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Foraminal Stenosis as a Cause of Postdiscectomy Syndrome

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ABSTRACT

AIM: To reveal the relation between postdiscectomy syndrome and foraminal stenosis due to height loss of disc level in patients operated for one-sided L5-S1 disc herniation.

MATERIAL and METHODS: In this study, 100 operated patients due to L5-S1 one-sided disc herniation were included. Mean age was 46.60 years (±10.52 years), the youngest patient was 26 and the eldest was 74 years old. Foraminal height, width, and intervertebral disc height were measured via computed tomography (CT). The diameters were compared preoperatively and postoperatively. The relation between the measurements and clinic findings was investigated.

RESULTS: Six months after discectomy, for the operated side, the mean foraminal height decreased from 16.78 ± 1.75 mm to 14.43 ± 1.62 mm ($p<0.05$) and the mean foraminal width decreased from 6.30 ± 1.43 mm to 5.34 ± 1.56 mm ($p<0.05$). For the non-operated side, the mean foraminal height decreased from 14.71 ± 2.05 mm to 14.55 ± 1.86 mm ($p>0.05$) and the mean foraminal width decreased from 6.13 ± 1.95 mm to 5.84 ± 1.84 mm ($p<0.05$). According to the correlation test, for the operated side, a statistically significant relationship was determined between the decrease in foramen height and leg pain visual analog scale (VAS) score. Moreover, a statistically significant relationship was determined between the decrease in the posterior side height of the disc level and the leg pain VAS score.

CONCLUSION: Overall, we found that after microdiscectomy, as the height of the foramen decreased, leg pain also increased. Moreover, the decrease in the posterior side height of the disc level was associated with an increase in leg pain. Therefore, over time, the collapse of the disc distance decreases the foramen height, which causes leg pain. After microdiscectomy, in patients whose leg pain was relieved at first but started again after a time, the foramen and disc level diameters should be checked.

KEYWORDS: Herniated disc, Disc height, Foraminal stenosis, Foraminal measurements, Postdiscectomy syndrome, Lumbar

INTRODUCTION

The postdiscectomy syndrome (PDS) is the reoccurrence of a number of symptoms that arise after a disc operation (11,12,13,15,16). This syndrome is also known as failed back surgery syndrome (FBSS) and post-nucleotomy syndrome (4,9). Follett and Dirks described it as ineffective surgical interventions to relieve low back pain, radicular pain, or a combination of both (5).

Herniated disc material is removed by lumbar microdiscectomy in patients with symptoms resistant to conservative treatments or neurologic conditions. Leg pain is dramatically relieved after microdiscectomy. But in some patients, after a certain period of time, leg pain increases again. Although we did not encounter common conditions related to surgical complications, residual disc, recurrence, instability, infection, etc., we could not find a pathological reason to explain the leg pain complaints in some patients.

With this study we aimed to investigate any significant changes in the foraminal measurements and intervertebral disc height after microdiscectomy and how these changes are related

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to relapsing leg pain complaints. L5 nerve root is the most common root which involved in foraminal stenosis pathology (75%) (10) and is due to L5-S1 extraforaminal disc herniation or stenosis of this level (1,12). Therefore, we decided to focus on the L5-S1 disc level for the present study. Moreover, we made measurements via computed tomography (CT) because CT scans provide information about the foraminal area and also sagittal images provide better visualization of the foramen (3,12).

MATERIAL and METHODS

In this study, 100 operated patients (44 females, 56 males) due to L5-S1 herniation were included. The mean age was 46.60 years (±10.52 years), with the youngest being 26 years old and the oldest 74.

The radiological and clinical outcomes of the patients were investigated. Radiological studies were performed preoperatively and six months after surgery to assess the measurements of the neural foramina and the disc heights at L5-S1 level via CT (Figure 1-3).

All patients were operated with the standard microdiscectomy procedure under general anesthesia. The patients were positioned in prone position. The L5-S1 intervertebral disc levels were confirmed based on the intraoperative C-arm fluoroscopic images. After a longitudinal midline skin incision and subcutaneous dissection, the muscular aponeurosis was incised away from the midline on the side of the approach. Muscle dissection was performed subperiosteally from the spinous process with an elevator. To confirm the level, at this point, repeat imaging was performed. After the retractors were in place, the microscope was positioned. The ligamentum flavum was exposed and removed using a Kerrison rongeur. The medial aspect of the inferior facet of the superior vertebra and the inferior portion of the upper lamina may be removed for adequate visualization. By removing the fragmented or herniated disc tissue, disc excision was performed. The annulus was incised and from behind the posterior longitudinal ligament a portion of disc was removed with pituitary rongeurs. After irrigation, meticulous hemostasis was obtained using bipolar cautery. The mean operative time was 83 minutes and mean blood loss was 117 mL. All patients were mobilized 4–6 hours after surgery and discharged the next day. The clinical

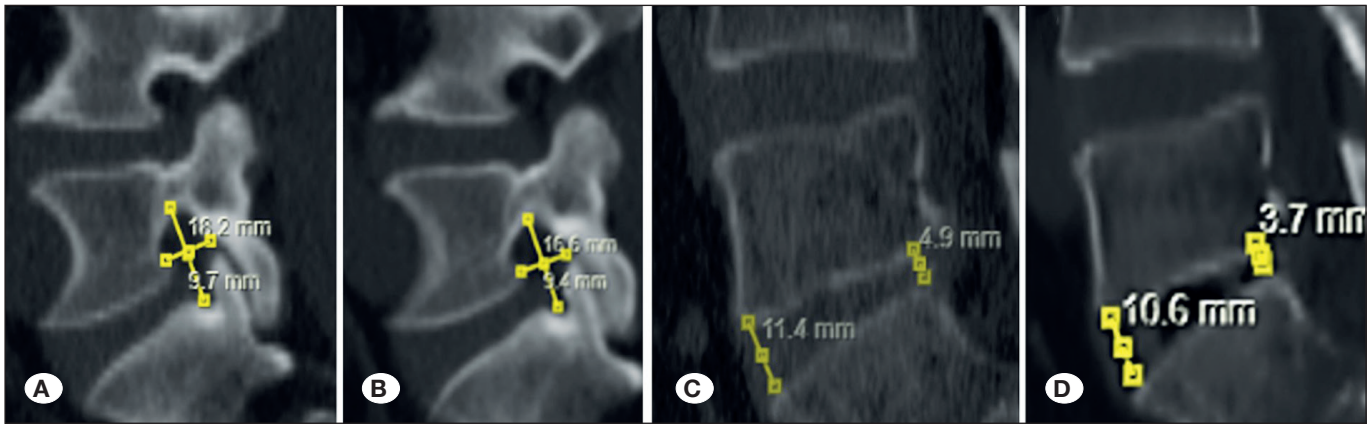

Figure 1: Foraminal and discal measurements of the patient. **A)** Preoperatively foraminal height and width measurement. **B)** Postoperatively foraminal height and width measurement. **C)** Preoperative anterior and posterior disc height measurement. **D)** Postoperative anterior and posterior disc height measurement.

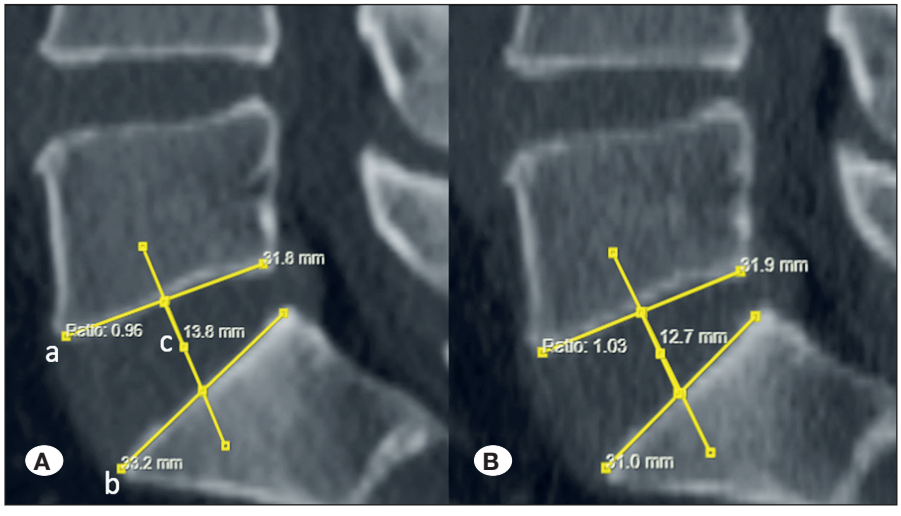

Figure 2: Measurement method of middle disc height. The middle disc height of the patient decreases from 17.2 mm **(A)** to 13.5 mm **(B)** six months after surgery. (a) The inferior margin of the L5 vertebral body. (b) The superior margin of the sacrum. (c) Distance between the midpoints of A and B.

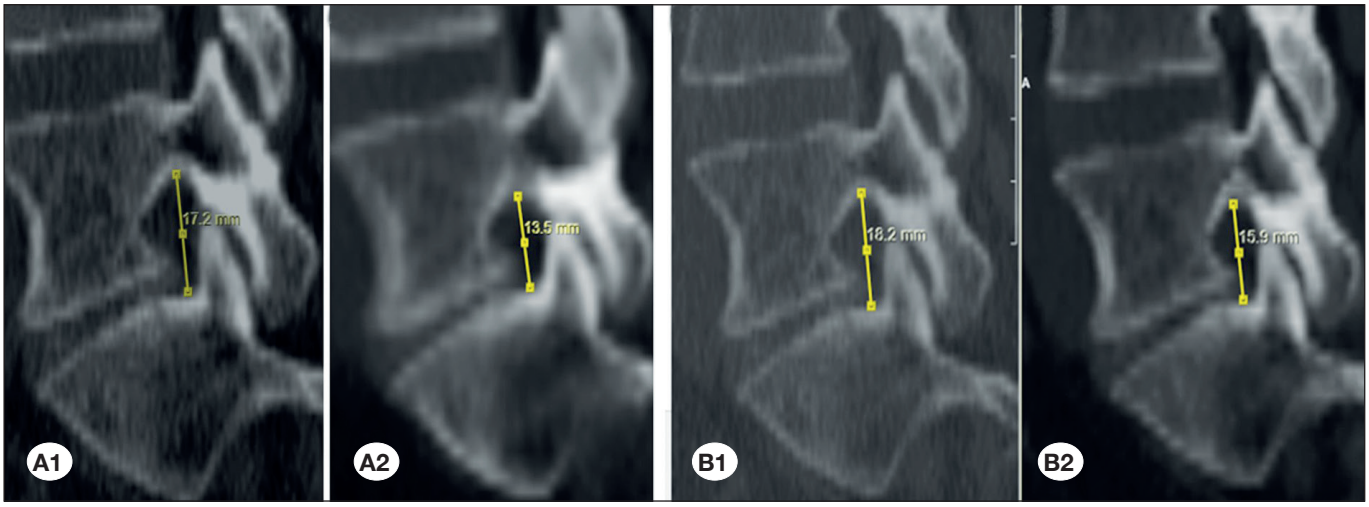

Figure 3: Foraminal height change of two patients. **A1 and A2:** The foraminal height decreases from 17.2 mm to 13.5 mm six months after surgery at the operated side. **B1 and B2:** The foraminal height decreases from 18.2 mm to 15.9 mm six months after surgery.

outcome was assessed using the visual analog scale (VAS) scores before surgery as well as one day and six months after surgery.

Statistical analysis was performed using SPSS 22.0 statistical package software and the Microsoft Excel. Continuous variables were summarized as medians or means and SDs. The influence of all the categorical variables was tested using the chi-square test. A two-sided p value of <0.05 was considered to be statistically significant. A multivariate analysis was then performed using a forward stepwise logistic regression analysis.

RESULTS

We did not include patients who had surgical complications, such as BOS fistula and nerve root damage, and complications encountered in the postoperative period, such as discitis, residue, recurrence, adjacent segment disease, or sagittal balance-related problems. One hundred patients (42 right, 58 left) who were operated for L5-S1 herniation and who were outside these criteria were evaluated. The average duration of symptoms was 11 months among all patients. Back pain and leg pain with numbness at the affected side were the main complaints (Table I). All patients were operated with the standard microdiscectomy procedure. Marked leg pain reduction was detected in the early postoperative period. While the mean preoperative leg pain VAS score was 7.8, it decreased to 1.5 in the first postoperative day. However, leg pain VAS score was found to increase over time and it was found to be 3.7 in the sixth postoperative month (Table II).

Preoperatively, the mean right foraminal height of L5-S1 level was 15.95 ± 2.13 mm and mean left foraminal height was 15.54 ± 2.20 mm. The mean right foraminal width of L5-S1 level was 5.86 ± 1.17 mm and mean left foraminal width was 5.68 ± 1.34 mm. The mean anterior, middle, and posterior disc heights of L5-S1 levels were found to be 11.85 ± 2.46 mm, 9.25 ± 2.14, and 6.13 ± 0.88, respectively (Table III).

Table I: Sign and Symptoms of Patients

Variable	Value n (%)
Leg pain	50 (100)
Positive straight leg raise	47 (94)
Sensory deficit	46 (92)
Back pain	42 (84)
Motor weakness	6 (12)
Bowel/bladder changes	0 (0)
*Achilles reflex	
Grade 0	0 (0)
Grade 1	13 (26)
Grade 2	37 (74)
Grade 3	0 (0)
Grade 4	0 (0)

**Grade 0 means no response, 1+ a decreased response, 2+ normal response, 3+ an increased response, and 4+ repeating reflex or clonus.*

Six months after surgery, the mean right foraminal height of L5-S1 level was 14.76 ± 1.73 mm and mean left foraminal height was 14.22 ± 1.71 mm. The mean right foraminal width of L5-S1 level was 5.47 ± 1.51 mm and mean left foraminal width was 5.39 ± 1.91 mm. The mean anterior, middle, and posterior disc heights of L5-S1 levels were found to be 10.27 ± 2.15 mm, 8.13 ± 1.49, and 5.12 ± 0.97, respectively (Table III).

When we compared the foraminal heights and widths for the operated sides preoperatively and at the sixth postoperative month, the mean foraminal height decreased from 16.78 ± 1.75 mm to 14.43 ± 1.62 mm ($p<0.05$) and mean foraminal width decreased from 5.74 ± 1.43 mm to 5.43 ± 1.56 mm

Table II: Mean Leg Pain VAS Scores of Patients

	Preoperative	First postoperative day	Sixth postoperative month
VAS	7.8	1.5	3.7

Table III: Mean Foraminal and Intervertebral Discal Measurements of Patients for L5-S1 Level

	Right For. Height	Right For. Width	Left For. Height	Left For. Width
Preoperative (mm)	15.95 ± 2.13	5.86 ± 1.17	15.54 ± 2.20	5.68 ± 1.34
Postoperative (mm)	14.76 ± 1.73	5.47 ± 1.51	14.22 ± 1.71	5.39 ± 1.91

Table IV: Mean Foraminal Measurements of Operated and Non-Operated Disc Sides of Patients for L5-S1 Level (*:$p < 0.05$)

	Operated Side		Non-operated Side				
	Foraminal Height*	Foraminal Width*	Foraminal Height	Foraminal Width*	Ant. Disc Height	Mid. Disc Height	Post. Disc Height*
Preoperative (mm)	16.78 ± 1.75	5.74 ± 1.43	14.71 ± 2.05	6.13 ± 1.95	11.85 ± 2.46	9.25 ± 2.14	6.13 ± 0.88
Postoperative (mm)	14.43 ± 1.62	5.43 ± 1.56	14.55 ± 1.86	5.84 ± 1.84	10.27 ± 2.15	8.13 ± 1.49	5.12 ± 0.97

($p<0.05$) (Table III). For the non-operated side, the mean foraminal height decreased from 14.71 ± 2.05 mm to 14.55 ± 1.86 mm ($p>0.05$) and mean foraminal width decreased from 6.13 ± 1.95 mm to 5.84 ± 1.84 mm ($p<0.05$) (Table IV).

Based on the correlation test, a statistically significant relationship was determined between the decrease in foramen height in the sixth postoperative month and the increase in leg pain VAS score in the sixth postoperative month compared to the first postoperative day (Pearson correlation = 0.408; $p<0.05$). Also, for the same periods, a weak relationship was observed between the decrease in foramen weight and the increase in leg pain VAS score but was not statistically significant (Pearson correlation = 0.269; $p>0.05$).

Overall, a statistically significant relationship was determined between the decrease in the posterior side height of the disc level in the sixth postoperative month and the increase in leg pain VAS score in the sixth postoperative month compared to the first postoperative day (Pearson correlation = 0.391; $p<0.05$). However, no strong or statistically significant relationship was observed for the change of anterior or middle side height of the disc level.

DISCUSSION

Postdiscectomy syndrome is a condition that no surgeon and patient would like to experience. After microdiscectomy, in some patients, leg pain is relieved at first but recurs after a certain period of time. Although we excluded classical causes, such as recurrence, residual, discitis, etc., we encountered difficulties in finding the cause of pain. This is a challenge for both the patient and the surgeon.

Sebaaly et al. summarized the etiologies of FBSS for the postoperative period as recurrent disc herniation, sagittal balance-related problems, adjacent segment disease, pelvic incidence and lumbar lordosis mismatch, and battered root or nerve root entrapment syndrome (13).

Although foraminal stenosis is known to be a cause of postdiscectomy syndrome, it is often overlooked. As Orita et al. described, patients with postdiscectomy syndrome are primarily treated conservatively through medication, rehabilitation, and nerve block. But they are often refractory to conservative treatment. They indicate that patients with concordance between the demonstrated area of stenosis and radicular symptoms, are candidates for surgical foraminal decompressive procedure (12).

The normal parameters of lumbar foramina have been well documented by radiographic and cadaveric studies (12). Lack of safe passage of vital neurovascular structures through the spinal canal leads to leg pain. The foraminal height is critical to allow this safe passage (6,12).

Because of its anatomical features, L5-S1 foraminal stenosis tends to cause severe chronic pain and neurological disorder (11,12,13,15,16). Lumbar disc herniation and degenerative spondylolisthesis are commonly occurring spine pathologies and have their origins predominantly in L4-5 and L5-S1 levels (7). L5–S1 level is unique because of the wedge-shaped disc and its junctional location, coronally oriented facets and presence of iliolumbar and lumbosacral ligaments (12). L5-S1 intervertebral foramen is located between the highly mobile lumbar segment and the immobile sacrum.

According to a cadaveric study; foraminal height of ≤15 mm and posterior disc height of ≤4 mm leads to significant nerve root compression (7). Recent studies using CT and MRI have provided much more information for the assessment and measurement of lumbar foraminal stenosis (12). Hasegawa et al. determined that the height of the L5-S1 foramen was 19.9 mm and the width was 5.4 mm in their study of 18 cadavers

between the ages of 35 and 86 (8). In another similar cadaveric study, Cinotti et al. determined these diameters as 19.1 mm and 5.4 mm for the L5-S1 foramen, respectively (16 cadavers, aged between 38 and 79 years) (2). Recently, an in vivo 3D CT study on 59 patients (aged between 22 and 58 years) showed a mean L5-S1 foraminal height of 15.9 mm and mean foraminal width of 5.0 mm (14).

The data we obtained are more similar to that of an in vivo 3D CT study. In the present study, in the group with L5-S1 lumbar disc herniation, the affected side mean foraminal height was 16.78 mm, but after surgery it decreased to 14.43 mm ($p<0.05$). The reduction in mean posterior disc height measurement (from 4.22 mm to 3.69 mm) caused this, and we found that the greater the reduction in foramen height, the more severe the increase in leg pain. The mean foraminal height was also decreased in the non-operated side, but this decrease was not statistically significant ($p>0.05$).

Therefore, if a decrease in foramen or posterior disc level height is observed and leg pain cannot be attributed to any other reasons, surgical methods that preserve foraminal or disc level height should be considered in such patients. Further research on the efficacy of the different types of surgery is needed, but it can be concluded that a decrease in foraminal and posterior height of the disc level causes repeating leg pain after standard microdiscectomy.

CONCLUSION

With this study, we have shown statistically that there is a decrease in foramen height after discectomy and that there is a correlation between this decrease and leg pain. We cannot say that the height of the foramen decreases in every patient. This may be related to many factors such as the patient's weight, age, job, and the amount of surgically removed disc, etc. As a result we can say that after microdiscectomy, in patients whose pain was not relieved or whose pain was relieved at first but recurs after a certain period of time, after excluding the known classical reasons, it is necessary to assess the foramen and disc level measurements. Alternative methods can be applied to maintain the height of the foramen. However, this may be the subject of a different study.

AUTHORSHIP CONTRIBUTION

Study conception and design: HG, SEC

Data collection: SS, YK

Analysis and interpretation of results: DG, HG

Draft manuscript preparation: HG

Critical revision of the article: SEC

All authors (HG, SEC, YK, SS, DG) reviewed the results and approved the final version of the manuscript.

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