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THE RESULTS AND COMPLICATIONS OF INTERLAMINAR ENDOSCOPIC APPROACH FOR LUMBAR DISC HERNIATION: AN OVERVIEW OF A SINGLE-SURGEON EXPERIENCE

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ABSTRACT

Objective: Interlaminar endoscopic approach has become a main operative option for lumbar disc herniations over the past decade. This method stands out for not only successful pain management but also for low complication rate, as shown in many studies. We aimed to present the results of a single senior surgeon with long-term follow-up.

Materials and Methods: The interlaminar approach was executed to 142 patients with lumbar disc herniation. In total, 151 disc herniations were performed. Motor deficit and intractable radicular pain were considered indication for interlaminar endoscopic lumbar discectomy (IELD), similar to open microdiscectomy. Cauda equina syndrome and vertebral instability deemed as contraindications.

Results: All patients had severe radicular pain. One hundred and thirty-two patients (92.9%) exhibited positive nerve stretch results, and 67 (47.2%) patients had motor deficit. Ten patients had a history of prior lumbar surgery. L4-L5 (33.1%) and L5-S1 levels (59.2%) were the most frequently operated levels. Nine patients (6.3%) underwent IELD for multiple level. Complications were noted in six patients (4.2%) during hospitalization. Dural tear occured in four patients (2.8%) and motor deficit was observed in one patient (0.7%). No repair surgery was required for dural tear. The mean follow-up duration was 9.1 years. Nine patients (6.3%) had recurrent disc herniation. The mean duration of recurrence was 20.9 months, and 77.8% of recurrences occurred in the first year. One patient underwent posterior stabilization 1 year after the last surgery. No infection or spondylodiscitis was experienced in our cases.

Conclusion: The results of a single experienced senior surgeon indicated that IELD was a highly safe method. This method is on course to become a common method for treating many lumbar spine disorders as technological advancements in endoscopic tools and the increase in patient experience.

Keywords: Endoscopic discectomy, interlaminar endoscopy, lumbar disc herniation

INTRODUCTION

A fully endoscopic approach has become the method preferred by many surgeons for lumbar degenerative diseases recently. The interlaminar and transforaminal approaches constitute the main pathways towards spinal canal and intervertebral foramen. In 2005, Ruetten[1] first described the interlaminar technique for lumbar discectomy. A stab incision, minimal muscle retraction, limited bone removal, unnecessity of significant neural manipulation, minimal loss of blood, shorter time for operation and, as a result, early return to daily work makes the endoscopic techniques more desirable to perform[2,3]. Its indications were expanded as the endoscopic tools were advanced and the convenience of the method came out by many studies.

The endoscopes with narrower diameter and working canula would let the surgeon for lumbar discectomy unless the herniation located out of the spinal canal in earlier years[4,5]. Less injury rates of normal structures and avoiding bone resection to get through the interlaminar space are the advantages of these endoscopes. On the other hand, widening the diameter and working canula in endoscopes provided broader manipulation by efficient bony work and better visual resolution. Paracentral or foraminal lumbar disc herniations with or without migration, central canal stenosis and unilaterally or bilaterally lateral recess stenosis can be performed with interlaminar endoscopic approach in any level of lumbar vertebra in cases with the absence of significant instability[6]. Such advances in technology and increased surgical experience made spinal surgeons execute this technique more frequently.

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In addition to the successful outcome of endoscopic surgery in pain management, the complication rates make this approach to be considered a safe method. In this study, we present a single-surgeon experience using the interlaminar endoscopic approach, detailing the results from 142 patients. We describe the indications and surgical techniques employed, as well as a comparison of complications with existing literature.

MATERIALS AND METHODS

Interlaminar endoscopic lumbar discectomy (IELD) was performed on 142 patients using a uniportal technique. Nine patients had multilevel disc herniation and a total of 151 disc herniations were operated. Of 142 patients, 78 patients were males, and 64 patients were females (Male/Female: 1.2). The mean age of the patients was 42.9±12.2 years, with the ages ranging from 17 to 79. Prior to surgery, neurological evaluations were conducted, and all patients underwent magnetic resonance imaging (MRI) of the lumbar region. The patients with motor deficit and/or intractable radicular pain were considered candidates for surgery, as in indications for open lumbar microdiscectomy (Figure 1). Cauda equina syndrome and vertebral instability were acknowledged as contraindication for IELD. All perioperative and postoperative complications were noted. In the absence of early complications, the patients were mobilized on the same day of operation and discharged the following day.

Surgical Technique

The surgical technique described by Ruetten et al.[1,5] is fundamentally followed in all operations. The patients were fixed in the prone position on the operating table under general anesthesia. Biplanar fluoroscopic control was performed by positioning the C-arm beneath the operating table under sterile conditions. The incision site is first marked, and the skin and muscle fascia are simultaneously incised in a fashion medial to the midline of the targeted interlaminar space. Following a blunt insertion of the dilator with an outer diameter of 6.9 mm, a wider and beveled-opening surgical sheath (an outer diameter of 7.9 mm) was placed to the lateral edge of the interlaminar space under fluoroscopic guidance. Thereafter, a direct endoscopic view was provided through continuous irrigation during the surgery. Surrounding soft tissues were resected using cauterization and, the exposing ligamentum flavum was incised sufficiently to allow the manipulation the endoscope in the spinal canal. If the bony structures obstructed the access to the spinal canal, bone resection was performed using a burr or Kerrison rongeur. After visualizing the dura and nerve roots, the beveled opening of the surgical sheath was rotated to retract the nerve root to minimize neural damage. After cauterizing the epidural veins, discectomy was performed. In cases of caudally or cranially migrated disc herniations, the interlaminar approach provides a comfortable access along the entire level by allowing the endoscope to be maneuvered like a joystick after sufficient bony removal.

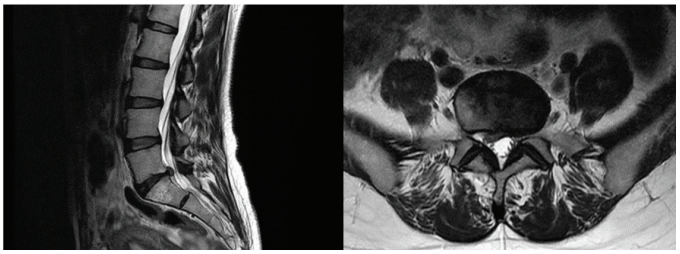

Figure 1. A right paracentral L5-S1 disc herniation caused severe right leg pain and motor deficit was operated with interlaminar endoscopic approach

Statistical Analysis

All variables in patient database were assessed with descriptive results obtained. All statistical analysis was conducted using SPSS v26.0 (IBM Corp., Armork, USA).

RESULTS

A total of 151 IELDs were executed in 142 patients. In preoperative evaluation, a positive nerve stretch test was positive in 132 patients (92.9%) with the Lasegue test positive in 130 (91.5%) and the femoral stretch test positive in two (1.4%). Sixty-seven patients (47.2%) had motor deficit, and 36 patients (25.4%) had hypoesthesia in the relevant dermatome. Additionally, 3 patients (2.1%) presented neurogenic claudication due to concomitant spinal stenosis secondary to large disc fragments. A history of previous lumbar surgery was noted in 10 patients, of whom five had undergone microdiscectomy and five had received endoscopic discectomy. The majority of the procedures were performed at the L4-L5 and L5-S1 levels (33.1% and 59.2% respectively). Also, one patient had an operation for D12-L1 level and one for L1-L2 level (Table 1). Nine patients (6.3%) underwent IELD for multiple levels. Of 9 patients, one underwent IELD for single-level lumbar disc herniation and two-level spinal stenosis, while others for multiple-level lumbar disc herniation. Sixty-five patients were operated only on the right side (45.8%), 75 patients (52.8%) were only on the left side, and 2 patients were bilaterally operated on (1.4%). In 8 cases, additional ipsilateral foraminotomy and/or decompression was made to have optimal relief of neural structures.

A total of 6 patients (4.2%) had surgery-related complications. Dural tear occurred in 4 patients (2.8%) and motor deficit was encountered in 1 patient (0.7%). One of the patients with dural tear had accompanying spinal stenosis and underwent decompression. None of the patient with dural tear developed closed or open cerebrospinal fluid (CSF) fistula requiring surgical repair. In another patient, pain did not improve after surgical intervention. A lumbar MRI revealed incomplete disc removal, and the patient underwent additional surgery for discectomy during the hospitalization. The mean follow-up duration for the 142 patients is 9.1 years (range, 2-12 years).

Table 1. Demographics and clinical features

	Total		L4-L5		L5-S1		Upper lumbar		Multiple	
	n	%	n	%	n	%	n	%	n	%
Number of patients	142	100	47	33.1	84	59.2	2	1.4	9	6.3
Age	42.9		48.55		40.3		53.5		37.6	
Male/female	78/64	1.2	26/21	1.2	48/36	1.3	0/2	-	4/5	0.8
Side										
Right	65	45.8	26	55.3	33	39.3	0	0	6	66.7
Left	75	52.8	21	44.7	51	60.7	2	100	1	11.1
Both	2	1.4	0	0	0	0	0	0	2	22.2
Neurological findings										
Motor deficit	67	47.2	23	48.9	39	46.4	0	0	5	55.5
Sensorial deficit	36	25.4	9	19.2	25	29.8	1	50	1	11.1
Nerve stretch test	132	92.9	44	93.6	78	92.9	1	50	9	100
Claudication	3	2.1	1	2.1	2	2.4	0	0	0	0
Complication										
Dural tear	4	2.8	3	6.4	1	1.2	0	0	0	0
Recurrent	9	6.3	2	4.3	7	8.3	0	0	0	0
Incomplete removal	1	0.7	1	2.1	0	0	0	0	0	0
De novo motor deficit	1	0.7	1	2.1	0	0	0	0	0	0
Infection	0	0	0	0	0	0	0	0	0	0
Previous lumbar surgery	11	7.8	4	8.5	7	8.3	0	0	0	0

During the follow-up, 9 patients (6.3%) had recurrence at the same lumbar level, and another surgical intervention was recommmended. The recurrences occurred in a mean interval of 20.9 months (15 days-7 years). Seventy-seven point eight percent of the recurrences occurred in the first year (4.9%), and the mean duration of recurrence is 6.4 months when excluding the recurrences that occur after one year. Eight patients with recurrence had undergone either microscopic or endoscopic discectomy once during the follow-up. One patient who initially had IELD surgery first operated for recurrent disc herniation with IELD technique, but the patient underwent another surgery for posterior stabilization one year after the last operation. No infections or secondary spondylodiscitis were reported among our cases. When examining the recurrence timing of the surgeon, 6 patients (66.6%) were included in the first half of the patient group during the initial three years. Also, the same difference was observed in the distribution of surgical complications over the years. Four surgical complications (66.6%) occurred in the initial three years, including the incomplete disc removal.

DISCUSSION

Recently, IELD is getting preferable among the spine surgeons. Many neurosurgery and orthopaedic surgery clinics have been executing endoscopic discectomy techniques more frequently rather than discectomy under operating microscope. Moreover, endoscopic spine surgery is advancing to be recognized the primary method for the disc surgery[7]. In 2016, Ruan et al.[8] estimated that endoscopic and microscopic techniques achieve similar success and complication rates excepting the shorter operating time and hospital stay on behalf of endoscopic technique. A later meta-analysis by Li et al.[9] presents that endoscopic discectomy has benefits to minimize intraoperative incidents. Also, they mentioned that both techniques yield comparable outcomes regarding success and recurrence rates. Another study of Barber et al.[10] highlighted the advantages of endoscopic discectomy, including perioperative blood loss, quicker return-to-work times, postoperative visual analogue scale and Oswestry disability index scores, and specific biomarkers. However, they also commented that most studies included in their meta-analysis were retrospective and a high risk of bias should be considered[10]. It should be remembered that the success of endoscopic technique is yet considered to rely on proper patient selection and the execution of precise surgical method [11].

As a complication of discectomy, dural tear might result in poor outcome such as spinal headache, CSF fistula, pseudomeningocele, meningitis or epidural abscesses which may necessitate an additional surgical intervention. In open microdiscectomy, the prevalence of dural tear varies from 1% to 17%[12]. In a study by Sencer et al.[13], the rate of dural tear after percutaneous IELD was presented as 3.6% and, they stated that one of the 6 patients needed surgery for open CSF fistula. Solimon mentioned a rate of 6% for dural tears after interlaminar endoscopic approach. But their indication for interlaminar endoscopic approach is spinal stenosis and the

difference of pathological entity and the need of more surgical manipulation may ease to occur dural tear[14]. For unilateral biportal endoscopic approach (UBE) to lumbar disc herniations, he reported a rate of 4.7% for dural tears in another study[15] and Kim et al.[16] reported a rate of 3.3%. For dural tear, the rate in endoscopic lumbar approaches might be mentioned as 2.7% (range, 0-8.6%) according to another study[17]. On the other hand, Lewandrowski et al.[18] exhibited a total rate of dural tear as 1.07% for endoscopic lumbar surgery, with an extremely low CSF fistula rate of 0.025%. Gautschi et al.[19] mentioned that 79.4% of spine surgeons use artificial sealant patches or other glue products to repair dura without direct suturing. In our series, we encountered dural tear in four patients (2.8%). All dural injuries occurred during the manipulation of surgical sheath to retract the nerve root and three of four patients had caudally migrated disc herniation (Figure 2). None of these patients had a history of previous lumbar surgery. In our cases, a commercial fibrin glue product was used to seal the durotomy area, and the suturing was not required. No open or closed CSF fistula have been experienced after incidental durotomy.

The difficulties in manipulation of surgical sheath may also be a reason of transient or permanent motor deficit in addition to the dural tear. Despite the similarities of the procedure with microscopic technique, the surgeon can readily be disorientated in consequence of the misplacement of surgical sheath, especially with lack of experience. Both the traversing root and exiting root are at risk if the surgical sheath is positioned more medially or laterally than necessary[20]. Postoperative motor deficits mostly tend to be transient and occur less frequently than dural tears. In our series, we only encountered postoperative drop foot in one patient who underwent surgery for sequestrated and cranially migrated L4-L5 disc herniation (0.7%). In the literature, there are several studies to report motor deficit after endoscopic lumbar surgery with low rates. In a study on complications of both transforaminal and interlaminar endoscopy, the motor deficit occurred in a rate of 0.8% in the patients executed IELD[21]. And in another study, Choi et al.[22] mentioned a rate of 1.5% for neural injury in the learning curve period of UBE. Shriver et al.[23] reported a rate of 1.6% for new neurological deficit in percutaneous procedures, however, they found no statistically significant compared to microscopic discectomy, which had a rate of 3% for new neurological deficit. In a study focused on disc herniations of L4-L5 level, migrated or extruded disc herniations are identified as independent risk factors motor deficit and delayed recovery[24], indicating a higher likelihood of complications associated with retracting the nerve root in these cases. Although the optimal position of surgical sheath can be established after high-speed drill of lateral edge of interlaminar space, it must be noted that anatomical variations of roots may be occasionally encountered and pose challenges. The lumbosacral region (L4-S3) has the highest incidence of intradural and extradural variations including close spacing between the roots and extradural anastomoses[25]. In our case, the traversing root was found to be exiting dura at a higher position and leading the surgeon to approach the axilla of the traversing root via interlaminar route. To retract the traversing root medially and access the herniated disc, the bone resection was extended laterally to position the working sheath next to nerve shoulder. However, we believe that placing the working sheath laterally in a location with minimal space between the exiting and traversing root, due to a higher positioning of traversing root, resulted in inreased compression in addition to the pressure from the herniated disc material, until optimal decompression was achieved.

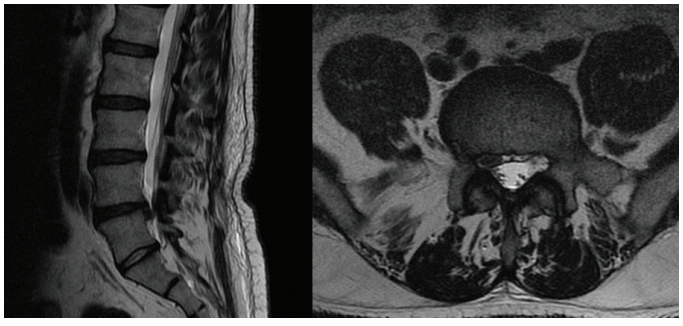

Figure 2. A sequestrated and caudally migrated L4-L5 disc herniation extending into the right lateral recess. Dural tear occurred during the surgery, but no CSF fistula observed or dural repair is needed in postoperative period
CSF: Cerebrospinal fluid

The recurrence of disc herniation after surgical intervention have been widely discussed and several risk factors have been mentioned yet. Cinotti et al.[26] and Suk et al.[27] indicated young age, male age, trauma history, and smoking as risk factors of recurrence. Moliterno et al.[28] stated that the patients with relatively low body mass indices tend to have higher recurrence rate, while Kim et al.[29] mentioned that the older age and higher body mass index were significantly associated with recurrence of disc herniation due to increased degeneration of disc. Diabetes also has been identified as a clinical and histopathological risk factor for recurrence with lower buoyant density of proteoglycans of the disc material[30]. A meta-analysis showed that the recurrences occur more frequently within the first 6 months after surgery[31]. Our series also presented that the early recurrences are more common, similar to the literature. Recurrence rates are vary in many studies, even those with the longer follow-up periods in the literature. Wu et al.[32] stated a recurrence rate of 8.2% within 30 months of follow-up. Kim and Park[33] showed a 10.3% recurrence rate after a mean follow-up duration of 19.5 months. In a prospective randomized controlled study of Ruetten et al.[34], a recurrence rate of 6.6% was reported with 24 months of follow-up. Various retrospective studies have documented very low or no recurrence rates through endoscopic interlaminar approach (0-1.4%)[35-37]. But Yin et al.[31] calculated the pooled recurrence rate as 4.2% for endoscopic interlaminar approach in their meta-analysis, with a follow-up duration ranging from 6 and 60 months. The early recurrence rate is 4.9% in our case series (Figure 3).

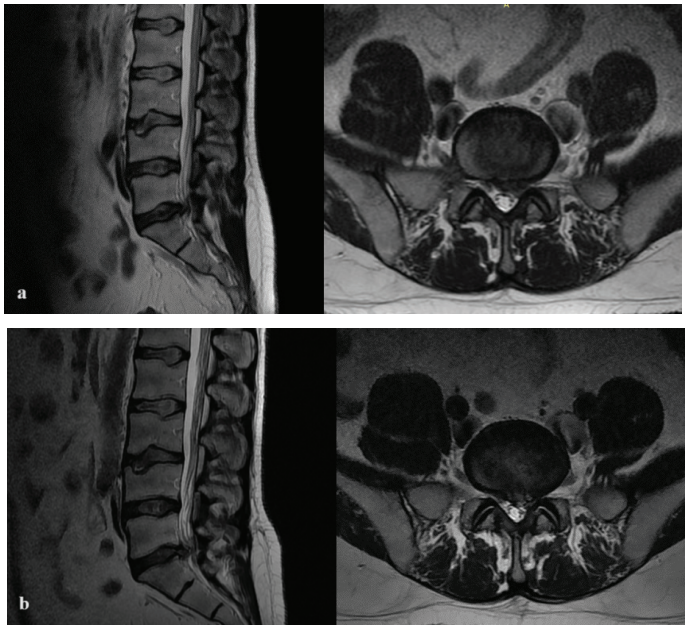

Figure 3. (a) A patient underwent IELD for left paracentral disc herniation in the level of L5-S1. (b) Six months later, the patient was operated for a recurrent disc herniation in the same region
IELD: Endoscopic lumbar discectomy

Compared to the literature, we have a longer mean follow-up period and the recurrence rate reached 6.3% after the mean period of 9 years. One of our patients who was operated for recurrent disc herniation required a stabilization surgery due to developing spondylolisthesis at his third year after the initial surgery. Also, one of our patients underwent additional intervention due to the failure of pain relief after the surgery and we defined the case as incomplete herniation removal instead of recurrence.

The studies addressing the learning curve for IELD is particularly limited compared to transforaminal approaches in the literature. A collective review for learning curve of all endoscopic spinal procedures mentioned that the majority of the studies indicated no influence of experience on complication and recurrence rates[38]. Similarly, the studies focusing specifically on IELD did not demonstrate an association between the increased experience and change in the rate of those[39,40]. In our series, we observed differences in complication and recurrence rates after the first half of the patients underwent surgery. While these results should be included in a larger meta-analysis for more robust evaluation, at least, it is worth noting that our series includes a larger number of patients compared to many other studies.

Infections following IELD have been rarely reported. In our series, we did not encounter any surgical site infection. Many studies mentioned no infection in their series including with the large number of cases[37,41,42]. Deep surgical site infection was presented in a study of Yorukoglu et al.[21] with a rate of 0.14%, in a study of Liu et al.[43] with a rate of 0.79% and in a study of Wang et al.[44] with a rate of 0.6%. Fukuhara et al.[45] suggested that the low postoperative infection rates after endoscopic lumbar surgery are attributed to the requirements of the surgical method such as small incision and continuous irrigation. It should be considered that the postoperative infection rates after microscopic lumbar discectomy are also reported to be below 1% in the literature[46,47]. A meta-analysis of 42 articles presented that superficial and deep surgical site infections do not show any significant difference between microscopic lumbar discectomy and endoscopic lumbar discectomy (2.1% for microdiscectomy vs. 0.5% for endoscopic discectomy)[23]. While we acknowledge that IELD is a very safe method for minimizing the risk of surgical site infection, we do not claim it to be superior to microscopic discectomy.

Study Limitations

This study examined a cohort of patients who underwent a specific surgical procedure performed by a single surgeon. Our aim was to present the complications while minimizing the effects of multiple surgeons and their differing approaches. Since all patients received the same treatment, a comparative analysis was unnecessary. We briefly noted the surgical success in terms of pain relief and did not provide a scale to compare preoperative and postoperative pain levels. Although this was not the primary focus of our study, the absence of a pain scale may be seen a limitation of our article. Also, we searched the literature to review the differences with UBE, however, the various inferences were limited in the literature, since UBE is a relatively recent technique in spinal surgery.

CONCLUSION

IELD is not only an effective method for achieving adequate disc removal, minimal tissue harm, earlier mobilization and shorter hospital stay but also a safe one with low complication rates. Because the spinal endoscopic procedures are not routinely executed worldwide and the procedures are not commonly a part of basic training of the neurosurgical surgeons, a higher complication rates may be encountered during the learning curve. Nonetheless, the results of a single experienced senior surgeon indicate that the safety of IELD is satisfactory and consistent with the literature. With the technological advances in the endoscopic tools and the increase in experience, the spinal endoscopic procedures have the potential to become common option for treating many lumbar spine disorders.

Footnote

Ethics Committee Approval: No ethics commitee approval has been sought since this observational study was conducted retrospectively.

Informed Consent: Retrospective study.

Authorship Contributions

Surgical and Medical Practices: M.İ., Concept: O.Ö., M.O.A., M.İ., Design: O.Ö., M.O.A., M.İ., Data Collection or Processing: O.Ö.,

M.O.A., M.İ., Analysis or Interpretation: O.Ö., M.O.A., Literature Search: O.Ö., Writing: O.Ö.

Conflict of Interest: The authors have no conflicts of interest to declare.

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