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Original Article

Comparison outcomes of repeat mini-open microdiscectomy versus fusion for recurrent lumbar disc herniations regarding preoperative radiological features-single institute experience

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Abstract

Aim: The aim of this study was to compare the clinical results of two different surgical approaches for patients with recurrent lumbar disc herniation. Furthermore, we retrospectively analysed both groups and compared preoperative radiological features, which may be useful to select most appropriate surgical technique.

Materials and Methods: 36 patients underwent mini-open microdiscectomy and 14 patients underwent microdiscectomy with fusion surgery for recurrent lumbar disc herniation in our institution between 2007-2017. Patient's demographic characteristics and clinical results, as well as preoperative radiological features (such as disc height, disc degeneration, facet joint angle on sagittal and axial plane, existence of foraminal stenosis or previous facetectomy, facet joint degeneration, adjacent segment degeneration, sagittal instability, coronal instability) were retrospectively analyzed and compared between two groups.

Results: There were no statistically significant differences between the groups in terms of postoperative visual analog scale and Oswestry Disability Index scores. The mean age, mean duration of hospital stay and operation time were significantly lower in microdiscectomy group (p=0.003, p<0.001, p<0.001, respectively). There was no recurrence during a mean follow-up of 54.3 months. Disc degeneration grade, degree of foraminal stenosis and facet joint degeneration, sagittal instability grade, facetectomy rate, adjacent segment degeneration and number of microdiscectomies are statistically higher in stabilization group than simple microdiscectomy group (p<0.001, p<0.001, p<0.001, p<0.001, p<0.001, p=0.047, p=0.010, respectively). Furthermore, sagittal and axial facet joint angles are significantly higher in the microdiscectomy group than the fusion group (p<0.001, p<0.001, respectively).

Conclusion: Preoperative radiological evaluation of patients with recurrent disc herniation can help physicians in order to select the most appropriate surgical approach and therefore minimize surgical risks.

Keywords: Disc herniation; discectomy; fusion; lumbar; mini-open; recurrent

INTRODUCTION

Recurrent disc herniation is the development of new disc herniation on the ipsilateral or contralateral side at a previously operated level after a pain-free interval of at least 6 months (1). Recurrent disc herniation, which is the most common cause of failed lumbar discectomy, has been reported to develop at a rate of between 3.8% and 21.2% in the literature (2,3). Recurrent disc herniations can be treated conservatively, with repeat discectomy or with discectomy and fusion surgery (4-6). Minimally invasive re-microdiscectomy provides adequate decompression on the nerve root and relieves symptoms. Although most surgeons prefer this technique, possible epidural scars, root degeneration, iatrogenic root injuries and instability that could be caused by a second laminotomy and partial facetectomy have been the main concern of further recurrence and failed back surgery (7,8). Therefore, some surgeons have performed fusion surgery as a standard procedure for recurrent disc herniations (9,10). However, complications related to instrumentation, adjacent segment degeneration rate, and cost of the procedure are the limitations of fusion surgery (5,11).

The choice of surgical technique for the treatment of recurrent disc herniation remains controversial. Several

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risk factors have been identified that may lead to the development of recurrent disc herniation, these risk factors can be divided into two main groups as clinical and radiological risk factors. Among clinical risk factors, male gender is considered to be an unchangeable risk factor, while modifiable clinical risk factors include smoking, heavy work and high body mass index (12,13). Radiological findings, which are related to recurrent disc herniation, are as follows: Intervertebral disc degeneration, disc height, facet joint degeneration, foraminal stenosis, facet joint axial and sagittal orientation, sagittal and coronal instability (14,15). After confronting a patient with a recurrent lumbar disc herniation, each surgeon is directed to one of two standard treatments considering these factors and regarding to clinical experience. Taking only a few risk factors into account and neglecting other risk factors can certainly lead to a misinterpretation of the patient's condition and recurrence may develop after incorrect surgical approach. Therefore, all radiological risk factors should be assessed to select the appropriate surgical technique.

The aim of this study was to compare the clinical results of patients who had undergone repeat mini-open microdiscectomy or fusion for recurrent lumbar disc herniations. We retrospectively evaluated preoperative radiological findings of patients from both groups and compared the clinical results after a mean follow-up time of 54,3 months.

MATERIALS and METHODS

This clinical study was approved by the medical ethical committee of the authors' institution (Reference number 2019/01-003). Written informed consent was obtained from all patients. Between June 2007 and June 2017, 1,340 patients underwent mini-open lumbar discectomy for lumbar disc herniation. In total, 56 patients were operated by a senior neurosurgeon (HIS) for recurrent disc herniation. Criteria for selecting candidates for second operation were as follows: 1- A pain-free period of at least 6 months after the primary lumbar disc surgery. 2- Presence of radicular symptoms, which cannot be regressed despite conservative treatment for at least 6 weeks. 3- Diagnosis of paracentrally located disc herniation at the same level in Magnetic resonance imaging (MRI) exam. Three patients with multisegmented spinal canal stenosis with 7, 8 and 10 years follow-up periods after the initial operation and another three patients, who refused surgery were excluded from the study.

Fifty patients were evaluated with lumbar spine anteroposterior/lateral, flexion/extension X-rays and lumbar vertebra MRI scans. The patients were operated with one of two techniques considering preoperative recurrence number, age, radiological risk factors and experience of the surgeon. Patients who had recurrence for the third time underwent fusion surgery. In total, 36 patients underwent mini-open microdiscectomy and 14 patients underwent re-discectomy with intervertebral and posterolateral fusion surgery. (Transpedicular screw fixation with transforaminal lumbar interbody cage placement).

Age, sex, operation level, time from previous operation to recurrence (months), duration of operation (minutes), duration of hospital stay (days), duration of follow-up (months), intraoperative and postoperative complications of the patients in the two groups were analyzed and compared. Clinical outcomes were assessed with a visual analog scale (VAS; 1–10) for leg and back pain, and the Oswestry Disability Index (ODI; 1–100%) was used to measure function. VAS and ODI were measured both preoperatively and at last visit postoperatively. To avoid misinterpretation of radiological findings, measurements are defined precisely and performed with Surgimap® software. Radiological factors taken into account for our study are listed below:

Disc Height: The disc height index is calculated by dividing the height of the upper vertebra on the midvertebral line by the disc height. The midvertebral line is the line joining the intersection points of the cross lines extending from the four corners of the spine in the upper and lower spine in lateral neutral x-ray scan (1).

Disc Degeneration: The modified Pfirrmann Grading System , which is divided into 8 grades based on MR signal intensity, disc structure, distinction between nucleus and annulus and disc height, was used to evaluate disc degeneration (14).

Sagittal Facet Joint Angle: On a sagittal MRI that bisected each facet joint, a line was drawn between the anterosuperior and posteroinferior aspects of each facet joint, and thereafter a line was drawn on the paralel to the horizontal line. The degrees of the two angles (right and left) were averaged (16).

Axial Facet Joint Angle: The facet line is drawn as the line connecting the anteromedial and posterolateral of the superior articular process in the axial section at the level of the facet joint. The midline is drawn through the center of the vertebral body and the middle point of the spinous process. The angle between the facet line and the midsagittal line was measured on both sides. The axial facet joint angle was taken as the mean angle of both sides (17).

Foraminal Stenosis: Lumbar foraminal stenosis assessment score on sagittal MRI sequence as follows. Grade 0: Normal. Grade 1: Mild (with deformity of the intervertebral foramen while the remaining fat still completely surrounds the existing nerve root). Grade 2: Moderate (with significant foraminal stenosis and epidural fat partially surrounding nerve root) and Grade 3: Severe (advanced stenosis, with complete obliteration of the foraminal epidural fat) (15).

Facet Joint Degeneration: Facet joint degeneration was examined by axial MR sections and assessment scores as follows. Grade 0: normal. Grade 1: mild narrowing of joint space and irregularity of the joint surface. Grade 2: moderate narrowing and irregularity of joint, sclerosis and osteophyte formation. Grade 3: Severe narrowing and almost total close of joint space, sclerosis and osteophyte formation (15).

Prescence of Facetectomy: The facetectomy procedure performed in the first operation was assessment scores as follows. Grade 0: excision of superior articular facet between 0 and one-quarter. Grade 1: excision of superior articular facet between one-quarter and one-half. Grade 2: excision of the superior articular facet between one-half and three-quarter. Grade 3: Three-quarter to total excision of the superior articular facet.

Adjacent Segment Degeneration: Coexistence of the following 2 radiological findings was considered as adjacent segment degeneration. 1. Disc degeneration, 2. Decrease in disc height, 3. End plate degeneration, 4. Disc herniation, 5. Facet degeneration and / or hypertrophy, Ligamentum flavum hypertrophy, 6. Coronal and / or sagittal osteophyte formation, 7. Coronal and / or presence of sagittal instability. Adjacent segment degeneration were determined by senior author and evalutaed in four Grade. Grade 0: Normal. Grade 1: There was adjecent segment degeneration in one level at distal or proximal segment. Grade 2: There were adjecent segment degenerations in two levels at distal or proximal segment. Grade 3: There were adjecent segment degenerations in one or two level in both distal and proximal segments.

Sagittal Instability: Sagittal instability was examined by lateral lumbar X-ray and assessment scores as follows. Grade 0: Normal. Grade 1: Vertebral body anterior translation relative to the lower segment vertebral body is between 0% and 25%. Grade 2: Vertebral body anterior translation relative to the lower segment vertebral body is between 25% and 50%. Grade 3: Vertebral body anterior translation relative to the lower segment vertebral body is more than 50%.

Coronal Instability: Coronal instability was examined by anteroposterior lumber X-ray and assessment scores as follows. Grade 0: Normal. Grade 1: the disc height is reduced 50% or more on the discectomy side than on the opposite side. Grade 2: Local scoliosis and lateral osteophytic changes. Grade 3: Local scoliosis and coronal listesis. Coronal instability criteria were determined by senior author and evalutaed in four Grade.

Statistical analysis

The SPSS 15.0 for Windows program was used for statistical analysis. Descriptive statistics: The number and percentage were used as categorical variables; mean, standard deviation; minimum, maximum and median were taken as numerical variables. Two independent group comparisons were performed by Student's t test when the numerical variables provided normal distribution condition, while the Mann Whitney U test was used when they did not meet normal distribution condition. Dependent group analyses were performed using Paired t test when the differences between the numerical variables provided normal distribution and the Wilcoxon test was performed when the normal distribution condition was not provided. The ratios were compared with chi-square analysis. Statistical significance level was accepted as p <0.05.

RESULTS

There was no statistically significant difference in the sex ratio of patients who underwent microdiscectomy and fusion (p = 0.420). The mean age of the patients who underwent microdiscectomy was statistically lower than patients underwent fusion (p = 0.003) (Table 1). Preoperative radiological features and it's distribution in both treatment options are summarized in Table 2. Microdiscectomy was performed at L4-L5 level in 17 patients and at L5-S1 level in 19 patients. Fusion was performed at L4-L5 level in 4 patients, at L5-S1 level in 5 patients and L4-L5-S1 level in 5 patients.

Table 1. Gender and age distribution according to treatment options

		Total		Microdiscectomy n=36 (%72)		Fusion N=14 (%28)		
		N	%	N	%	n	%	p¥
Gender	Female	26	52.0	20	55.6	6	42.9	0.420
	Male	24	48.0	16	44.4	8	57.1	
		Ort.±SD	Min-Maks	Ort.±SD	Min-Maks	Ort.±SD	Min-Maks	p
Age		52.2±13.6	22-77	48.7±13.0	22-76	61.1±11.0	39-77	0.003

¥Chi Square test

There was no statistically significant difference between the groups in terms of time from previous operation to recurrence (month) and follow-up period (month) (p = 0.298, p = 0.837, respectively). The mean duration of hospital stay (day) and operation time (minute) of the patients who underwent microdiscectomy were significantly lower than the fusion group (p <0.001, p<0.001, respectively). There was no statistically significant difference between the groups in terms of intraoperative complication and postoperative complication rates (p=1.000, p=0.001, respectively) (Table 3). Postop VAS for back pain, VAS for leg pain and ODI scores were significantly decreased in all patients (p<0.001, p<0.001, p<0.001, respectively). There was no statistically significant difference in the mean VAS for back pain, VAS for leg pain and ODI scores between the groups (p = 0.112, p = 0.103, p = 0.972, respectively).

Table 2. Preoperative radiological features and it's distribution in both treatment options

		Total		Microdiscectomy n=36 (%72)		Stabilization N=14 (%28)		
		N	%	N	%	n	%	p¥
Disc Height	>0.5	24	48.0	20	55.6	4	28.6	0.098
	0.4-0.5	23	46.0	15	41.7	8	57.1	
	0.2-0.39	3	6.0	1	2.8	2	14.3	
	<0.19	-	-	-	-	-	-	
Disc degeneration	Grade 1-2	4	8.0	4	11.1	0	0.0	<0.001
	Grade 3-5	39	78.0	32	88.9	7	50.0	
	Grade 6-7	7	14.0	0	0.0	7	50.0	
	Grade 8	-	-	-	-	-	-	
Sagittal facet joint angle	>60°	35	70.0	32	88.9	3	21.4	<0.001
	50-60°	12	24.0	4	11.1	8	57.1	
	40-49°	3	6.0	0	0.0	3	21.4	
	<40°	-	-	-	-	-	-	
Axial facet joint angle	>50°	12	24.0	10	27.8	2	14.3	<0.001
	40-50°	29	58.0	26	72.2	3	21.4	
	30-39°	3	6.0	0	0.0	3	21.4	
	<30°	6	12.0	0	0.0	6	42.9	
Foraminal stenosis	Grade 0	15	30.0	15	41.7	0	0.0	<0.001
	Grade 1	23	46.0	21	58.3	2	14.3	
	Grade 2	8	16.0	0	0.0	8	57.1	
	Grade 3	4	8.0	0	0.0	4	28.6	
Facet joint degeneration	Grade 0	18	36.0	18	50.0	0	0.0	<0.001
	Grade 1	19	38.0	16	44.4	3	21.4	
	Grade 2	7	14.0	2	5.6	5	35.7	
	Grade 3	6	12.0	0	0.0	6	42.9	
Facetectomy	0-25%	25	50.0	25	69.4	0	0.0	<0.001
	25-50%	21	42.0	11	30.6	10	71.4	
	50-75%	4	8.0	0	0.0	4	28.6	
	>75%	-	-	-	-	-	-	
Adjacent segment degeneration	Absent	25	50.0	19	52.8	6	42.9	0.047
	One segment at upper or lower	22	44.0	17	47.2	5	35.7	
	Two segments at upper or lower	1	2.0	0	0.0	1	7.1	
	Both upper and lower	2	4.0	0	0.0	2	14.3	
Sagittal instability	No	41	82.0	36	100.0	5	35.7	<0.001
	0-25%	4	16.0	0	0.0	4	57.1	
	26-50%	1	2.0	0	0.0	1	7.1	
	>50%	-	-	-	-	-	-	
Coronal instability	No	44	88.0	33	91.7	11	78.6	0.135
	Mild	4	8.0	3	8.3	1	7.1	
	Moderate	2	4.0	0	0.0	2	14.3	
	Severe	-	-	-	-	-	-	
Number of microdiscectomies	1	38	76.0	31	86.1	7	50.0	0.010
	2	10	20.0	5	13.9	5	35.7	
	3	2	4.0	0	0.0	2	14.3	
	>3	-	-	-	-	-	-	

**Mann Whitney U Test, ¥Chi Square test

However, only postop mean VAS for leg pain was significant lower in the microdiscectomy group than the fusion group (p = 0.028) (Table 4).

Small dural tears were observed in three patients in the microdiscectomy group and one patient in the fusion group. Spinal fluid leakage did not develop in any of these patients postoperatively. All patients recovered without neurological deficits. In the postoperative period, one patient in the microdiscectomy group developed superficial infection and this was resolved with local debridement and antibiotherapy for 2 weeks. Another patient in the microdiscectomy group developed a deep infection and epidural abscess at the first month of follow-up. This patient recovered without any problem with deep debridement and 6 weeks of antibiotic treatment. One patient in the fusion group developed transient ileus and recovered with medical treatment. There was no recurrence during a mean follow-up of 54.3 months in both groups.

Table 3. Operation information and complication distribution according to treatment options

	Total		Microdiscectomy		Fusion		
	Mean±SD	Min-Max (Median)	Mean±SD	Min-Max (Median)	Mean±SD	Min-Max (Median)	p**
Duration of Hospital stay (day)	2.3±2.2	1-8 (1)	1.0±0.2	1-2 (1)	5.4±1.6	3-8 (5.5)	<0.001
Operation time (minute)	101.4±46.2	45-240 (90)	77.8±21.0	45-120 (75)	162.1±36.6	120-240 (150)	<0.001
Time from previous operation to recurrence (month)	35.4±28.8	12-116 (21)	36.0±27.6	12-116 (24)	33.8±33.0	12-109 (16)	0.298
Duration of follow-up (month)	54.3±22.6	24-96 (48)	53.8±22.1	24-92 (48)	55.6±24.9	24-96 (48)	0.837
	n	%	n	%	n	%	p$^{¥}$
Intraoperative Complication	4	8.0	3	8.3	1	7.1	1.000
Postoperative Complication	3	6.0	2	5.6	1	7.1	1.000

** Mann Whitney U Test, $^{¥}$ Chi Square test

Table 4. Clinical outcome distribution according to treatment options

		Total		Microdiscectomy		Fusion		
		Mean±SD	Min-Max (Median)	Mean±SD	Min-Max (Median)	Mean±SD	Min-Max (Median)	p**
VAS back pain	Preop.	7.2±1.1	5-10 (7)	7.1±1.1	5-10 (7)	7.5±0.9	6-9 (7.5)	0.173
	Postop.	1.8±0.9	0-4 (2)	1.9±1.0	0-4 (2)	1.8±0.7	1-3 (2)	0.836
	P	<0.001$^{\neq}$		<0.001$^{\neq}$		<0.001$^{\neq}$		
	Difference	5.4±1.0	3-7 (5)	5.2±1.0	3-7 (5)	5.7±0.9	4-7 (6)	0.112
VAS leg pain	Preop.	7.8±1.0	6-10 (8)	7.8±1.0	6-9 (8)	7.9±1.1	6-10 (8)	0.991
	Postop.	0.9±0.8	0-3 (1)	0.8±0.7	0-2 (1)	1.4±0.8	0-3 (1)	0.028
	P	<0.001$^{\neq}$		<0.001$^{\neq}$		<0.001$^{\neq}$		
	Difference	6.9±1.1	5-9 (7)	7.0±1.0	5-9 (7)	6.5±1.2	5-9 (6)	0.103
ODI score	Preop.	38.8±4.8	32-48 (38)	38.7±4.7	32-48 (38)	39.1±5.0	32-48 (38)	0.914
	Postop.	10.6±2.8	7-17 (10)	10.5±2.8	7-17 (10)	10.9±2.8	7-17 (10.5)	0.655
	P	<0.001$^{\neq}$		<0.001$^{\neq}$		<0.001$^{\neq}$		
	Difference	28.2±4.3	18-39 (28)	28.2±3.9	21-39 (28.5)	28.2±5.3	18-35 (27.5)	0.972*

* Student t test, ** Mann Whitney U Test, $^{\#}$ Paired t Test, $^{\neq}$ Wilcoxon Test

DISCUSSION

The most important finding of this study was that although 72% of the patients underwent microdiscectomy, no recurrence was observed at a mean follow-up of 53.4 months. This may be an indicator of the importance of retrospective evaluation of preoperative radiological features in determining the surgical technique to be selected. Patients with recurrent disc herniation who are unresponsive to conservative treatment should be directed to either microdiscectomy or fusion surgery. Fusion surgery is more costly, and requires longer operation duration and extending healing time (5). Generally, one of these two surgical techniques is chosen considering the experience of the physician and the expectations of the patient. If microdiscectomy is performed on a patient who needs fusion, it is highly likely that recurrence will be observed. Likewise, if microdiscectomy is sufficient, fusion surgery will increase the cost and surgical morbidity. It is critical to identify appropriate indications for surgical techniques to avoid both drawbacks.

Disc height index and moderate disc degeneration have been shown to increase the risk of recurrence (1,18,19). Disc height decrease is especially remarkable in Grade 7 and 8 disc degeneration according to Pfirmann classification and accompanying facet joint degeneration is also seen at this stage due to increased forces on the facets, which may cause foraminal stenosis. It has been reported that a low axial facet joint angle is a risk factor for the development of disc herniation (19,20). Yang and King reported that 75 to 97% of the compression load applied to the lumbar spine was met by the intervertebral disc and 3-25% by the facet joints (21). A high axial facet joint angle has been shown to result in higher facet joint contact pressure in biomechanical studies (1). If the axial facet joint angle is low, the pressure on the disc will be increased as the pressure involved by the facet joint will decrease. In this case, it is thought to increase the risk of disc herniation. Facet joint degeneration can cause narrowing of the central canal, lateral recesses and foramina (22). As the severity of both facet joint degeneration and intervertebral foramen stenosis increases, recurrence can be expected with microdiscectomy in patients with recurrent disc herniation. Therefore, we compared these two preoperative radiological features in groups retrospectively. Fusion surgery was preferred in patients with advanced facet joint degeneration and foraminal stenosis in our study.

In a recent study, the three-dimensional lumbosacral model was reconstructed and compared with the normal, one-quarter excision of the superior articular process an one-half excision of the superior articular facets groups, in terms of biomechanical indexes (maximum shear stress on the annulus in L5, von Mises stress of the facet cartilage, maximum principle capsular strain and deformation of the lumbosacral model). While there was no significant difference between the normal and one-quarter excision group, all biomechanical indexes deteriorated in the model with one-half excision of the superior articular process (23). Since the deterioration of the biomechanical indexes after more than one-quarter facetectomy of the superior articular process may increase the biomechanical indexes affecting the disc and increase the risk of recurrence, we added facetectomy to our preoperative risk factor analysis. Degenerative changes in the adjacent segment can be seen clinically and radiologically, but the lack of a universally accepted classification system leads to confusion in terminology (24).

Microdiscectomy seems less invasive and less expansive but would expose to risk of re-recurrence. On the other hand, fusion appears more invasive and expansive but would provide lower risk of recurrence. In fusion surgery, preoperative determination of appropriate screw length prevents the risk of anterior cortex perforation and major vascular injuries (25). Although not statistically significant, the reoperation rate was higher in microdiscectomy groups in meta-analyses compared to fusion groups due to recurrent lumbar disc hernia. The most common cause of reoperation was recurrence in microdiscectomy groups and adjacent segment degeneration and implant removal in fusion groups (6). In our study, although the microdiscectomy group accounted for 72% of the cases, there was no need for reoperation for recurrence.

There are some limitations to this study, including the relatively small sample size, disproportionate distribution of patients between groups and retrospective design of study. Since the study primarily aimed at analyzing radiological risk factors, patient-modifiable risk factors such as habit of smoking, occupation, and BMI were not included. However, we believe that this study is a good example of comparing two surgical technique results by analyzing preoperative invariable radiological risk factors in order to decide the surgical technique to be selected.

CONCLUSION

When our case series were retrospectively analyzed, we realized that disc degeneration grade, foraminal stenosis grade, facet joint degeneration grade, sagittal instability grade, facetectomy rate, adjacent segment degeneration rate and number of microdiscectomies are statistically significant higher in stabilization group than microdiscectomy group. Furthermore, sagittal and axial facet joint angles are statistically significantly higher in the microdiscectomy group than the fusion group. This preoperative radiological features can help physicians in order to minimize the risk of recurrence and to determine the most appropriate surgical technique.

Conflict of interest : The authors declare that they have no competing interest.

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