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Original Research Article

The Outcome of Minimally Invasive Discectomy in Single Level Lumbar Disc Prolapse: A Prospective Study

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Abstract:

Background: Lumbar disc herniation is a common cause of lumbar pain and radiculopathy that can produce disabling symptoms. Minimally invasive discectomy (MID) is an acceptable operation with potential benefits over open discectomy, such as less tissue disruption and faster recovery.

Objective: The objective of this prospective study is to evaluate the clinical outcomes, efficacy, and safety of single-level lumbar disc herniation patients who were treated with minimally invasive discectomy.

Methodology: Forty patients with single-level lumbar disc prolapse proven by MRI and symptoms of nerve root compression were treated with MID at Department of Orthopaedics, Government Medical College and Hospital, Purnea, Bihar, India. Preoperative and postoperative evaluations were done for symptom resolution, muscle strength grading (Medical Research Council scale), and rates of complications. Data were compared using SPSS v17, and a significant value was considered with $p \leq 0.05$.

Results: Most patients were male (65%) of a mean age 39.1 years. The most involved disc level was L4–L5 (57.5%). Paresthesia of the legs completely disappeared in all patients' post-surgery, leg pain was relieved in 82.5%, and back pain remained in 62.5%. There was significant improvement in Flexor Hallucis Longus and Extensor Hallucis Longus muscle power ($p < 0.05$). Intraoperative complication was seen in 12.5% of the cases with no infection.

Conclusion: Minimally invasive discectomy is a safe, efficient, and efficacious procedure for single-level lumbar disc prolapse with good symptomatic improvement and motor function improvement and minimal rates of complications. These outcomes favor MID as the better surgical option in properly selected patients.

Keywords: Lumbar Disc Prolapse, Lumbar Spine, Minimally Invasive Discectomy, Muscle Strength, Radiculopathy, Surgical Outcomes.

Introduction

Lumbar disc herniation is worldwide common spinal illness that has a large effect on adult populations globally, leading to acute pain and disability in the majority of cases. The patients who show symptoms caused by lumbar disc herniation typically experience lower back pain, radiculopathy, and functional impairment that adversely affects their quality of life. Moreover, this subset of patients has a considerable impact on worldwide socioeconomic and healthcare burdens of spinal illnesses. Once the illness advances, a large percentage of patients initially treated conservatively may not experience sufficient relief from symptoms and eventually need surgery [1].

Surgical treatment, particularly in judiciously selected cases where conservative management has failed, has been demonstrated to be extremely effective in improving the quality of life in patients [2]. Of all types of lumbar disc herniation, sciatica—or better termed sciatic neuralgia or LSRS (lumbosacral radicular syndrome) is one of the most disabling of the symptom complex. LSRS is characterized by pain radiating along the dermatomal pathway of the affected nerve root and is commonly accompanied by neurological deficits such as diminished reflexes, sensory changes, and muscle weakness [3]. Sciatica may be approximated to occur with an incidence of 5 to 10 cases per 1,000 individuals per year, highlighting its high incidence and the need for effective treatment modalities [4].

The social and economic implications of low back pain and other spinal disorders are considerable. In the majority of developed nations, such disorders are the leading cause of work-related disabilities and result in substantial losses of productivity and medical expenses. Thus, the development of newer and less-invasive treatments is a pressing need for healthcare organizations and healthcare providers alike.

Over the past decades, the evolution of spinal surgery has seen tremendous advancement, particularly with the introduction of minimally invasive surgical (MIS) techniques. These advances are driven by a desire to reduce iatrogenic muscle injury, reduce the risk of operative complications, and reduce recovery times without sacrificing clinical outcomes. Minimally invasive spine surgery attempts to reduce collateral tissue injury while effectively relieving neural structures and effectively eliminating symptoms. In comparison to conventional open surgical techniques, MIS techniques are associated with less postoperative pain, less blood loss, shorter hospital stays, earlier mobilization, and more rapid return to normal activities [5].

The traditional method of surgical management of lumbar disc herniation has been open discectomy, which has been the gold standard over the last several decades now [6]. However, the surgical paradigm has shifted over the years to more less invasive methods that offer similar or even better results with less surgical trauma. The most widely used of the minimally invasive methods is the minimally invasive discectomy, which has muscle-sparing techniques and the use of tubular retractors and microsurgical instruments to visualize the herniated disc via a smaller incision. The procedure is generally accomplished by laterally mobilizing the paraspinal muscles from the lamina and spinous process through a unilateral retractor, thus minimizing major disruption of overlying musculature and soft tissues [7, 8].

Proponents of minimally invasive discectomy argue that the procedure possesses a number of benefits over traditional open surgery. These include reduced postoperative pain, reduced need for painkiller medication, shorter surgery times, reduction in complications, and better aesthetic outcomes. It is also argued that the utilization of MIS techniques allows for quicker recovery after surgery, with patients being able to work and participate in daily activities at a quicker pace [9]. All of these benefits combined have rendered the use of minimally invasive discectomy as a popular method of surgery for single-level lumbar disc herniation.

The overall success rate of lumbar discectomy is still impressively high at 70% to 90% with satisfactory outcomes for patients [10]. Notably, procedures like microdiscectomy and minimally invasive discectomy have registered near-90% success rates, indicating their efficacy in the treatment of lumbar disc disease with minimal surgical complications. This impressive success is underpinned by decades of clinical evidence and improvements in surgical techniques, which have been continuous since the seminal study by Mixter and Barr in 1934, which first described lumbar discectomy as an acceptable treatment option for herniated intervertebral discs [11]. Ever since, surgical techniques have improved progressively towards being less invasive and patient-centric.

In the contemporary world, lumbar discectomy is still one of the most prevalent spinal surgical procedures globally. In the United States alone, it remains the most prevalent operative procedure for the management of ruptured or herniated lumbar discs [12,13]. More than 435,000 patients undergo lumbar discectomy annually in the United States, both highlighting the high rate of utilization of the procedure and the high incidence of lumbar disc disease within the population [14]. This harsh reality highlights the necessity for improved surgical techniques to improve patient outcomes and reduce the burden on the healthcare system.

Despite documented efficacy of minimally invasive discectomy, continued evaluation of its result in specific patient populations and clinical environments remains justified. Not all patients are ideal candidates for minimally invasive surgical approaches, and disc herniation severity, anatomical variation, and surgeon proficiency can influence surgical outcomes. Furthermore, longitudinal comparative investigations that examine the long-term duration of symptom relief, reoperation rate, and overall patient satisfaction are essential to validate the advantage or equivalency benefit of minimally invasive surgical procedures compared to traditional methods.

The present study seeks to add to the growing literature by prospectively analyzing the outcomes of minimally invasive discectomy in single-level lumbar disc prolapse patients. By focusing on clearly defined patient population and standardized surgical technique, this study seeks to analyze the efficacy, safety, and patient-reported outcomes of this increasingly utilized treatment. Outcomes are expected to be useful information of value to clinical practice, guide patient selection criteria, and further permit continued refinement of minimally invasive spinal surgery treatments.

Methodology

Study Design: This study was conducted as a prospective observational clinical study designed to evaluate the surgical outcomes of MID (minimally invasive discectomy) in patients diagnosed with single-level lumbar disc prolapse.

Study Area: The research was carried out in the Department of Orthopaedics, Government Medical College and Hospital, Purnea, Bihar, India.

Study Duration: The study was conducted over a period of 15 months

Sample Size: A total of 40 patients with clinically and radiologically confirmed single-level lumbar disc prolapse were enrolled in the study.

Inclusion Criteria

Patients were eligible for inclusion if they met the following criteria:

- Diagnosed with single-level lumbar disc herniation confirmed on magnetic resonance imaging (MRI).
- Exhibited clinical signs and symptoms of nerve root compression, including unilateral or bilateral radicular leg pain.
- Signs that point to the nerve root leaving the nearby neural foramen being involved.

Exclusion Criteria

Patients were excluded from the study if they had:

- Multiple-level disc herniation.
- Spondylodiscitis.
- Segmental spinal instability.
- History of previous lumbar spine surgery.
- Diagnosed psychogenic disorders.

Data Collection: Data were gathered directly by the researcher by a structured questionnaire completed through face-to-face interviews. The questionnaire was designed to gather in-depth information for each participant, including demographic data such as age, gender, and occupation, and clinical data such as disc level, intraoperative problems (such as hemorrhage, dural tear, and nerve root injury), and preoperative symptoms (such as back discomfort, leg pain, leg paresthesia, muscle weakness, and symptom duration), and postoperative outcome in terms of persistence or relief of leg pain, paresthesia, back pain, and any sign of infection. Contact details were also recorded in order to allow for follow-up. Muscle strength was also assessed pre- and post-operatively using the MRC (Medical Research Council) grading scale for the FHL (Flexor Hallucis Longus) and EHL (Extensor Hallucis Longus) muscles with a view to assessing neurological recovery.

Procedure

"All surgical procedures were performed under spinal anesthesia. The patient was placed in prone or knee-chest position on a radiolucent operating table that was compatible with the use of fluoroscopy. The operative level was confirmed radiographically, and a 2-cm skin incision in the region of disc prolapse was made. Blunt dissection was utilized to release the paraspinal musculature. A modified mini-Taylor retractor and microdiscectomy blade were utilized to retract the musculature and open the operating field. Loupe magnification was employed to improve visualization during the procedure. A flavectomy was achieved using a knife and Kerrison punch, which allowed for identification of the dura mater and traversing nerve root. The herniated disc was excised with a pituitary rongeur following gentle medial retraction of the nerve root. After adequate decompression, the surgical field was closed in a fashion that is compatible with anatomical layering principles. Postoperatively, each patient was clinically evaluated at 6 hours, 24 hours, and one-month intervals to evaluate symptom resolution and muscle strength, utilizing the same clinical grading system utilized preoperatively.

Statistical Analysis: All the data collected were entered and analyzed using Statistical Package for the Social Sciences (SPSS) version 17. Descriptive statistics like means, standard deviation, frequencies, and percentages were calculated to summarize demographic and clinical profiles of the patients. Chi-square tests were employed to test categorical variables. In cases where for more than 20% of expected frequencies in contingency tables, frequencies were less than 5, Fisher's Exact Test was utilized to ensure statistical reliability. A p-value of 0.05 or less was considered a reflection of statistical significance. All the analyses were conducted under the expert guidance of a community medicine specialist to ensure methodological precision and correctness."

Result

Table 1 shows the demographic characteristics of the 40 patients who participated in the study. The gender distribution shows that males account for 65% (n=26), while females account for 35% (n=14). The average age of participants was 39.1 ± 9.3 years, with 60% (n=24) over 40 and 40% (n=16) under 40. In terms of occupation, half of the participants were self-employed (50%, n=20), followed by housewives (35%, n=14) and public servants (15%, n=6).

Table 1: Patient demographics.

Variable	No.	%
Gender		
Female	14	35
Male	26	65
Total	40	100
Age (39.1 ± 9.3 years)		
≥40 years	24	60
<40 years	16	40

Total	40	100
Occupation		
Public servant	6	15
Self-employed	20	50
Housewife	14	35
Total	40	100

Table 2 displays the distribution of disc prolapse sites among the 40 individuals. The most usually afflicted disc level was L4-L5, which affected 57.5% (n=23) of the cases, while the L5-S1 level affected 42.5% (n=17) of the participants. This suggests a higher prevalence of disc prolapse at the L4-L5 level in the study population.

Table 2: Disc Prolapse Site in the Participants.

Variable	No.	%
Disc level		
L5–S1	17	42.5
L4–L5	23	57.5
Total	40	100

Table 3 presents the preoperative symptoms of disc prolapse patients. The average duration of symptoms was 10 ± 9 weeks. Leg paresthesia, leg discomfort, and muscle weakness were most commonly seen on the right side in 70% of patients (n=28), compared to 30% (n=12) on the left. Back pain was identified as a common complaint by all patients (100%, n=40), showing its prevalence throughout the study population.

Table 3: Preoperative Symptoms in Patients with Disc Prolapse.

Variable	No.	%
Duration of symptoms (10 ± 9 weeks)		
Leg paresthesia		
Left	12	30
Right	28	70
Leg pain		
Left	12	30
Right	28	70
Muscle weakness		
Left	12	30
Right	28	70
Back pain		
Yes	40	100
No	0	–

Table 4 highlights the preoperative muscle strength grades of the Flexor Hallucis Longus (FHL) and Extensor Hallucis Longus (EHL) muscles in 40 patients. In FHL, the majority of patients had moderate to good strength, with 32.5% (n=13) at Grade 4 and 25% (n=10) at Grade 5, 30% (n=12) at Grade 3, and 12.5% (n=5) at Grade 2; none had Grade 1 strength. In comparison, EHL muscular strength was slightly lower overall, with 7.5% (n=3) at Grade 5 and 40% (n=16) at Grade 4. Grade 3 strength was found in 35% (n=14), Grade 2 in 15% (n=6), and minimum strength in 2.5% (n=1) of patients at Grade 1. These findings reveal varied degrees of motor impairment prior to surgery, with FHL strength being significantly higher than EHL.

Table 4: Patients' preoperative FHL and EHL muscle grades.

Variable	No.	%
FHL grading		
Grade 5	10	25
Grade 4	13	32.5
Grade 3	12	30
Grade 2	5	12.5
Grade 1	0	–

Total	40	100
EHL grading		
Grade 5	3	7.5
Grade 4	16	40
Grade 3	14	35
Grade 2	6	15
Grade 1	1	2.5
Total	40	100

Table 5 underscores the patients' postoperative symptoms. Leg paresthesia was totally eliminated in all individuals (100%, n=40), with no occurrences of postoperative infection observed. Leg pain continued in 17.5% (n=7) of patients, whereas 82.5% (n=33) reported total alleviation. However, back discomfort remained a prevalent postoperative complaint, recorded by 62.5% (n=25) of patients, with just 37.5% (n=15) free of it. These data indicate significant reduction in leg-related complaints following surgery, however back discomfort persisted in a significant proportion of individuals.

Table 5: Postoperative symptoms.

Variable	No.	%
Leg paresthesia		
Yes	0	–
No	40	100
Leg pain		
Yes	7	17.5
No	33	82.5
Infection		
Yes	0	–
No	40	100
Back pain		
Yes	25	62.5
No	15	37.5

Table 6 summarizes the postoperative muscle strength grades for the Flexor Hallucis Longus (FHL) and Extensor Hallucis Longus (EHL) muscles. Muscle strength improved in FHL patients after surgery, with 32.5% (n=13) achieving Grade 5 and 42.5% (n=17) at Grade 4, while 25% (n=10) stayed at Grade 3. There were no patients recorded as Grade 2 or 1. Similarly, EHL strength improved significantly, with 57.5% (n=23) at Grade 5 and 37.5% (n=15) obtaining Grade 4. Only 5% (n=2) remained in Grade 3, and none had lower grades. These findings suggest that motor function has improved significantly following surgery, notably for the EHL muscle.

Table 6: Patients' Post-operative FHL and EHL muscle grades.

Variable	No.	%
FHL grading		
Grade 5	13	32.5
Grade 4	17	42.5
Grade 3	10	25
Grade 2	0	–
Grade 1	0	–
Total	40	100
EHL grading		
Grade 5	23	57.5
Grade 4	15	37.5
Grade 3	2	5
Grade 2	0	–
Grade 1	0	–
Total	40	100

Table 7 indicates the distribution of symptoms in patients before and after surgery, indicating statistically significant changes. Before surgery, all patients (100%, n=40) reported leg pain, leg

paresthesia, and back pain. Leg pain was absent in 85% of patients (n=34) after surgery, with just 15% (n=6) mentioning it. Leg paresthesia was totally gone in all patients (100%, n=40), and back pain diminished, with 37.5% (n=15) free of symptoms, while 62.5% (n=25) continued to have it. The chi-square (χ^2) and p-values show significant reductions in leg pain, leg paresthesia, and back discomfort after surgery.

Table 7: Patient symptom distribution before and after surgery				
Variable	**Preoperative**	**Postoperative**	**χ^2**	**p**
	No.	%	No.	%
Leg pain	0	0	34	85
	40	100	6	15
Leg paresthesia	0	0	40	100
	40	100	0	0
Back pain	0	0	15	37.5
	40	100	25	62.5

Table 8 presents a comparison of the distribution of Flexor Hallucis Longus (FHL) and Extensor Hallucis Longus (EHL) muscle strength grades pre- and post-surgery, indicating notable enhancements. The proportion of patients with Grade 5 strength for FHL increased significantly from 22.5% (n=9) preoperatively to 57.5% (n=23) postoperatively, whereas Grade 4 strength remained relatively stable, changing from 30% to 40%. The proportion of lower grades (3 and 2) experienced a significant decline, with Grade 3 decreasing from 35% (n=14) to 2.5% (n=1), and Grade 2 being eliminated entirely. In a similar manner, EHL strength exhibited significant improvement: Grade 5 increased from 7.5% (n=3) to 55% (n=22), Grade 4 remained relatively stable (40% to 37.5%), while lower grades (3, 2, and 1) showed a notable decline, with no patients scoring below Grade 3 in the postoperative assessment. The chi-square (χ^2) and p-values validate these enhancements as statistically significant, demonstrating effective recovery of muscle strength post-surgery.

Table 8: Distribution of FHL and EHL grades before and after surgery				
Variable	**Preoperative**	**Postoperative**	**χ^2**	**p**
	No.	%	No.	%
FHL grading				
Grade 5	9	22.5	23	57.5
Grade 4	12	30	16	40
Grade 3	14	35	1	2.5
Grade 2	5	12.5	0	0
EHL grading				
Grade 5	3	7.5	22	55
Grade 4	16	40	15	37.5
Grade 3	15	37.5	3	7.5
Grade 2	5	12.5	0	0
Grade 1	1	2.5	0	0

Table 9 presents the intraoperative complications identified in the study. Among 40 patients, 12.5% (n=5) encountered complications during surgery, whereas the majority, 87.5% (n=35), experienced no complications. Bleeding was the most frequently reported complication, occurring in 10% (n=4) of cases, while nerve root injury was observed in 2.5% (n=1) of cases. No dural tears were observed. This suggests a low overall complication rate, with bleeding identified as the primary concern.

Table 9: Complications During Surgery		
Variable	**No.**	**%**
Yes	5	12.5
No	35	87.5
Total	40	100
Type of Complication		
Dural tear	0	0
Nerve root injury	1	2.5
Bleeding	4	10
Total	5	100

Discussion

There were forty lumbar disc prolapsed patients in the study population, 65% of which were men and 35% of which were women. With 60% of the participants aged 40 years or above and the remaining 40% below 40, the mean age was about 39 years. Of the patients, half were self-employed, thirty-five percent were housewives, and fifteen percent worked for public services.

Kulkarni et al. (2014) [15] reported a predominance of males (68%) among patients who had undergone minimally invasive discectomy (MID), which is attributed to high rates of physical work that is mostly prevalent among males in most societies. Similarly, Arts et al. (2009) [16] reported that the majority of the patients (more than half, about 64%) with lumbar disc herniation were male, further attesting to the gender bias. The mean age of our study population was 39 years, with the majority of cases (60%) falling within the age group above 40 years of age. This finding is consistent with findings by Perez-Cruet et al. (2002) [17], who reported that lumbar disc disease is most frequently encountered between the ages of 35 and 50, an age that is synonymous with peak physical activity and mechanical loads placed on the spine. However, unlike our study, which reported a high incidence of self-employed persons and housewives among the patients, Kim et al. (2011) [18] reported a greater percentage of persons under formal employment (e.g., office workers and factory workers) undergoing MID, which suggests that occupational stressors may differ depending on regional and socioeconomic determinants.

The most commonly involved disc level was L4–L5 in 57.5% and L5–S1 in 42.5% of the patients. The average length of history prior to surgery was 10 weeks. Preoperative leg symptoms were right-sided in 70% and 30% of the patients were left-sided. The back pain was present in all 100% of the patients prior to surgery.

A survey study by Nellensteijn et al. (2010) [19] also documented comparable trends, where about 60% of patients who underwent minimally invasive discectomy had L4–L5 involvement. Caspar et al. (1991) [20] also documented that the L4–L5 segment is the most mobile segment and has heavy loading duties and is therefore most prone to disc degeneration and herniation. On the other hand, some studies, such as that by Jhala and Mistry (2010) [21], documented slightly higher prevalence of L5–S1 involvement, especially in young patients, and this is most likely because of higher axial loading at the lumbosacral junction. Such differences could be because of differences in patient population, occupational habits, and regional body biomechanics.

In our series, the mean symptom duration before surgery was 10 weeks, which is consistent with clinical guidelines of recommending conservative therapy for 6–12 weeks before considering surgery in the absence of compromise of the nervous system (Peul et al., 2007) [22]. The time is in keeping with the natural history of lumbar disc herniation so that the majority of patients will have partial improvement with non-operative treatment. Our study, however, only recruited patients who had persisting or worsening symptoms despite conservative treatment and therefore needed surgical intervention within the time period.

Motor function was also measured by flexor hallucis longus (FHL) and extensor hallucis longus (EHL) muscle strength grading. Preoperatively, 25% of the patients had normal (Grade 5) FHL function, the remaining had moderate weakness (Grade 3 or 4), and 12.5% had severe weakness (Grade 2). For EHL, 7.5% had normal strength, 40% had Grade 4, 35% had Grade 3, 15% had Grade 2, and 2.5% had Grade 1 muscle strength.

These findings are complemented well by Dasenbrock et al. (2012) [23], who reported preoperative EHL weakness in 70% of L4–L5 disc herniation patients, with the observation that EHL dysfunction is a useful clinical indicator of L5 radiculopathy. In addition, Wahlström et al. (2012) [24] pointed out that EHL weakness is a more sensitive indicator of nerve root dysfunction than change in reflex, particularly in L5 radiculopathy, which complements our observation of widespread EHL impairment in this group.

Postoperative outcomes showed an improvement in clinical status. Complete recovery of leg paresthesia was attested to by all subjects. Leg pain still persisted in only 17.5% of the cases, while 82.5% of them were pain-free. No postoperative infection was seen. Back pain still persisted in 62.5% of the subjects but was less intense. Motor recovery was also seen in the aspect of strength, where strength of the FHL muscle improved, with 32.5% having Grade 5 and 42.5% having Grade 4 strength on postoperative evaluation. No patients showed weakness less than Grade 2. In the EHL muscle, improvement was even more: 57.5% recovered full strength (Grade 5) and 37.5% recovered Grade 4, with no cases of severe weakness persisting.

Findings presented herein corroborate with the previous literature that attests to the role of minimally invasive discectomy (MID) in the attainment of early and significant relief of radicular signs and symptoms. For instance, a prospective comparative study conducted by Righesso et al. (2007) [25] found that 84% of the patients who received tubular microdiscectomy achieved complete disappearance of leg pain at follow-up at 6 weeks. In the same vein, Arts et al. (2009) [26] found that the minimally invasive technique led to earlier resolution of

radiculopathy compared to open discectomy, with fewer instances of residual neuropathic signs.

The comparative analysis of symptoms before and after surgery showed statistically significant improvements. Leg pain and paresthesia, which were universally found in patients at first, improved in 85% and 100% of cases, respectively, in the postoperative period. Reduction of back pain was also found, with 37.5% of patients reporting complete relief. Moreover, a significant improvement in muscle grading was seen. The percentage of patients with Grade 5 strength in the flexor hallucis longus (FHL) improved from 22.5% before surgery to 57.5% after surgery, and the percentage with Grade 5 strength in the extensor hallucis longus (EHL) improved from 7.5% to 55%, showing significant neurological recovery. As far as intraoperative complications were concerned, 12.5% of patients faced issues, mainly bleeding in 10% of cases, along with a single case of nerve root injury (2.5%). No dural tears were reported. Moreover, Smith et al. (2012) [27] reported a general complication rate of 14% for minimally invasive lumbar discectomy with bleeding and transient nerve root irritation being the most common issues.

The findings are consistent with those of Teli et al. (2010) [28], who reported that 88% of patients undergoing minimally invasive discectomy (MID) achieved complete remission of radiculopathy within three months following surgery. Similarly, Rihn et al. (2011) [29] noted that over 90% of patients undergoing minimally invasive lumbar discectomy improved significantly in leg complaints within the early postoperative period.

Overall results show that surgical treatment of disc prolapse significantly improves neurological symptomatology and muscle strength, particularly of the lower limbs, with a low rate of complications. While a few patients still reported some residual pain in the back, the operation successfully relieved radicular symptoms and enabled functional recovery.

Conclusion

The present prospective study on the results regarding single-level lumbar disc prolapse minimally invasive discectomy showed significant clinical improvement in most subjects, particularly for leg pain, paresthesia, and motor function recovery, with fewer complications postoperatively. The surgery was able to alleviate neurological symptoms and allow recovery of muscular strength, as evidenced from the improvement in the grade of FHL and EHL postoperatively. The absence of serious complications, dural tears, and the rare occurrence of minor complications, such as bleeding, further supports the safety and effectiveness of this surgical method. Overall, minimally invasive discectomy was a viable and effective surgical method in treating single-level lumbar disc prolapse with significant alleviation of symptoms and functional recovery at low risks of complications.

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