Full-Endoscopic Lumbar Discectomy for Recurrent Lumbar Disc Herniation: A Retrospective Study with Patient-Reported Outcome Measures

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Abstract:

Introduction: Revision surgery for recurrent lumbar disc herniation after surgical treatment is at times challenging due to epidural adhesions and scar. This study aimed to review the clinical results and safety of full-endoscopic lumbar discectomy via interlaminar (FELD-IL) and transforaminal (FELD-TF) approaches for revision surgery.

Methods: We conducted a retrospective study including 52 lumbar disc herniation revision patients (mean age, 51.8 years; male/female, 13/39), with 17 FELD-IL and 35 FELD-TF cases. Complication incidences were assessed by reviewing surgical videos and postoperative magnetic resonance images of nerve decompression outcomes. Patients' responses to Japan Orthopedic Association Back Pain Evaluation Questionnaire (JOABPEQ) and numerical rating scales (NRS) for lumbar pain, leg pain, and leg numbness were recorded before and during follow-up. The Wilcoxon-signed rank tests were utilized to compare pre- and postoperative group variables.

Results: The average operation time was 33.0 min in FELD-IL and 31.7 min in FELD-TF. Seven FELD-IL cases required lamina excavation with high-speed drill bars for scar tissue dissection from the lamina. Dura injury occurred during the excavation in one case. No complication was noted in the FELD-TF group. Successful decompression of the nerve was achieved in all cases. Complete sets of JOABPEQ and NRS were obtained in 64.5% of FELD-IL and in 82.9% of FELD-TF. The mean follow-up period was 18.6 months. All the subdomain of JOABPEQ and NRS improved significantly postoperative in both groups. There was no difference regarding the improvement of scores between the procedures except NRS for lumbar pain, which was more favorable in FELD-IL. Recurrence of herniation occurred in one patient (6%) after FELD-IL and two patients (6%) after FELD-TF.

Conclusions: Both FELD-IL and FELD-TF are safe and effective revision procedures for recurrent lumbar disc herniation. FELD-TF could be performed employing the same procedure as primary surgery in revisions, regardless of the previous surgical approach.

Keywords:

Lumbar disc herniation, Recurrence, Full-endoscopic lumbar discectomy

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Introduction

Recurrence of symptomatic lumbar disc herniation occurs in 5%-15% of surgical treatment[1-3] calling for an urgent need for revision surgery, employing the same posterior approach for recurrent disc herniation after lumbar spine surgery. It could sometimes impose a considerable challenge due to epidural adhesions and scar tissues, which increase the risk of dural nerve injury[4]. Because of these concerns, both the patient and the surgeon tend to choose conservative treatments for the recurrent disc herniation, unless the symptom becomes intolerable[3]. Revision surgery via a posterior approach includes repeated discectomy with or without intervertebral fusion[3,5]. Both of these two surgical options have been reported to provide comparable clinical results. However, another concern emerges regarding revision discectomy that might lead to instability due to excessive resection of the intervertebral facet joints for the nerve expo-

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sure to avoid intraoperative injury. This concern might prompt surgeons to opt for instrumental fusions regardless of necessity.

Full-endoscopic lumbar discectomy (FELD) is a minimally invasive spine surgical technique, which enables an introduction of an endoscope and related instruments directly into the lesion through an 8-mm cannula without dissecting the soft tissues around the nerve[6-10]. FELD could be applied using two approaches, namely, interlaminar (IL) approach and transforaminal (TF) approach. While both approaches could provide comparable clinical results, the advantage of the TF strategy enables a direct approach to the herniated disc via the foramen without dissecting the ligamentum flavum or retracting any dural nerve under local anesthesia[11]. Therefore, FELD via the TF approach (FELD-TF) might be more suitable for revision surgery for recurrent lumbar disc herniation, particularly in instances where the history of surgery via the posterior approach with interlaminar and epidural space might be occupied with scar tissues. Furthermore, this approach might not cause an adhesion at the foraminal space to result in another revision failure due to low invasiveness; thus, repeated FELD-TF might be feasible for patients with a history of the same previous surgical approach. In contrast, FELD via IL approach (FELD-IL) is suitable for intracanalicular disc herniation at L5/S1 or sequestrated disc herniation located at L4/5 level or higher for which FELD-TF is challenging to access[10]. Despite its low invasiveness, the FELD-IL technique might still be challenging for a patient with a history of surgery via interlaminar space occupied by operative scar tissue. However, there are not many available reports regarding information for safety and clinical outcomes of FELD via IL and TF approaches for recurrent disc herniation[12-15].

This study aimed to reveal the clinical outcomes of FELD for recurrent lumbar disc herniation. The outcomes evaluated with a patient-reported outcome measure (PROM) and numerical rating scales (NRS) were reviewed retrospectively from the medical records of our institute, leading to the hypothesis that both the FELD-TF and FELD-IL are safe and effective surgical options for symptomatic recurrent lumbar disc herniation.

Materials and Methods

Subjects

This retrospective study involved patients who underwent FELD as revision for recurrent symptomatic lumbar disc herniation in our hospital from January 2013 to February 2018. The institutional ethical review board approved the study protocol. Informed consent was obtained in the form of opt out on the website. All data were handled following the ethical standards of the Helsinki Declaration.

The indications for FELD-IL were as follows: (1) intracanalicular disc herniation at L5/S1 and (2) intracanalicular sequestrated disc herniation located at L4/5 level or higher. The indications of FELD-TF were as follows: (1) lesion is located at L4/5 level or higher and (2) bulging, subligamentous, or transligamentous extruded disc herniation at the disc level. The contraindications of FELD were as follows: (1) cases with intervertebral instability, (2) cases with infection at the lesion, and (3) cases with a bleeding tendency or other severe systemic diseases that interfere with placing in the prone position during the surgery. The inclusion criteria of this study are patients who had a history of surgery at the same disc level. The exclusion criteria were as follows: (1) patients with combined symptoms due to disease of another disc level, (2) surgery that was performed in combination with intervertebral fusion or other spine-related surgery, and (3) patients who could not understand the PROM.

A review of the database of the medical record revealed that 1,003 FELD cases were performed during this period. All the surgery was performed by one surgeon (K.Y.). Among them, 52 cases in 49 patients met the criteria, including 17 cases in 16 patients who underwent FELD-IL, and 35 cases in 33 patients underwent FELD-TF. Table 1 shows the demographic data of the patients. The previous diagnosis was lumbar disc herniation (LDH) in 44 cases and lumbar spinal stenosis in 8 cases. The approach of prior surgery was via IL in 44 cases and via TF in 8 cases. The mean duration from the last operation to the recurrence of symptoms was 73 months, while the mean duration from recurrence of symptoms to reoperation was 4.5 months.

Assessment

Pre- and postoperative magnetic resonance imaging (MRI) was accessed to enable the evaluation of plausible nerve compression. The intraoperative video was reviewed to assess the incidence of intraoperative complications, including injuries of the dura and nerve. All the assessments on images were performed by two experienced spine surgeons (K. K. and T.I.) aside from the chief operative surgeon. The operation time and incidence of postoperative complications were assessed from the patients' medical records.

Clinical outcome was assessed with the Japan Orthopedic Association Back Pain Evaluation Questionnaire (JOABPEQ) before and at least 6 months after the surgery. JOABPEQ is a PROM that evaluates the health-related quality of life for patients with lumbar spine disorders. The scores include 5 domains with 25 questionnaires as follows: low back pain, lumbar function, walking ability, social life function, and mental health. Besides, the NRS scale of 0-10 (0 is for best, 10 is for worst) scoring for low back pain, lower limb pain, and lower limb numbness was recorded by the patients at the same time.

Statistical analysis

Power analysis revealed that when we assumed power of 0.8, alpha of 0.8, with a standard deviation of 20 points, the sample size allowed the detection of a difference of 20 points in JOABPEQ with paired test of 10 cases. The Shapiro-Wilk test was used to determine the normality of

Table 1. Demographic Data for Lumbar Disc Hernia Revision Surgery.

	FELD-IL (n=17)	FELD-TF (n=35)
Age, years	48.4 (13.3), 30–82	55.1 (13.5), 21–79
Sex, male/female	2/15	11/24
Duration until recurrence, months	81.3 (122.0), 1–394	71.4 (98.1), 0–353
Duration until revision surgery, months	86.2 (123.3), 2–408	74.5 (97.2), 3–360
Follow-up period, months	16.1 (13.6), 6–55	18.7 (16.8), 6–68
Previous diagnosis		
Lumber disc herniation	21 patients	27 patients
Lumber spinal stenosis	0 patient	8 patients
Previous surgery		
Posterior open surgery	5 patients	14 patients
MED, MEL	2 patients	9 patients
FELD-IL	10 patients	3 patients
FELD-TF	0 patient	8 patients
Laser disc decompression	0 patient	1 patient
Level of lumbar disc		
L2/3	1 patient	2 patients
L3/4	0 patient	7 patients
L4/5	3 patients	26 patients
L5/S1	13 patients	0 patient
Operation time (min)	33.0 (16.5), 18–84	31.7 (12.7), 16–75

Mean (SD), range. FELD-IL, full-endoscopic lumbar discectomy via interlaminar; FELD-TF, full-endoscopic lumbar discectomy via transforaminal

continuous variables. The Wilcoxon signed-rank test was used for pre- and postoperative comparison of variables with non-normal distribution. The Mann-Whitney U test was used to compare the means between the two groups. JMP ver.13 software was used for the statistical analysis.

Results

The review of intraoperative video and MRI images confirmed the successful excision of the herniated intervertebral disc and nerve decompression in all the patients' cases. Among 17 cases in the FELD-IL group, lamina excavation with a high-speed drill bar was needed in 7 cases to dissect the scar tissue from the lamina and to expose the dura. In one of the cases, injury of the dura occurred during the excavation of transligamentous extrusion at the L2/3 disc level. The injury was a pinhole; thus, it was left unrepaired. However, the patient was kept in bed rest for 2 days. Thereafter, no related symptoms occurred. In contrast, in the case of the FELD-TF group, neither the use of drill bar nor intraoperative complications, including injury of the dura or a nerve, were reported.

The mean operation time was 33.0 min in FELD-IL and 31.7 min in FELD-TF, which shows no significant difference between the procedures (Table 1). Among the FELD-IL group, the mean operation time was significantly longer in the subgroup that needed to use a drill bar for lamina excavation than those that did not have the need (42.9 vs. 26.1 min, p=0.0001). Within the FELD-TF cases, there was no difference in operation time between the patients with a history of TF method and IL method in the previous surgery.

Table 2 presents the summary of the clinical results of the patients' reported outcomes of the FELD-IL and FELD-TF groups before the revision surgery and at postoperative follow-up. JOABPEQ and NRS at before and after surgery were obtained in 11 of 17 patients in FELD-IL (follow-up rate: 64.7%) and 29 of 35 patients (follow-up rate: 82.9%). The average follow-up period was 18.6 months for both procedures. JOABPEQ at follow-up significantly improved from the preoperative one in all domains for low back pain, lumbar function, walking ability, social life function, and mental health in both procedures ($p<0.0001$). No significant differences were observed between procedures in each score at the follow-up or the improvement of scores. NRS was also significantly improved in both procedures for all items, with low back pain, lower limb pain, and lower limb numbness. The NRS for low back pain at follow-up was significantly lower in FELD-IL than that in FELD-TF ($p<0.05$).

One patient incurred recurrence of disc herniation after the revision surgery among the FELD-IL group, and two of such cases occurred among the FELD-TF group. The recurrence rate was 6% in both procedures. All the cases were treated by repeated FELD with the same approach as the first revision surgery.

Discussion

This retrospective study revealed the feasibility and safety of both FELD-IL and FELD-TF for recurrent LDH with a history of surgical treatment. Both procedures could be performed with relatively short operation time and provided significant improvement of PROMs. The reviewed intraop-

Table 2. Patient-Reported Outcomes after Revision Surgery for Recurrent Lumbar Disc Herniation.

	FELD-IL (n=11)	FELD-TF (n=29)
Follow-up period	18.6 (16.6), 6–55	18.6 (15.1), 6–56
JOABPEQ (low back pain)		
Before operation	10.5 (15.9), 0–43	13.2 (20.5), 0–71
During follow-up	72.6 (32.2)*, 0–100	55.6 (38.0)*, 0–100
JOABPEQ (lumbar function)		
Before operation	28.7 (23.4), 0–83	32.8 (25.5), 0–83
During follow-up	69.2 (28.5)*, 10–100	59.7 (25.8)*, 0–100
JOABPEQ (walking ability)		
Before operation	31.7 (26.1), 0–86	17.0 (17.9), 0–64
During follow-up	64.8 (27.1)*, 14–100	51.2 (29.8)*, 0–100
JOABPEQ (social life function)		
Before operation	18.9 (16.9), 0–51	16.9 (16.4), 0–73
During follow-up	49.3 (22.6)*, 22–100	41.4 (21.5)*, 0–92
JOABPEQ (mental health)		
Before operation	33.6 (16.8), 3–63	30.8 (18.4), 0–74
During follow-up	61.7 (16.1)*, 45–90	51.4 (18.3)*, 17–96
NRS (low back pain)		
Before operation	7.0 (3.0), 1–10	7.3 (2.4), 1–10
During follow-up	1.5 (2.4)*†, 0–8	3.4 (2.8)*, 0–10
NRS (lower limb pain)		
Before operation	8.6 (1.3), 7–10	8.0 (1.9), 3–10
During follow-up	2.4 (3.1)*, 0–8	3.3 (2.5)*, 0–8
NRS (lower limb numbness)		
Before operation	8.7 (1.5), 6–10	6.7 (3.3), 0–10
During follow-up	2.5 (3.4)*, 0–10	3.2 (2.7)*, 0–10

Mean (SD), range, *: $p<0.0001$ for before operation. †: $p<0.05$ for FELD-TF.
JOABPEQ, Japan Orthopedic Association Back Pain Evaluation Questionnaire; NRS, numerical rating scales; FELD-IL, full-endoscopic lumbar discectomy via interlaminar; FELD-TF, full-endoscopic lumbar discectomy via transforaminal

erative MRI images confirmed successful decompression of nerve in all cases. FELD-IL sometimes required the excavation of lamina with a high-speed drill bar and carefully peeling off the adhesion between the nerve and the scar tissue to expose the herniated disc beneath the dural nerve, and, unfortunately, a dural injury occurred in one case. It should be noted that performing FELD-IL as a revision surgery after an open surgery using the IL approach is technically demanding and requires meticulous review of the preoperative imaging. It also requires preparation for the conversion to open surgery in the case of intraoperative complications. In contrast, FELD-TF was feasible without complications even among the subgroup with a history of the same surgical approach. Although the indication of FELD-TF was limited to bulging, subligamentous, or transligamentous extruded disc herniation at disc level located at L4/5 level or higher, this procedure is recommended for revision surgery with a history of either posterior approach or TF approach.

For recurrent disc herniation, re-excision of the hernia is recommended as an option for treating lower extremity pain but without lumbar instability. It is reported that comparable good results could be obtained using either conventional open Love method, microscopic Love method, or microendoscopic discectomy for recurrent hernia[16-18]. However, the posterior approach with those techniques for recurrent disc herniation has an increased risk of dural injury and cerebrospinal fluid leakage, compared with the initial surgery[19,20]. In addition, regarding the previous laminectomy, a wider exposure is sometimes necessary due to a lack of anatomical landmarks and epidural scarring. A further adhesion might occur on the dura and paravertebral muscles, which might cause failed back surgery syndrome. Furthermore, lumbar instability might be induced if additional resection of the facet joints is performed.

Several authors reported the usefulness of FELD for recurrent LDH after surgery. Shin et al. reported 41 case series with previous open lumbar discectomy, which were revised by FELD via IL approach in 32 patients and via the TF approach in 9 patients[13]. They reported successful clinical improvement of symptoms with relatively short operation time while reporting injury of the dural sac in two cases (4.8%) and recurrence of herniation in two cases (4.8%). Kapetanakis et al. reported the result of revision FELD-TF in 55 case series with a previous conventional microdiscectomy, showing significant improvements in symptoms and Short-Form 36 Health Survey Questionnaire with-

out severe complications or recurrence of herniation[12]. Ruetten et al. conducted a randomized study comparing FELD-IL or FELD-TF and conventional microsurgical discectomy in 87 patients with recurrent herniation after conventional discectomy[15]. They showed that the clinical outcomes were similar between FELD and microsurgery, while FELD was significantly favorable in bleeding volume, surgery time, and rate of complications, including dura injury, postoperative dysesthesia, delayed wound healing, and additional revision surgery. The recurrence rate after the revision surgery was similar in their report (4.8% in microsurgery, 6.7% in FELD), consistent with our current findings. However, dural injury occurred in one case during peeling of the adhesion between the nerve and the scar tissue. Rutten also reported that complication occurred more frequently in the FELD-IL group compared to the FELD-TF group[15]. To prevent dural injury, it is important to expose the interlaminar margin and ensure that the landmark is clear. If the interlaminar space is covered with scar tissue and is difficult to detach, fenestration should be performed to expose normal tissue to reach the nonadhered dural space. Therefore, the basic FELD-IL technique using high-speed drill should be mastered for revision surgery after the open posterior surgery. If the dura is severely damaged and the cauda equina erupts, it is required to convert the surgery to an open operation for repair. Shibayama et al. reported the successful repair of incidental dural tear without suturing by applying a polyglactin sheet that was soaked in fibrinogen under microendoscopic surgery[21]. We have used their patch technique in FELD using bioabsorbable reinforcement felt, Dura wave® (GUNZE LIMITED, Tokyo, Japan), for the dura injury that had to be repaired. In the case of a pinhole injury, it is left untreated without any postoperative complications.

Our current study includes the patients who had undergone FELD for primary surgery. Repeated FELD-IL was performed to ten patients who had undergone FELD-IL, while FELD-TF was performed to eight patients who had undergone FELD-TF. Although the same approach was adopted, no adhesion or necessity of excavation of scars was observed in either procedure. In addition, FELD-TF could be performed under local anesthesia, and the reaction from the patient could be confirmed to avoid the nerve injury[6,11].

Our study does not preclude limitations. First, this is not a prospective study that compared one surgical procedure with another (FELD-IL vs. FELD-TF) to determine technique superiority; the surgeries were performed under two distinct patients' status criteria for each procedure. Second, the follow-up period is relatively short and varied among patients in the range of 6-68 months. Symptoms could change as the elapsed time after surgery increases. Nevertheless, the improvement of PROMs, along with the review of images performed in the current study, demonstrated the usefulness and safety of FELD as revision surgery for recurrent herniation.

Conclusion

FELD with either IL or TF approach is therefore a safe and effective surgical option for recurrent LDH with a history of surgical treatment. As FELD-TF does not need to expose the scar tissue of previous surgery, the procedure and operation time were similar to those for primary FELD-TF.

Conflicts of Interest: The authors declare that there are no relevant conflicts of interest.

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Author Contributions: KY is the chief operative surgeon and prepared the manuscript. KK and TI assisted the surgery and contributed the data collection. KO conducted the research and helped in preparing the manuscript.

Ethical Approval: The institutional ethical review board of Kitakyushu Municipal Medical Center approved the study protocol (approve number: 202008002). Informed consent was obtained in the form of opt out on the website. All data were handled following the ethical standards of the Helsinki Declaration.

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