

Retrospective Study

e Clinical Outcome of Full-endoscopic Interlaminar Discectomy for Single-level Lumbar Disc Herniation: A Minimum of 5-year Follow-up

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Background: Full-endoscopic interlaminar discectomy (FEID) is widely applied for the treatment of lumbar disc herniation (LDH) and satisfactory short-term outcomes have been achieved. However, the long-term evaluation for this technique is still lacking, especially the comparison between FEID and microendoscopic discectomy (MED).

Objective: To evaluate the clinical outcome of FEID technique in comparison with MED for single-level LDH with a minimum of 5-year follow-up.

Study Design: Retrospective study.

Setting: Inpatient surgery center.

Methods: A total of 152 patients with single-level LDH located at either L4-L5 or L5-S1 who underwent either FEID or MED from August 2008 to April 2011 at our hospital were enrolled in this study. General parameters including operative time, length of hospital stay, mean time to return to work, complications, and recurrences were recorded. Clinical outcomes were evaluated using visual analog scale (VAS) for low back and leg pain, Oswestry Disability Index (ODI) for functional assessment, and modified MacNab criteria for patient satisfaction.

Results: At the final follow-up, the VAS of leg and back pain decreased from 7.6 ± 1.6 and 3.1 ± 2.2 points preoperatively to 1.6 ± 1.2 and 1.7 ± 0.9 at the final follow-up, respectively ($P < 0.05$). The ODI score was $69.5\% \pm 10.5\%$ preoperatively, and declined to $21.8\% \pm 7.0\%$ at the final follow-up ($P < 0.05$). VAS, ODI, and modified MacNab criteria of the FEID group were improved compared to the control group though there were no statistically significant differences between the 2 groups.

Limitations: This was a retrospective study with a relatively small sample size. Additionally, this study contained only clinical outcomes, without long-term radiological outcomes.

Conclusions: The application of FEID achieved similar satisfactory long-term clinical outcomes for the surgical treatment of LDH as MED. However, compared with MED, FEID exhibits advantages including less operation time, shorter hospital stay, and faster postoperative recovery.

Key words: Lumbar disc herniation, full-endoscopic interlaminar discectomy, microendoscopic discectomy, long-term

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Lumbar disc herniation (LDH) is a common degenerative disease. In the 1930s(1,2), discectomy for LDH was developed and open discectomy has become the conventional standard surgery for LDH

(3), despite its limitations. Minimally invasive surgery is applied to reduce operation-induced trauma and to improve clinical outcomes with less sequela. The endoscopic technique was developed to minimize

dural scarring and secondary iatrogenic instability associated with open surgery (4-6). In 1997, Foley and Smith (7) developed the microendoscopic discectomy (MED) technique for LDH which allows spine surgeons to decompress symptomatic lumbar nerve roots reliably via an endoscopy and minimally invasive surgical approach. In recent years, this endoscopic surgery has been broadly adopted due to its advantages including minimal traumatization, rapid recovery, and simplified procedures (8).

In 2006, Ruetten et al (9) first introduced the full-endoscopic interlaminar discectomy (FEID) technique using an optimal system and newly developed instruments for lumbar degenerative diseases. More satisfactory clinical results were obtained by the application of FEID compared to conventional open discectomy and minimally invasive surgery (10-18). However, current studies have been mostly focused on short-term clinical results of FEID, and there is a lack of evaluation of its long-term outcome (17). Thus, the goal of the present study is to evaluate the clinical results of FEID via comparison of traditional MED with a minimum of 5-year follow-up and to provide guidelines for future applications.

METHODS

Patients

In this retrospective study, 152 patients (84 men and 68 women) with LDH who presented to our hospital from August 2008 to April 2011 were enrolled. The characteristics of patients are summarized in Table 1. The mean age was 39.5 ± 8.9 years old (ranging from 18 to 58 years old). All cases were single level, non-foraminal and soft disc herniation at either L4-L5 or L5-S1. There were 46 cases with L4-L5 disc herniation (FEID/MED: 18/28) and 86 cases with L5-S1 disc herniation (FEID/MED: 54/52). FEID was performed in 72 cases (M/F:

40/32) and MED was applied in 80 cases (M/F: 44/36). All of these cases presented with symptomatic disc herniation accompanied by a varying degree of back pain and/or preoperative unilateral sciatica and had failed with conservative treatments. X-ray and magnetic resonance images (MRI) were applied for preoperative diagnosis and postoperative evaluation.

As shown in Table 1, patients from both the FEID and MED groups had similar clinical characteristics. There were no statistical significant differences in age, gender, level of herniated disc, type of herniated disc, and mean time of follow-up between the 2 groups.

Surgical Procedures

FEID was applied with the patient in the prone position. A minimal skin incision about 8 mm was made in the craniocaudal middle of the interlaminar window. A dilator, 6.9 mm in the outer diameter, was inserted bluntly to the lateral edge of the interlaminar window. An operating sheath, with a 7.9 mm outer diameter and beveled opening, was directed towards the ligamentum flavum. The whole procedure was performed under visual control and constant irrigation (9). A lateral incision in the ligamentum flavum was made and widened to allow access to the spinal canal. The procedures under endoscopy are illustrated in Fig. 1. If the interlaminar osseous window limited the direct access into the spinal canal through the ligamentum flavum, it was expanded using a burr. All of the surgical instruments were supplied by Richard Wolf GmbH, Knittlingen, Germany.

In the MED group, the patient, under general anesthesia, was positioned kneeling prone. To confirm the surgical segment with a C-arm, an 18 mm incision was made. Then, dilators, operating sheath, and endoscopy were placed accordingly. The procedure was performed under visual control. Finally, drainage tubes were inserted and suturing was performed.

Table 1. Clinical characteristics of patients.

Clinical characteristics	FEID	MED	P value
Number of patients	72	80	
Mean age (years)	38.3 ± 8.5	40.7 ± 9.2	> 0.05
Gender (male/female)	40/32	44/36	> 0.05
Mean duration of symptom (months)	2.8 ± 0.6	3.2 ± 0.8	> 0.05
Herniated level (L4-L5/L5-S1)	18/54	28/52	> 0.05
Herniated type (protrusion/extrusion/sequestration)	58/9/5	63/12/5	> 0.05
Mean follow-up (months)	74.8 ± 4.2	76.2 ± 4.8	> 0.05

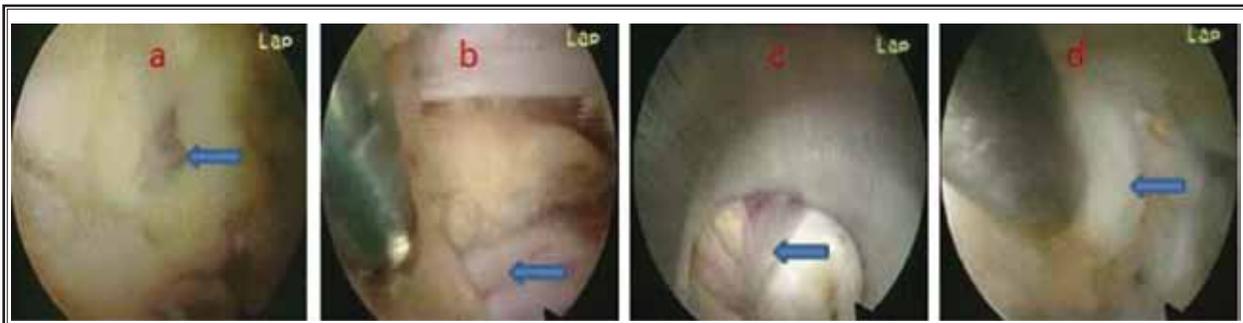


Fig. 1. A) Incision in the ligamentum flavum; B) exploration of nerve; C) traction of nerve with the rotation of operating sheath; D) removal of the herniated disc.

All operations were performed by 2 experienced surgeons in our department randomly.

Outcome Measurements and Follow-up

The follow-up was achieved by the outpatients department via telephone. In addition to general parameters such as operative time, length of hospital stay, time to return to work, complications, and recurrences, visual analog scale (VAS) and Oswestry Disability Index (ODI) for 3 months, one year, 2-years, and the final follow-up were evaluated. Patient satisfaction was evaluated using the modified MacNab grading standard (19) and summarized in Table 2. In addition, recurrence was classified according to the time period, with early recurrence at ≤ 6 months and late recurrence at > 6 months postoperative with a minimal of a 2-week interval (20).

Statistical Analysis

All statistical analysis was performed using the SPSS (version 17.0, USA). Quantitative data were presented as the mean \pm standard deviation. Repeated measures ANOVA was used for statistical analyses of differences in mean values, and the Fisher's exact test and Chi-square test were used for categorical data between the groups and comparison of preoperative and postoperative results. The Mann-Whitney U test and paired t test were applied to compare the preoperative and postoperative VAS and ODI scores. Significant difference was accepted at $P < 0.05$.

RESULTS

The operation was successfully completed for each patient. The clinical good-to-excellent rate was 89.9% in FEID: excellent 26 (36.1%), good 38 (53.8%), fair 9 (11.1%), and poor (0%). In comparison, the rate for MED was 72.5%: excellent 22 (27.5%), good 36 (45.0%),

Table 2. Patient satisfaction was evaluated using the modified MacNab grading standard.

Excellent	No pain; no restriction of activity.
Good	Occasional back or leg pain of sufficient severity to interfere with the patient's ability to do his normal work or his capacity to enjoy himself in his leisure hours
Fair	Improved functional capacity, but handicapped by intermittent pain of sufficient severity to curtail or modified work or leisure activities
Poor	No improvement or insufficient improvement to enable increase in activities; further operative intervention required

Table 3. General parameters of FEID and MED group.

General parameters	FEID	MED	P value
Mean operative time (min)	57.4 \pm 11.5	66.2 \pm 6.7	< 0.05
Mean length of hospital stay (day)	4.2 \pm 0.6	6.4 \pm 1.1	< 0.05
Mean time to return to work (day)	5.6 \pm 2.2	12.4 \pm 3.7	< 0.05
Complications	7 (9.7%)	11 (13.8%)	> 0.05
Recurrences	6 (8.3%)	7 (8.8%)	> 0.05

fair 18 (22.5%), and poor 4 (4.7%). Significant differences was found between the 2 groups ($P < 0.05$).

All of the patients were followed up for 60 to 96 months with an average follow-up of 75.7 ± 4.5 months. General parameters were summarized in Table 3. The mean operation time was 57.4 ± 11.5 minutes in the FEID group and 66.2 ± 6.7 minutes in the MED group with significant differences ($P < 0.05$). The mean length of hospital stay of the FEID group was significantly shorter than that of MED (4.2 ± 0.6 days vs 6.4 ± 1.1 days) ($P < 0.05$). The mean time to return to work

was 5.6 ± 2.2 days in the FEID group and 12.4 ± 3.7 days in the MED group ($P < 0.05$).

There were no serious complications with the operating procedures nor did significant nerve injury occur in either group. Dural tears were noticed in 9 cases (FEID: 4, 5.6%; MED: 5, 6.3%) during the operation, but no further treatment was required. Transient postoperative dysesthesia occurred in 7 patients (FEID: 3, 4.2%, MED: 4, 5.0%). There were 2 separate cases of hematoma and wound infection in the MED group, which needed reoperation. The complication rate was higher in the MED group than in the FEID group though not significant.

Recurrences were detected in 6 patients (8.3%) in the FEID group (L4-L5: 2, L5-S1: 4) and 7 patients (8.8%) in the MED group (L4-L5:3, L5-S1:4) with no significant difference ($P > 0.05$). Early recurrences occurred in 6 cases (FEID: 4, MED: 2) and late recurrence in 7 cases (FEID: 2, MED: 5). Still no significant difference could be found in early or late recurrences between the 2 groups ($P > 0.05$). Three recurrent cases in the MED group needed fusion while no fusion was performed in the FEID group recurrent cases.

Preoperative and postoperative VAS of leg and back pain and ODI of both groups are summarized in Table 4. For the FEID group, the VAS of leg and back pain decreased from 7.6 ± 1.6 and 3.1 ± 2.2 points preoperatively to 1.6 ± 1.2 and 1.7 ± 0.9 at the final follow-up, respectively ($P < 0.05$). The mean decreases were 6.0 ± 1.7 and 1.4 ± 1.3 points, respectively. The ODI score was $69.5\% \pm 10.5\%$ preoperatively, which was declined to $21.8\% \pm 7.0\%$ at the final follow-up with a mean decrease of $47.7\% \pm 11.2\%$ ($P < 0.05$). For the MED group, the VAS of leg and pain decreased from 7.4 ± 1.7 and 3.3 ± 1.9 points preoperatively to 1.7 ± 1.3 and 2.0 ± 1.1 at the final follow-up, respectively ($P < 0.05$). The mean decreases were 5.7 ± 1.8 and 1.3 ± 1.1 points, respectively. The ODI score was 72.6 ± 11.2 points pre-

operatively, which declined to 26.4 ± 8.5 points at the final follow-up with a mean decrease of $47.7 \pm 11.2\%$ ($P < 0.05$).

There was no significant difference of the preoperative VAS and ODI scores between the 2 groups. At the 3-month, one-year, 2-year, and final follow-up postoperatively, the result was not statistically significant in each group. No significant differences in VAS and ODI scores were noticed postoperatively between the 2 groups.

DISCUSSION

Microsurgery through the interlaminar approach (21) for LDH was developed in the late 1970s with the advantages of being minimally invasive and providing rapid recovery times and simplified operating procedures (22). However, clinical results (23,24) showed no statistical differences between the minimally invasive procedure and conventional open surgery. Excellent clinical results have been achieved by FEID (11-18). However, there is a lack of the long-term outcome evaluation (17). In the present study, satisfied clinical outcome of full-endoscopic interlaminar operation for LDH was presented with a minimum of 5-year follow-up.

At the final follow-up, the good-to-excellent rate was comparable with that of traditional open surgery (75% – 95%) (25). Our results indicated that sufficient and safe decompression of nerve root and discectomy (9) were obtained in both groups. Compared to MED, FEID results in much less iatrogenic damage in the paravertebral muscles and posterior osteoligamentous structures, especially ligamentum flavum (9,12,15,20). Though the clinical effects of MED have been demonstrated earlier (26,27), the FEID approach should be recommended because of its advantages of a shorter hospital stay, faster rehabilitation and lower postoperative costs of care, reduced surgical trauma, and easier revision operations, which have also been demonstrated in this study

Table 4. Preoperative and postoperative clinical outcomes of FEID group and MED group.

Outcome	Group	Preop.	Postop.			
			3 months	1 year	2 years	Final Follow-up
VAS leg pain	FEID	7.6 ± 1.6	1.2 ± 0.8	1.1 ± 0.9	1.4 ± 1.1	1.6 ± 1.2
	MED	7.4 ± 1.7	1.3 ± 0.9	1.2 ± 1.0	1.5 ± 1.2	1.7 ± 1.3
VAS back pain	FEID	3.1 ± 2.2	1.8 ± 1.5	1.6 ± 1.4	1.5 ± 1.1	1.7 ± 0.9
	MED	3.3 ± 1.9	1.9 ± 1.4	1.8 ± 1.3	1.6 ± 1.0	2.0 ± 1.1
ODI (%)	FEID	69.5 ± 10.5	19.3 ± 6.5	15.6 ± 5.9	17.4 ± 6.3	21.8 ± 7.0
	MED	72.6 ± 11.2	23.4 ± 7.2	18.8 ± 6.8	21.3 ± 7.6	26.4 ± 8.5

(9,10,14,28). It is worth noting that the minimal defect to the ligamentum flavum with the FEID procedure is related to nonsignificant epidural scarring (9).

The goal of a minimally invasive technique is to achieve the current results while minimizing traumatization and its negative consequences (29), which have been achieved in both groups. Fritsch and Kaltenkirchen (30) found that global complication rates ranged between 1.6% and 24.8% for standard open surgery, 2.3% to 10.8% for microsurgery, and 0% to 16.8% for percutaneous surgery. Dural tears are a common complication as a result of the lack of a 3-dimensional view of the operative field (27). The rate of dural tears varied between 0.4% and 10.4% which was equivalent to our study. Ruetten et al (12) reported that transient dysesthesia after FEID for LDH was observed in 3.8% of patients. Our experiences suggested that retraction of the nerve was inevitable intraoperatively while working in that small space and resulting in postoperative dysesthesia. Therefore, experienced surgeons are preferred. Though not significant, patients in the FEID group seemed to have a lower complication rate compared to patients in the MED group.

Recurrences of LDH have received wide attention. As noted, the recurrence rate of LDH in the MED group was approximately 10%, while the recurrence rate of opening surgery was 4% – 14% (31,32). Soliman et al (32) noted a recurrence rate of 11.1% in a 7.2 year follow-up, though it was only 3.6% in the first year. Different from traditional surgery, recurrence time in the FEID group appeared mostly early postoperatively. The reported recurrence rate was 3.3% – 5.7% in the FEID group at short-term follow-up (12,14,15). In the present study, the recurrence rate is 8.3%. Interestingly, early recurrences accounted for 2/3 cases. The possible causes were as follows: incomplete resection of the annulus fibrosus, improper management of the endplate, improper position of the working channel, large defect of the annular, type of herniation, and steep learning curve (9,10,12,14,15,33,34). Advanced age may result in late recurrences (20). In the present study, the FEID group had a higher rate of early recurrence; however,

the overall recurrence was comparable. Hyeun SK et al suggested that minimizing the annular defect size by using an annular sealing technique may result in a decreased recurrence rate (33). In addition, in our opinion, a strict selection of indication must be kept in mind to avoid unnecessary recurrences.

Our results found a significant decrease in both VAS and ODI during the follow-up. Similar to previous studies (12,14,17), there was no significant difference between FEID and MED in the improvement of clinical symptoms with a minimum of 5-year follow-up. However, both scores have a slight increase at 2-year post-surgery and at the final follow-up. This may be related to lower back and leg pain gradually aggravating disc degeneration and decreased lumbar physical function with increasing age (27,35). However, there was no statistically significance between the 2 groups for both VAS and ODI scores at one-year and the final follow-up. This showed that the satisfied postoperative clinic outcome could be maintained. Nevertheless, this result was better than traditional surgery (36,37). It was shown that FEID could achieve satisfied long-term outcome.

There were limitations in this study. First, this study incorporated a retrospective design and the sample size was relatively small. Second, there could be bias since all operations were performed by 2 experienced surgeons. Finally, clinical outcomes were measured without radiological results. Despite of these limitations, satisfied long-term clinical outcomes of FEID were confirmed.

CONCLUSION

FEID achieved satisfactory long-term clinical outcomes for the surgical treatment of LDH with less operation time, shorter length of hospital stay, and faster postoperative recovery compared to MED. Though no statistical difference was found, the complication rate seemed lower in FEID. It offers an alternative surgical treatment for LDH though early recurrence and a steep learning curve could be challenges for surgeons to overcome and proper surgical indications should be carefully considered.

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