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Unilateral Dynamic Stabilization in Recurrent Lumbar Disc Herniation

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ABSTRACT

AIM: To evaluate the effectiveness and outcomes of unilateral dynamic stabilization in patients with recurrent lumbar disc herniation (RLDH).

MATERIAL and METHODS: Patients requiring an operation due to RLDH at the L4–5 level were included in the study.They divided into the following two groups: SD group who had only revision discectomy (n=20) and DD group who had unilateral dynamic rod stabilization with discectomy (n=20). Low back and leg pain were evaluated with the visual analog scale (VAS), and functional results were evaluated with the Oswestry disability index (ODI). The VAS scores were evaluated in two different regions as VAS Low Back (VASLB) and VAS Leg (VASL). The results of each patient were evaluated preoperatively and at 1 and 12 months postoperatively. The anterior disc height (ADH), posterior disc height (PDH), and segmental angle (SA) were measured on the sagittal computed tomography (CT) scans of each patient's lumbar spine. Modified Pfirrmann grades in the operated and adjacent segments on lumbar magnetic resonance imaging (MRI) were assessed preoperatively and at 12 months postoperatively.

RESULTS: A total of, 40 patients (17 women and 23 men; mean age, 47.9 years) were enrolled. There was no statistically significant difference in the VASLB scores between the two groups (p=0.42). The decrease in VASL scores was statistically significant between groups (p<0.05). A statistically significant decrease in ODI scores was also observed (p<0.05). When ADH and PDH obtained preoperatively and postoperatively were compared for the SD group, the differences were not statistically significant. Significant differences were found for ADH and PDH obtained preoperatively and postoperatively in the DD group (p<0.05). However, for SA, the difference was not significant between the two groups (p=0.28).

CONCLUSION: Unilateral dynamic stabilization for RLDH leads to fewer surgical complications and provides sufficient stability by preserving segmental movements.

KEYWORDS: Unilateral dynamic, stabilization, recurrent lumbar disc herniation, Dynamic rod

ABBREVIATIONS: RLDH: Recurrent lumbar disc herniation, **SD:** Patients who had only revision discectomy were evaluated as the SD group, **DD:** Patients who had unilateral dynamic rod stabilization with discectomy were evaluated as the DD group, **VAS:** Visual analog scale, **VASLB:** VAS Low Back, **VASL:** VAS Leg, **ODI:** Oswestry disability index, **ADH:** Anterior disc height, **PDH:** Posterior disc height, **SA:** Segmental angle, **PEEK:** Polyetheretherketone.

INTRODUCTION

Lumbar disc herniation is a common degenerative disorder of the vertebrae and is the most common cause of spinal surgical cases (19,23). However, recurrent lumbar disc herniation (RLDH) is a common complication of lumbar discectomy surgery. Lumbar discectomy reportedly has a recurrence rate of 5%–25% (3,7,29). Surgical intervention is indicated in patients with persistent pain and loss of motor and/or sensory function that do not benefit from conservative treatment.

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RLDH surgery can be difficult and cause morbidity due to granulation tissue in surrounding tissues, especially the perineural tissue. Additionally, iatrogenic instability may develop during surgery. Some studies suggest that only revision discectomy is the preferred approach in RLDH (14,19), whereas others suggest that stabilization eliminates the need for subsequent surgical intervention (5,7,9,24).

Facet joints are important structures in vertebral movement and stabilization. Biomechanically, they cover approximately 20% of the pressure load of the vertebrae and help to prevent abnormal movements (20,31). In the RLDH surgery, facet joint damage can be caused to prevent morbidity due to adhesions in neural tissues. In this case, iatrogenic instability may develop in the future. Some studies have shown dynamic stabilization in cases with disc degeneration and adjacent segment degeneration, especially in patients with severely degenerated discs (1,30).

Despite the advances in surgical techniques, satisfactory results cannot be obtained due to the complications of RLDH surgery and there is currently no standard surgical practice. For these reasons, the dynamic rod system can provide a balance between successful fusion that allows physiological motion, reduced risk of adjacent segment degeneration, and adequate stabilization (22,33). However, there are few studies on unilateral dynamic stabilization and none for RLDH. This study aimed to examine the effect of revision discectomy or unilateral dynamic rod stabilization on the clinical and radiological outcomes of RLDH patients requiring surgical interventions.

Table I: Quality of life Outcomes at 12 Months Follow-Up

	SD	DD	p*
VAS Low Back			
Preoperative	7.4	7.7	
Postoperative (1st month)	3.3	3.5	0.42
Postoperative (12th month)	2.4	2.6	
VAS Leg			
Preoperative	7.6	7.9	
Postoperative (1st month)	3.1	2.8	**< 0.05**
Postoperative (12th month)	2.5	1.3	
ODI			
Preoperative	73.1	72.8	
Postoperative (1st month)	18.5	17.4	**< 0.05**
Postoperative (12th month)	16.8	11.6	

***:** Statistical significance, p<0.05; **VAS:** Visual analogue scale; **ODI:** Oswestry Disability Index score.*

MATERIAL and ETHODS

The study protocol was approved by the ethical committee of the University of Health Sciences, Adana City Training and Research Hospital (No: 113-2170).

Patients

In this study, data of 40 patients who were operated on for RLDH at the University of Health Sciences, Adana City Training and Research Hospital between July 2018 and July 2021 were reviewed retrospectively. Patients aged between 18 and 65 years who had been operated on once and required surgery due to L4–5 level RLDH were enrolled in the study. However, those with instability, congenital deformity, active infection, chronic rheumatic disease, terminal-stage cancer, and chronic organ failure were excluded from the analysis.

Patients who underwent RLDH surgery at the L4–5 level were divided into the following two groups: SD group who had only revision discectomy (n=20) and DD group who had unilateral dynamic rod stabilization with discectomy (n=20).

Low back and leg pain were assessed using the visual analog scale (VAS, 0–10) (32), and functional outcomes were evaluated using the Oswestry disability index (ODI, 0%–100%) (10). The VAS scores were evaluated in two different regions as VAS Low Back (VASLB) and VAS Leg (VASL). Each patient was evaluated preoperatively and at 1 and 12 months postoperatively. The VAS and ODI scores were compared between the two groups (Table I).

Radiologic Evaluation

Anterior disc height (ADH), posterior disc height (PDH), and segmental angle (SA) were measured on sagittal CT scans of each patient's lumbar spine (Figure 1). The values obtained preoperatively and at 1 and 12 months postoperatively were compared in each group (Table II).

We determined the modified Pfirrmann grades (15) in the operated and adjacent segments on lumbar (MRI) preoperatively and at 12 months after surgery.

Table II: Comparison of ADH, PDH, and SA Among Groups Conditions

Parameters	SD			DD		
	Preoperative	Postoperative*	p	Preoperative	Postoperative*	p
ADH (cm)	1.22	1.19	0.27	1.16	1.32	**< 0.05**
PDH (cm)	0.77	0.73	0.41	0.74	0.87	**< 0.05**
SA (°)	22.6	22.1	0.34	23.1	22.9	0.28

***:** Postoperative (12th month); **ADH:** Anterior disc height; **PDH:** Posterior disc height; **SA:** Segmental angle.*

Surgical Technique

All patients were operated on in the prone position under general anesthesia. While only classical L4–5 discectomy was performed in the SD group, unilateral transpedicular screws with a diameter of 5.5–6.5 mm and a length of 40–45 mm were placed in the L4 and L5 vertebrae after L4–5 discectomy in the DS group, accompanied by C-arm scopy. A polyetheretherketone (PEEK) rod (Efspine, Izmir, Turkey) was placed (Figures 2–4). The facet joint was preserved in surgeries in all groups.

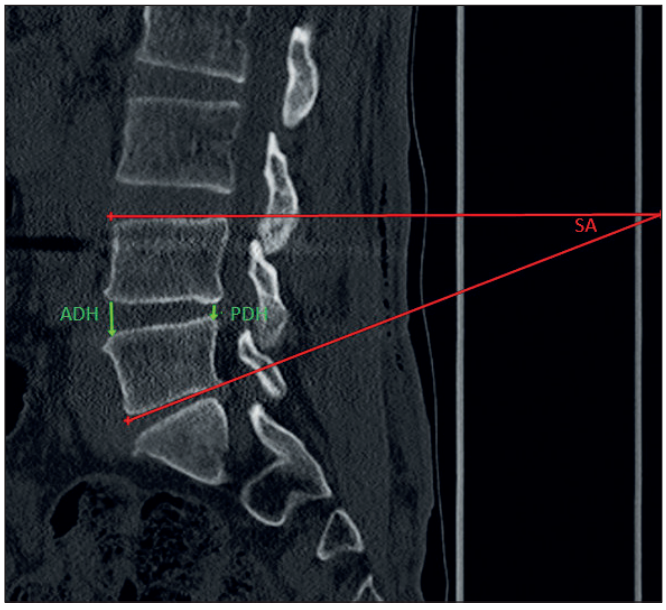

Figure 1: Measurement techniques of segmental angle (SA), anterior disc height (ADH), and posterior disc height (PDH).

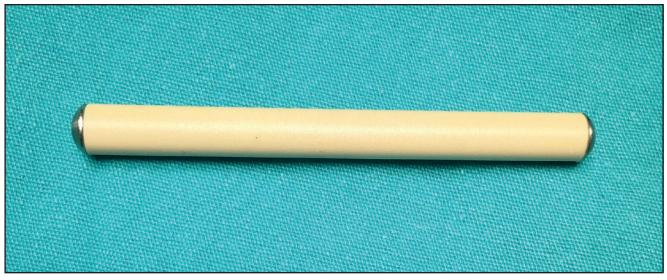

Figure 2: Polyetheretherketone (PEEK) rod.

Statistical Analysis

Mann–Whitney and Wilcoxon signed-rank tests were used for continuous variables, and Fisher's exact test was used for categorical variables. A p-value < 0.05 was considered statistically significant. The data were analyzed using IBM SPSS for Windows (V19).

RESULTS

The study included 40 patients (17 women, 23 men) with RLDH at the L4–5 level. The patients' mean age was 47.9 years. There was no statistically significant difference in age (p=0.68), sex (p=0.32), and body mass index (p=0.54) between the SD and DD groups. The mean hospital stay was 1.4 days (1–5 days) and 2.9 days (1–8 days) in the SD and DD groups, respectively, showing statistically significant difference (p<0.05). The demographic and clinical data of both groups are summarized in Table III.

Clinical Outcome

In the SD group, while the VASLB scores were 7.4 points in the preoperative period, they decreased to 3.3 and 2.4 points at 1 and 12 months postoperatively, respectively. In the DD group, while it was 7.7 points in the preoperative period, it decreased to 3.5 and 2.6 points at 1 and 12 months postoperatively, respectively. The difference was not statistically significant between the two groups (p=0.42) (Table I).

While the VASL scores were 7.6 points in the preoperative period in the SD group, they decreased to 3.1 and 2.5 points at 1 and 12 months postoperatively, respectively. In the DD group, while it was 7.9 points in the preoperative period, it decreased to 2.8 and 1.3 points at 1 and 12 months postoperatively, respectively. A statistically significant decrease in VAS B scores was found between the two groups (p<0.05).

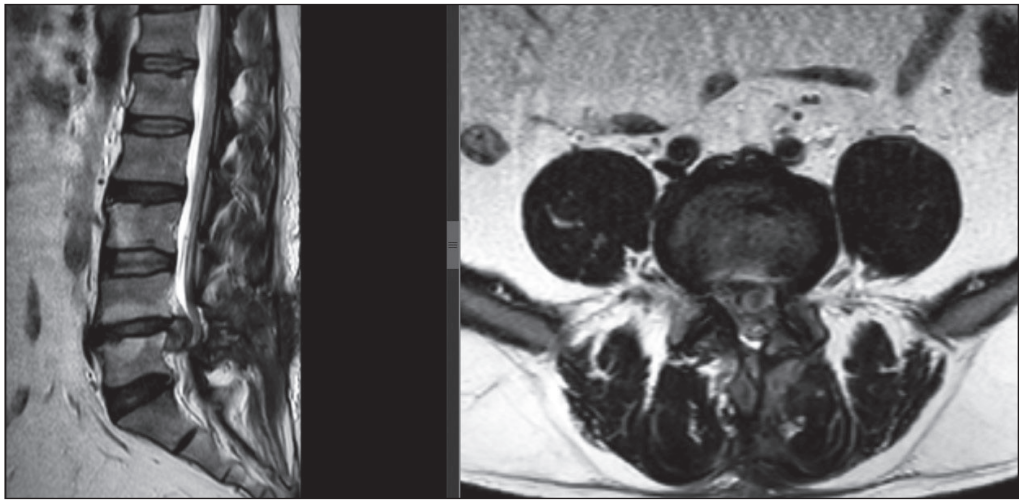

Figure 3: Preoperative lumbar MRI images of a patient who was operated on for a left recurrent lumbar disc herniation.

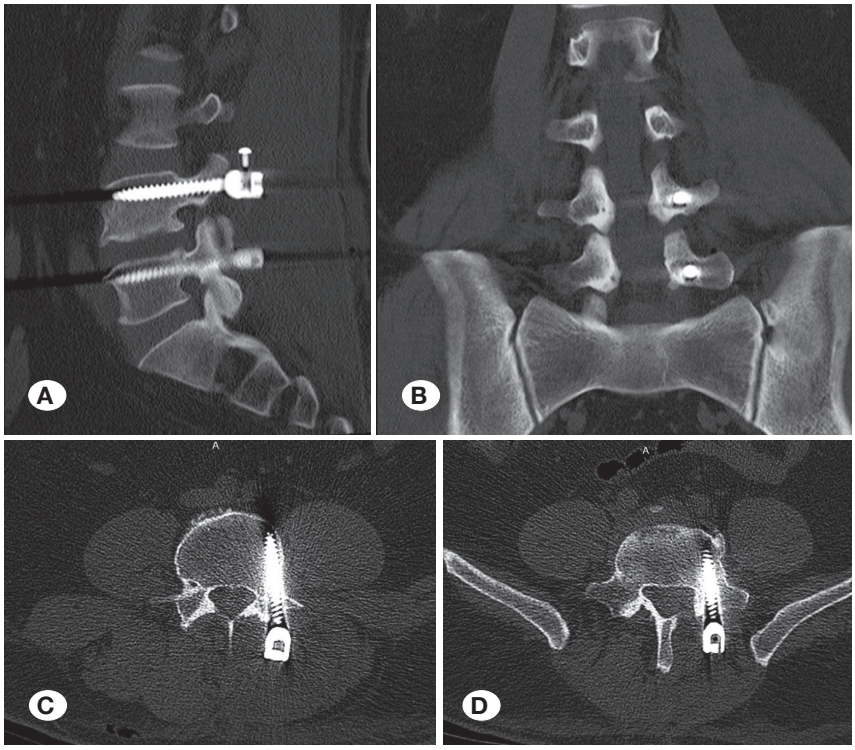

Figure 4: Postoperative lumbar CT images of a patient who was operated on for a left recurrent lumbar disc herniation. **A)** Sagittal section. **B)** Coronal section. **C)** L4 vertebrae axial section. **D)** L5 vertebrae axial section.

Table III: Patient Characteristics

	SD	DD	p*
n	20	20	–
Age	46.7	49.2	0.68
Female sex, n (%)	8 (40)	9 (45)	0.32
Smoker, n (%)	6 (30)	5 (25)	0.59
Diabetic, n (%)	3 (15)	3 (15)	0.35
BMI	28.3	27.6	0.54
Hospital stay (day)	1.4	2.9	**< 0.05**
Complications, n (%)			
Re-herniated disc	4 (20)	- 0 (0)	**< 0.05**
Dural tear	2 (10)	1 (5)	**< 0.05**
Segmental kyphosis	3 (15)	- 0 (0)	**< 0.05**
Postoperative infection	1 (5)	1 (5)	

:** *Statistical significance p<0.05,* ***BMI: *Body Mass Index.*

In the SD group, while the ODI scores were 73.1 points in the preoperative period, they decreased to 18.5 and 16.8 points at 1 and 12 months postoperatively. In the DD group, while it was 72.8 points in the preoperative period, it decreased to 17.4 and 11.6 points at 1 and 12 months postoperatively. A statistically significant decrease in ODI scores between the two groups was noted (p<0.05).

Radiological Outcome

The preoperative mean ADH, PDH, and SA for the SD group were 1.22 cm, 0.77 cm, and 22.6°, respectively. When the postoperative values for each measurement were compared with the preoperative values, the differences were not statistically significant (Table II).

The mean preoperative ADH, PDH, and SA for the DD group were 1.16 cm, 0.74 cm, and 23.1°, respectively. Comparing the postoperative and preoperative values for each measurement,

Table IV: Modified Pfirrmann Grades of the SD Group and DD Group

Location / Modified Pfirrmann grades		Superior segment 0 1 2 3 4 5 6 7 8	Surgical segment 0 1 2 3 4 5 6 7 8	Inferior segment 0 1 2 3 4 5 6 7 8
SD group	Preoperative	2 8 7 1 1 1 0 0 0	0 0 0 1 5 7 6 1 0	0 5 5 5 4 1 0 0 0
	Postoperative 12th month	1 7 8 2 1 0 1 0 0	0 0 0 1 4 6 7 1 1	0 4 6 4 4 1 1 0 0
DD group	Preoperative	2 8 8 0 1 1 0 0 0	0 0 0 1 6 6 7 0 0	0 6 4 5 4 1 0 0 0
	Postoperative 12th month	1 7 7 2 1 1 1 0 0	0 0 0 2 7 5 6 0 0	0 5 5 4 4 1 1 0 0

statistically significant differences were found for ADH and PDH ($p<0.05$), whereas the difference was not significant for SA ($p=0.28$)

The Pfirrmann grades obtained preoperatively and at 12 months postoperatively were significantly different in each group ($p<0.05$) (Table IV).

Complications

In the 1-year follow-up, symptomatic RLDH was detected again in four patients (20%) on routine MRI in the SD group, whereas segmental kyphosis was detected in three patients (15%) on routine standard standing radiograms. Re-herniated or segmental kyphosis did not develop in the DD group. The differences were found to be statistically significant ($p<0.05$). Bilateral transpedicular stabilization with a rigid rod was applied to two out of four patients with RLDH.

Perioperatively, the dural tear was observed in two patients (10%) in the SD group, and one patient (5%) in the DD group. The dura mater was repaired in three patients without any sequelae.

Postoperative infection was observed in two patients (one patient (5%) in the DD group and one patient (5%) in the DD group), and all infected patients were treated with antibiotics.

Screw or PEEK misplacement or insufficient stability was not detected in any of the patients in the DD group. Moreover, neurological deterioration, pseudomeningoosis, or mortality was not detected in both patient.

DISCUSSION

Revision discectomy is the most common surgical procedure in RLDH patients with persistent pain and loss of motor and/or sensory function that does not benefit from conservative treatment. If the patient has additional preoperative or perioperative instability, lumbar stabilization is performed with revision discectomy (2,7). Revision of spinal surgery is very difficult due to changes in perineural granulation tissue and anatomical structures (9). Revision discectomy alone is reported to have effective and simple results in patients with RLDH (14,28). However, many surgeons recommend stabilization with discectomy, considering that it prevents instability, reduces the risk of intraoperative dural rupture, reduces recurrence, and reduces the risk of neural damage (2,3,9,27).

While many variations exist for rigid stabilization, the ideal technique remains unclear. Complications, such as degeneration of discs and facets, pseudarthrosis, and adjacent segment degeneration, develop due to stabilization systems (2,3,12). Recently, it has been shown that complications such as degeneration of discs and facets and adjacent segment degeneration are greatly reduced with dynamic stabilization (4,6,20,25). Since the stabilization was performed dynamically and unilaterally in our study, it can reduce the complications related to fusion while benefiting from the effects of dynamic stabilization.

Delank et al. and Heineck et al. showed that segmental stability can be affected when decompression of the lumbar spinal canal is performed (8,16). Accordingly, the absence of reherniated disc in the DD group in our study, the decrease in segmental kyphosis, and the non-significant difference in SA between the two groups may explain this.

Some studies have reported that dynamic stabilization allows physiological movements and preserves the load-bearing function, leading to rehydration and healing of disc tissue (11,13,17,25). Since stabilization was performed in the DD group, it is expected that the VASLB score is higher than that in the SD group, but no statistical difference was observed.

Lee et al. found that there was no significant loss in ADH and PDH of the 15 patients in their 2-year study and significant improvement in VAS and ODI scores (21). Similarly, in our study, no significant loss in ADH and PDH was observed. Thus, the width of the foramen can be preserved and the compression of the L5 root and radial pain can be reduced. Accordingly, it may explain the statistically significant decrease in VASL and ODI scores in the DD group, as compared to that in the SD group.

Patients with dynamic fixation reportedly have disc rehydration after surgery (11,18). In our study, the modified Pfirrmann grades in each group preoperatively and at 12 months postoperatively were significantly different ($p<0.05$). Moreover, the modified Pfirrmann grades of the surgical segment were significantly higher at 12 months post-surgery in the SD group than in the DD group ($p=0.031$). This result suggested that the PEEK rods may slow the degeneration of intervertebral discs, possibly because the PEEK rods share the load of the intervertebral disc. However, the adjacent segment Pfirrmann grades of the two groups were not different at the final control ($p=0.28$; $p=0.13$).

The healthy contralateral side is not affected by unilateral dynamic stabilization, the anatomical integrity is preserved as much as possible, and the risk of instability and screw-related complications is also reduced. The incidence of screw revision

or loss of screws after stabilization ranges from 2% to 36% (9,24,26). The reason for the lack of screw revision or loss of the screws in our study may be because it was unilateral at one level or the number of patients was limited.

Our study has some limitations. The retrospective design of this study, small number of patients, and short follow-up period have low statistical power for generalization.

CONCLUSION

Unilateral dynamic stabilization can preserve the anatomical integrity and segmental movements of patients with RLDH. Moreover, this treatment can improve the patient's quality of life by providing sufficient stability. Therefore, unilateral dynamic stabilization may be an effective surgical method in patients with RLDH.

AUTHORSHIP CONTRIBUTION

Study conception and design: CS

Data collection: CS, RA

Analysis and interpretation of results: CS, RA

Draft manuscript preparation: CS, RA

Critical revision of the article: CS, RA

Other (study supervision, fundings, materials, etc...): CS, RA

All authors (CS, RA) reviewed the results and approved the final version of the manuscript.

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