pain and functional improvement and increased return-to-work abilities for more than one year. Younger patients (<50 years), together with patients operated at early times and without preoperative neurological deficits, experienced better outcomes. No recurrence along with minor complication rates proved the effectiveness and safety of FELSS procedures through the

transforaminal approach for upper lumbar conditions.

Limitations

Our study has several limitations, as it examined a smaller sample size, which reduced the generalizability. Further, there was the absence of a comparison with conventional open surgery or other minimally invasive techniques. Lastly, this study consists of only a single-centre design and failed to provide results that would reflect various healthcare facilities. Therefore, future research with a prolonged follow-up period is required.

Ethical Consideration

This study was carried out following the Helsinki Declaration and the institutional research committee's ethical guidelines. The Institutional Review Board (IRB) granted ethical permission for the study, and the patient gave their informed consent. Further confidentiality and anonymity were strictly ensured by the researchers.

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Additional Information

Disclosures: The authors declare that there is no conflict of interest related to this work.
Ethical Review Board Approval: This study received approval from the Institutional Review Board (IRB) of Afridi Medical Complex, Peshawar.
Human Subjects: Informed consent was obtained from all participants/patients involved in the study.
Conflicts of Interest: In accordance with the ICMJE uniform disclosure requirements, all authors confirm the following:
Financial Relationships: The authors state that they have not had any financial relationships with organizations that could be perceived as having an interest in the submitted work, either currently or within the past three years.
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AUTHORS CONTRIBUTIONS

Sr.#	Author's Full Name	Intellectual Contribution to Paper in Terms of:
1.	Muhammad Farooq, Naeem ul Haq , Mumtaz Ali & Ali Shah Jehan	1. Study design and methodology.
2.	Naeem ul Haq, Muhammad Farooq & Mumtaz Ali	2. Paper writing.
3.	Ali Shah Jehan & Naeem ul Haq	3. Data collection and calculations.
4.	Naeem ul Haq & Muhammad Farooq	4. Analysis of data and interpretation of results.
5.	Mumtaz Ali & Muhammad Farooq	5. Literature review and referencing.
6.	Mumtaz Ali & Ali Shah Jehan	6. Editing and quality insurer.