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DOES SHORT SEGMENT LUMBAR STABILIZATION AND FUSION ACCELERATE ADJACENT UPPER SEGMENT INSTABILITY?

KISA SEGMENT LOMBER STABİLİZASYON VE FÜZYON KOMŞU SEGMENT İNSTABİLİTESİNİ HIZLANDIRIR MI?

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ABSTRACT

Objective: The true incidence and clinical impact of instability at an adjacent segment after stabilization of the lumbar spine is unclear. This study investigates the development of disc herniation or instability at the adjacent segment after stabilization of the lumbar spine.

Methods: Twenty-nine patients who received surgery using short-segment posterior instrumentation and fusion were evaluated for the development of adjacent upper segment disc herniation and instability. Stabilization and fusion were performed for listhesis or presumed instability after stenosis surgery or unstable disc herniation. For all patients, pre- and postoperative MRIs and X-ray images were obtained. Disc herniations were evaluated by MRI, and any slippage or rotational angling of the adjacent upper segments were measured by X-ray.

Results: Three patients had disc herniation and six patients had instability at the adjacent segment. No statistical correlation was found between the development of instability and disc herniation and age, gender, type of pathology, or level stabilized.

Conclusions: Stabilization and fusion were sufficient for patients and did not produce too much instability at the adjacent upper segment. Randomized studies with more patients and different instability criteria are needed to better understand adjacent segment instability.

Keywords: Adjacent segment instability, degenerative lumbar spine disease, instrumented fusion, short segment fusion

Level of evidence: Retrospective clinical study, Level III

ÖZET

Amaç: Lomber omurga sabitlemesinden sonra gelişen komşu segment instabilitesinin gerçek insidansı ve kliniğe yansıması aydınlatılmamıştır. Bu çalışma lomber omurga sabitlemesinden sonra komşu segmentte disk hernisi veya instabilite gelişiminin incelemesi amaçlanmıştır.

Yöntem: Kısa segment posterior enstrümantasyon ve füzyon uygulanan 29 hasta komşu segmentte disk hernisi veya instabilite gelişimi açısından incelenmiştir. Sabitleme ve füzyon listezis, instabil disk hernisi veya stenoz ameliyatı sonrasında gelişen instabilite nedeni ile uygulanmıştır. Tüm hastalara ameliyat öncesi ve sonrası MRG ve röntgen çekilmiştir. MRG'de komşu segment disk herniasyonu, röntgende kayma ve rotasyonal açılanma değerlendirilmiştir.

Bulgular: Üç hastada komşu segmentte disk herniasyonu, 6 hastada instabilite saptandı. İnstabilite ve disk herniasyonu gelişimi ile hastaların yaşı, cinsiyeti, patolojinin tipi veya sabitlenen seviye arasında istatistiksel bağlantı bulunamadı. Sonuç: Sabitleme ve füzyon komşu segmentte anlamlı derecede instabiliteye neden olmamaktadır. Daha fazla hasta ile ve farklı instabilite ölçütleri ile yapılacak randomize çalışmalar komşu segment instabilitesini daha iyi anlamayı sağlayacaktır.

Anahtar Sözcükler : Dejeneratif lomber omurga hastalığı; enstrümante füzyon; kısa segment füzyon; komşu segment instabilitesi

Kanıt Düzeyi: Retrospektif klinik çalışma, Düzey III

INTRODUCTION

Stabilization and fusion of the lumbar spine for instability are becoming increasingly common in neurosurgical practice[13]. Surgery aims to decompress the spinal cord, stabilize the spine and correct deformities, and ultimately to prevent chronic spinal deformity and instability. A variety of instruments, bones, and bone-like materials are used for stabilization. The true incidence and clinical impacts of instability at the adjacent upper segment after stabilization of the lumbar spine are unclear[1,3,8-9]. This study investigates the development of disc herniation or instability at the adjacent upper segment of the stabilized lumbar spine in 29 patients over an 18.21 ± 6.42 month follow-up period (range: 6–30 months).

MATERIALS AND METHODS

Twenty-nine patients received surgery at the Neurosurgery Clinic, Ministry of Health, Dışkapı Yıldırım Beyazıt Research and Training Hospital, Ankara, Turkey between January 2006 and December due to various pathologies. The surgeries used short-segment posterior instrumentation and fusion. The patients were evaluated for the long-term development of adjacent upper segment disc herniation and instability. 21 patients were male, eight patients were female, and the mean age at the time of surgery was 51.3 (33–69) years. Stabilization and fusion were performed at L3–4 for one patient, L4–5 for 16 patients, and L5–S1 for 12 patients. Stabilization and fusion were performed for single-level listhesis or presumed instability after lumbar stenosis operations, or unstable (radiological or perioperative) lumbar disc herniation.

For all patients, preoperative lumbar magnetic resonance imaging (MRI), and anteroposterior, lateral, hyperflexion, and hyperextension X-ray images were obtained. The anteroposterior and lateral X-ray images were obtained on the first day after surgery. Anteroposterior, lateral, hyperflexion, and hyperextension X-ray images were also obtained six months after surgery. In postoperative lateral X-rays, sagittal slippage and rotational angling of the adjacent upper segments were measured. Scorings were made according to White and Panjabi. In the lumbar MRIs, disc herniation and surgical indications for disc herniation were evaluated for the adjacent upper disc level. The first follow-up was conducted 1.5 months after the lumbar spinal surgery. The second follow-up visit was conducted six months after surgery. Patients then returned for follow-ups at six-month intervals. The patients included in this study returned for at least one follow-up, with a maximum of six follow-ups. The mean follow-up period was 18.21 ± 6.42 months, with a range of 6–30 months. During each follow-up visit, lumbar MRI and anteroposterior, lateral, hyperflexion and hyperextension X-ray images were obtained.

In the adjacent upper segment, the development of lumbar disc herniation and surgical indications for disc herniation were evaluated based on the following grading system: Grade 1 (no disc herniation), Grade 2 (non-surgical disc herniation), and Grade 3 (surgical disc herniation). Instability was evaluated according to White and Panjabi's criteria: Grade 1 (no instability; White-Panjabi score 0–2), Grade 2 (limited instability; White-Panjabi score 3–4), Grade 3 (instability; White-Panjabi score greater than or equal to 5).

Statistical analysis:

All statistical analyses were performed using Statistical Package for Social Sciences (SPSS) for Windows (Version 11.5, IBM, Chicago, IL, USA). Continuous variables were shown as mean ± standard deviation (minimum–maximum), and categorical variables were shown as case numbers and (%). The effect of one variable on disc herniation and instability was evaluated using the Student's t-test. Categorical variables were evaluated using the Pearson Chi square test and the Fisher's Chi square exact test. P-values <0.05 were considered to be statistically significant.

RESULTS

The patients' demographic data (e.g. age and gender), pathologies and surgeries are shown in Table-1. Out of 29 patients, ten patients had listhesis, five patients had listhesis plus lumbar disc herniation, and ten patients had lumbar stenosis plus instability. In postoperative MRIs of the 29 patients, the adjacent upper level instability grades and disc herniation grades are shown in Figure-2. One patient had the L2–3 level as the adjacent upper segment, 17 patients had the L3–4 levels as the adjacent upper segment, and 11 patients had the L4–5 levels as the adjacent upper segment. 26 patients had Grade 1 disc herniation (no disc herniation), two patients had Grade 2 disc herniation, and one patient had Grade 3 disc herniation. Three patients had two or more grades of disc herniation, two of these patients had stabilization and fusion at L3–4 and one patient had stabilization and fusion at L5–S1. 23 patients had no instability at the adjacent upper segment, while six patients had instability at the adjacent upper segment (Tables-1-4).

Table-1. Table showing patients'age, gender, pathology and level of posterior stabilization.

No	Age	Gender	Diagnose	Level of Posterior stabilization
1	44	F	LISTHESIS	L5-S1
2	43	F	LISTHESIS	L4-5
3	61	F	SPONDILOSIS AND INSTABILITY	L5-S1
4	69	F	SPONDILOSIS AND INSTABILITY	L4-5
5	38	F	LISTHESIS	L5-S1
6	55	F	LISTHESIS+HERNIATED DISC	L4-5
7	41	M	LISTHESIS	L5-S1
8	43	F	LISTHESIS	L5-S1
9	46	M	SPONDILOSIS AND INSTABILITY	L5-S1
10	54	F	SPONDILOSIS AND INSTABILITY	L4-5
11	61	F	SPONDILOSIS AND INSTABILITY	L4-5
12	51	M	LISTHESIS AND HERNIATED DISC	L4-5
13	33	F	LISTHESIS	L4-5
14	69	M	SPONDILOSIS AND INSTABILITY	L4-5
15	59	M	LISTHESIS	L5-S1
16	43	F	LISTHESIS	L5-S1
17	47	F	LISTHESIS AND HERNIATED DISC	L4-5
18	62	F	SPONDILOSIS AND INSTABILITY	L5-S1
19	69	F	SPONDILOSIS AND INSTABILITY	L5-S1
20	35	F	LISTHESIS	L4-5
21	58	F	LISTHESIS AND HERNIATED DISC	L5-S1
22	54	F	LISTHESIS	L4-5
23	54	M	LISTHESIS	L4-5
24	64	F	SPONDILOSIS AND INSTABILITY	L4-5
25	43	F	LISTHESIS	L3-4
26	46	M	LISTHESIS	L4-5
27	44	F	LISTHESIS	L4-5
28	48	M	LISTHESIS AND HERNIATED DISC	L4-5
29	53	F	SPONDILOSIS AND INSTABILITY	L4-5

*Student's t-test, **Fisher's Chi-square exact test, *** Pearsons's Chi-square test.

Table-2. Table showing patients' level of posterior stabilization, adjacent upper segment disc herniation grade and instability grade. In the evaluation of the adjacent upper segment;

No	Level of stabilization	Herniated disc in the adjacent segment*	White &Panjabi Score	Instability in the adjacent segment**
1	L5-S1	1	0	1
2	L4-L5	1	0	1
3	L5-S1	1	3	2
4	L4-L5	1	0	1
5	L5-S1	1	0	1
6	L4-L5	3	3	2
7	L5-S1	2	0	1
8	L5-S1	1	0	1
9	L5-S1	1	3	2
10	L4-L5	1	0	1
11	L4-L5	1	0	1
12	L4-L5	1	0	1
13	L4-L5	1	0	1
14	L4-L5	1	0	1
15	L5-S1	1	0	1
16	L5-S1	1	0	1
17	L4-L5	2	0	1
18	L5-S1	1	3	2
19	L5-S1	1	0	1
20	L4-L5	1	0	1
21	L5-S1	1	0	1
22	L4-L5	1	0	1
23	L4-L5	1	3	2
24	L4-L5	1	0	1
25	L3-L4	1	0	1
26	L4-L5	1	0	1
27	L4-L5	1	3	2
28	L4-L5	1	0	1
29	L4-L5	1	0	1

*1: no disc herniation, 2: non-surgical disc herniation, 3: surgical disc herniation. **1: no instability (White- Panjabi score 0-2), 2: limited instability (White-Panjabi score 3-4), 3: instability (White-Panjabi score greater than or equal to 5).

Table-3. Table showing the relationship between age, gender pathology adjacent upper segment of the patients and development of disc herniation at the adjacent upper segment.

Variables	No disc herniation	Disc herniation	p	Variables
Age (years)	51,7 ± 10,5	47,7 ± 7,0	0,526*	Age (years)
Gender			1,000**	Gender
Male	7 (%87,5)	1 (%12,5)		Male
Female	19 (%90,5)	2 (%9,5)		Female
Pathology			0,069***	Pathology
Listhesis	13 (%92,9)	1 (%7,1)		Listhesis
Listhesis + Lumbar disc herniation	3 (%60,0)	2 (%40,0)		Listhesis + Lumbar disc herniation
Stenosis + Instability	10 (%100)	-		Stenosis + Instability
Adjacent segment			0,872***	Adjacent segment
L2-L3	1 (%100)	-		L2-L3
L3-L4	15 (%88,2)	2 (%11,8)		L3-L4
L4-L5	10 (%90,9)	1 (%9,1)		L4-L5

*Student's t-test, ** Fisher's Chi-square exact test, *** Pearson's Chi-square test.

Table -4. Table showing the relationship between age, gender, pathology, the adjacent segment of the patients and development of instability at the adjacent segment

Variables	No instability	Instability	p
Age (years)	50,3 ± 10,3	55,0 ± 9,5	0,323*
Gender			1,000**
Male	6 (%75,0)	2 (%25,0)	
Female	17 (%81,0)	4 (%19,0)	
Pathology			0,649***
Listhesis	12 (%85,7)	2 (%14,3)	
Listhesis + Lumbar disc herniation	4 (%80,0)	1 (%20,0)	
Stenosis + Instability	7 (%70,0)	3 (%30,0)	
Adjacent segment			0,745***
L2-L3	1 (%100)	-	
L3-L4	13 (%76,5)	4 (%23,5)	
L4-L5	9 (%81,8)	2 (%18,2)	

*Student's t-test, ** Fisher's Chi-square exact test, *** Pearson's Chi-square test.

Herniation at the adjacent upper segment did not correlate with age (p=0.526), gender (p=1.000), pathology type (p=0.069), or level of stabilization (p=0.872). Development of instability at the adjacent upper segment did not correlate with age (p=0.323), gender (p=1.000), pathology type (p=0.649), or level of stabilization (p=0.745). Instability, which can cause pain and neurological deficits, is a major problem for spine surgeons. Surgery for instability is becoming more common as new techniques are developed. However, the stabilization and fusion of unstable segments prevent normal physiological movement, change the biomechanics of the vertebral column, and provoke adjacent segment degeneration[2,6,7,12].

DISCUSSION

Researchers are currently developing ways to reduce these biomechanical changes and preserve normal physiological movement. New surgical techniques, treatment models, and surgical instruments are being developed. Stabilization and fusion surgeries are essential for the treatment of listhesis, acute traumatic vertebral fractures, and degenerative disc diseases. However, sometimes pain is not caused by a loss of stability in the vertebral column, and may instead be caused by the loss of load distribution. In these cases, dynamic stabilization is necessary[10]. Lumbar listhesis is common with spinal disc diseases and spinal stenosis in elderly patients. In these cases, neurological decompression should be used. In patients with symptomatic stenosis, facetectomy is performed during surgery. This procedure causes instability and related complaints. Various stabilization techniques are used to treat lumbar fractures, degenerated discs, and tumoral diseases. Anterior, posterior, and combined techniques are used for stabilization[15]. Each technique has advantages and disadvantages. The technique used depends on the patient's assessment and pathology, as well as the surgeon's experience.

Suk et al.[14] operated on 76 patients with degenerative spondylolisthesis. They performed decompression, transpedicular stabilization, and posterolateral fusion on 36 patients, and interbody fusion on 40 patients. During a two year follow-up, the first group showed 92% fusion and the second group showed 100% fusion. In the first group there was 28% listhesis, while in the second group there was 45% listhesis. The researchers concluded that a large fusion area was needed in order to achieve fusion over a long-term follow-up period.

One of the aims of posterior stabilization and fusion surgery is to obtain normal lumbar lordosis. Putting cages between vertebral bodies helps to obtain normal lumbar lordosis. Godde et al.[4] compared rectangular and wedge-shaped cages, and found that lumbar lordosis increased in patients with wedge-shaped cages and decreased in patients with rectangular cages. A decrease in lumbar lordosis has a negative effect on biomechanics and increases mobility of the adjacent upper segment. Studies have shown that the fusion rates were higher for patients who underwent stabilization and fusion. However, adjacent segment diseases increased after rigid fixation[11]. Hillibrand and Robbins[5] defined adjacent segment diseases as new symptoms, i.e. radiographic changes that developed after spinal fusion surgery. In these patients the symptoms improved after surgery, but new symptoms eventually developed due to adjacent segment diseases.

In this study, we evaluated the stabilized and fused adjacent upper segments of 29 patients. Three patients developed disc herniation in the adjacent upper segment, but only one of them needed surgery. None of the patients developed instability requiring surgery at the adjacent upper segment. However, six patients developed instability that did not require surgery. Patients who had surgery because of disc herniation were also stabilized.

A pain-free spine capable of normal physiological movement is important for any patient's quality of life. The treatment of spinal pathologies should consider anatomical and physiological rules. Surgical techniques should not harm normal structures. The stabilized vertebrae should be as short as possible, and the stabilization material should be suitable for the anatomy, strong, and allow physiological movement. After surgery, patients should be monitored for contractures and loss of strength in the muscles surrounding the spine. Patients should be given physical therapy to strengthen these muscles and to relieve contractures.

There is burgeoning interest among surgeons in increased movement and loading at the adjacent segment after stabilization and the development of adjacent segment disease. Adjacent segment disease is defined by radiological degenerative changes and new symptoms known to occur following reconstructive spine surgery. This is most common immediately adjacent to the functional spinal unit.

In this study, the development of adjacent upper segment instability and disc herniation was evaluated in patients who underwent stabilization and fusion operations for different pathologies. The study included a sufficient follow-up period. The study found that adjacent upper segment instability was not very common. However, some patients did require surgery. Our data show that rigid stabilization and fusion were sufficient for patients. These patients did not display too much instability and disc herniation at the adjacent upper segment. Nevertheless, it is important to remember that every patient is different. Additional randomized studies, including more patients and different instability criteria, are required to fully understand adjacent upper segment instability. Minimally invasive approaches and surgeries that respect normal physiological angles will help to obtain optimum results.

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