



# HOW MUCH CAN I CHANGE THE LUMBOSACRAL ALIGNMENT WITH SURGERY IN ISTHMIC SPONDYLOLISTHESIS?

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## ABSTRACT

**Objectives:** The incidence of spondylolisthesis varies between 4-6 % in adult population. However, the incidence of isthmic spondylolisthesis is 2.6-4.4 %. It occurs in the sagittal plane by subluxation of a vertebral body through the other vertebral body. The aim of this study is to determine the changes in sagittal lumbosacral balance, which is a spinal instability parameter, after the surgical treatment in the isthmic spondylolisthesis and to demonstrate the effectiveness of the surgery in restoration of spinal stability

**Materials and Methods:** Twenty-six patients who underwent surgical treatment for lumbosacral isthmic spondylolisthesis in our study between January 2011 and June 2016 were studied retrospectively. They were classified according to Wiltse's criteria. Preoperative and postoperative Meyerding Slip Ratio (Grade), Slip Angle (SA), Lumbar Lordosis (LL), Lumbosacral Kyphosis Angle (LSK) and Sacral Slope (SS) measurements were performed and compared.

**Results:** A total of 26 patients with isthmic lumbosacral spondylolisthesis were enrolled in this study. The patient population included 13.1 % (n = 6) male and 76.9 % (n = 20) female. The mean age was 54.08 ± 12.74 years. 61.5 % (n = 16) of the cases were subtype A, 30.8 % (n = 8) were subtype B and 7 % (n = 2) were subtype C. The difference between preoperative and postoperative slip displacement and slip angle was statistically significant (p = 0.001; p < 0.01).

**Conclusion:** Isthmic spondylolisthesis is a clinically occurring condition in middle age group, especially in women. The surgery is effective in recovery of the clinical features of these patients and restoration of the lumbosacral alignment. The most obvious improvement in the balance between the spine and the pelvis is the slip displacement and slip angle.

**Key words:** spondylolisthesis; isthmic; subtype; surgical; lumbosacral; alignment.

**Level of evidence:** Retrospective clinical study, Level III.

## INTRODUCTION

The incidence of spondylolisthesis varies between 4 % and 6 %<sup>(11)</sup>. The incidence of isthmic spondylolisthesis is 2.6 - 4.4 %<sup>(10)</sup>. Spondylolisthesis is a condition that affects all age groups with a percentage of 2 - 8 % of the general population. This percentage is up to 20% in patients with complaints of low back pain. In the sagittal plane, the subluxation of a vertebral body over the other vertebral body occurs. Relatively the common mechanisms of the spinal instability are; ligamentous weakness and laxity, pars interarticularis defect, previous surgical intervention or trauma

<sup>(5,12)</sup>. Various types of classification have been made as long as the causes of the spondylolisthesis are determined. The universally accepted classification is proposed by Wiltse, Newman and Mac-Nab. According to this classification isthmic type; lytic, prolonged, and acutely separated by subtypes<sup>(16)</sup>.

Isthmic spondylolisthesis often happens after start to walk, rarely before 5 year-old. It is most commonly seen in the 2<sup>nd</sup> - 3<sup>rd</sup> decade of life. It may be inherited. The incidence of spondylosis or spondylolisthesis of the family members has been reported as 28 - 69 % and a strong genetic factor has been described

(5,10). It is believed that spondylolisthesis is almost always acquired<sup>11</sup>.

According to White and Panjabi, the clinical stability of the vertebra is the ability of the spine to limit the translocation pattern when physiological load is applied and the ability of the spinal cord nerve roots to avoid injury or irritation, as well as to prevent decapacitating deformity and pain due to structural changes<sup>(14)</sup>. Slow progressive instability is caused by; spondylosis, trauma, tumor, infection and congenital defects. One of the most common types of stability of this type is the isthmic type lumbar spondylolisthesis<sup>1</sup>.

Sagittal sacropelvic morphology and orientation determine the lumbar spine geometry and at the same time the mechanical stress in the lumbosacral junction. In order to better understand the process of spondylolisthesis, many parameters that define the relationship between the lumbosacral junction and the pelvis have been described<sup>(6-7)</sup>. Among these parameters there are: pelvic incidence, pelvic tilt and sacral slope. In many studies, the association between pelvic and spinal parameters has been shown to be important, based on measurements of standardized health-related quality of life (health-related quality of life - HRQOL)<sup>(8)</sup>.

The aim of this study is to determine the changes in sagittal lumbosacral balance, which is a spinal instability parameter, after the surgical treatment in the isthmic spondylolisthesis and to demonstrate the effectiveness of the surgery in restoration of spinal stability.

## MATERIAL AND METHODS

Twenty-six patients who underwent surgical treatment for lumbosacral isthmic spondylolisthesis in our study between January 2011 and June 2016 were studied retrospectively. The age, sex, grade and type of spondylolisthesis were evaluated. Wiltse classification was used to determine the type of spondylolisthesis and the isthmic subtype<sup>(16)</sup> (Figure-1).

Direct lumbosacral anteroposterior, lateral, flexion-extension functional graphs, computed tomography (CT) and magnetic resonance imaging (MRI) examinations were performed for all preoperative cases. In these tests; preoperative and postoperative Meyerding slip displacement (Grade), slip angle (SA), Lumbar Lordosis Angle (LL), Lumbosacral Kyphosis angle (LSK), Sacral slope (SS) measurements were compared and compared to

investigate the morphological changes causing instability and postoperative morphologic changes.

## Statistical Analysis

NCSS (Number Cruncher Statistical System) 2007 (Kaysville, Utah, USA) program was used for statistical analysis. Descriptive statistical methods (Mean, Standard Deviation, Median, Frequency, Odds, Minimum, and Maximum) were used when study data were evaluated. Paired sample t-test was used for intra-group comparison of normal distribution parameters and Wilcoxon Signed Ranks test was used for intra-group comparison of parameters without normal distribution. Significance was evaluated at  $p < 0.05$  levels.

## RESULTS

The study consisted of 26 cases, as 13.1 % ( $n = 6$ ) were male and 76.9 % ( $n = 20$ ) were female. The ages of the cases ranged from 26 to 76 years with a mean of  $54.08 \pm 12.74$  years. 61.5 % ( $n = 16$ ) were subtype-A, 30.8 % ( $n = 8$ ) were subtype-B and 7 % ( $n = 2$ ) were subtype-C isthmic spondylolisthesis. When we analyzed the distributions according to the levels of isthmic spondylolisthesis: 11.5 % ( $n = 3$ ) were in L3-4, 46.2 % ( $n = 12$ ) in L4-5 and 43.2 % ( $n = 11$ ) in L5-S1 levels (Table-1).

Preoperative Meyerding Grades; 30.8 % ( $n = 8$ ) of the cases were grade-I, 65.4 % ( $n = 17$ ) were grade-II and 3.8 % ( $n = 1$ ) were grade-III. Postoperative Meyerding Grades; 88.5 % ( $n = 23$ ) of the cases were grade I and 11.5 % ( $n = 3$ ) were grade II.

When compared with the isthmic spondylolisthesis subtypes, the change of slip angle and slip displacement were statistically significant ( $p = 0.001$ ;  $p < 0.01$ ).

The preoperative slip displacement was found to be  $30.11^\circ \pm 8.36^\circ$  and the postoperative was  $18.61^\circ \pm 9.44^\circ$ . The mean  $11.50^\circ \pm 5.10^\circ$  changes in the postoperative slip displacement were statistically significant ( $p = 0.001$ ;  $p < 0.01$ ) (Table-2).

The preoperative slip angle was found to be  $11.26 \pm 5.18$  and the postoperative slip angle was found to be  $7.39^\circ \pm 4.44^\circ$ . This change was  $3.87^\circ \pm 3.40^\circ$  postoperatively ( $p = 0.001$ ,  $p < 0.01$ ) (Table-2).

The mean difference between preoperative and postoperative was  $0.66^\circ \pm 7.80^\circ$  in Lumbar Lordosis,  $0.9^\circ \pm 6.14^\circ$  in Lumbosacral Kyphosis and  $0.46^\circ \pm 5.34^\circ$  in sacral slope. This change was not statistically significant ( $p > 0.05$ ) (Table-2).

**Table-1.** Summarizes the demographic characteristics of 26 cases of isthmic spondylolisthesis occurring in our study.

		Min.-Max.	Mean±SD
Age (yrs)		26-76	54.08±12.74
Slip Rate (mm)		20-55	30.11±8.39
Slip Angle (°)		3-23.4	11.26±5.18
Lumbar Lordosis (°)		36.3-68.4	53.11±9.11
Lumbosacral Kyphosis (°)		13.6-52.7	29.82±9.98
Sacral Slope (°)		26.3-57.1	38.65±8.36
		n	%
Sex	Female	20	76.9
	Male	6	23.1
Level	L3/4	3	11.5
	L4/5	12	46.2
	L5/S1	11	42.3
Isthmic spondylolisthesis	Subtype A	16	61.5
	Subtype B	8	30.8
	Subtype C	2	7.7
Meyerding Grade	1 (0-25%)	8	30.8
	2 (25-50%)	17	65.4
	3 (50-75%)	1	3.8

**Table-2.** The results of the statistical analysis of the measurements performed before and after the surgery in the lumbosacral alignment are presented in

	Comparing Differences		
	Mean	Std. Deviation	Sig. (2-tailed)
Preop - Postop Slip Rate	11,50000	5,10882	0,00
Preop - Postop Sacral Slope	,46154	5,34386	0,66
Preop - Postop Lumbosacral Kyphosis	,94615	6,14747	0,44
Preop - Postop Slip Nagle	3,87615	3,40539	0,00
Preop - Postop Lumbar Lordosis	,66923	7,80850	0,67
Preop - Postop Meyerding grade	,61538	,49614	0,00

Paired t-testi, \*p<0,05, \*\*p<0,01

## DISCUSSION

Isthmic spondylolisthesis is almost always considered to be acquired. Wiltse's study with 700 fetuses and Fredrickson's study with 500 newborns did not reveal any vertebra defect<sup>(3,15)</sup>. In women, the ratio of pars defect is less than half, in some studies and it is 1/3 of that in males but in females it is 4 times more in high-grade and the female patients are more symptomatic<sup>(5,10)</sup>. Similar to the literature, 13.1 % (n = 6) of cases were male and 76.9 % (n = 20) of female so the female / male ratio was 5.8. The most frequent level of isthmic spondylolisthesis is L5-S1<sup>(5,10,13)</sup>. In our study, 46.2 % (n = 12) was found in L4-5 level and 43.2 % (n = 11) in L5-S1 level.

In the study by Vinig et al., 25 % of patients with isthmic spondylolisthesis were classified as grade-II, of which 17

% were in L5-S1 and 8 % in L4-5<sup>(13)</sup>. He et al. reported that, grade-I was 19.1 % in male group and 25 % in female group. In males, 11.3 % were grade-II and above; 13.8 % of the women were grade-II and above<sup>(4)</sup>. When we look at the preoperative Meyerding grades in our study: 61.9 % (n = 39) were grade-II, 36.5 % were grade-I and only 1.6 % (n = 1) were grade-III. So, 98 % (n = 62) of our cases were low grade spondylolisthesis. According to Labelle, the most important measures in evaluating spondylolisthesis are: slip displacement, slip angle, LSK and SS<sup>(6)</sup>.

There are a few studies in the literature evaluating preoperative and postoperative spinopelvic alignment. Faldini C et al. performed the study of 41 cases of high grade isthmic spondylolisthesis which they evaluated the lumbar lordosis and sacral slope. According to this,

a significant change of 2° was detected in sacral slope. No significant change was observed in lumbar lordosis<sup>(2)</sup>. Maciejczake et al showed that, 60 cases of isthmic spondylolisthesis: lumbar lordosis, lumbosacral kyphosis angle and sacral slope evaluation were performed as preoperatively and postoperatively.

The cases were grouped as high and low grade. There was a significant increase in sacral slope both between groups and within the group. There was no significant change in LL and LSK. Similar results were obtained when grouped as balanced and unbalanced<sup>(9)</sup>. Zhang LL et al. In the study of 18 high grade L5-S1 isthmic spondylolisthesis, slip displacement, slip angle, sacral slope and lumbar lordosis were evaluated. No significant change in any parameters was found. Even if the statistical significance is not obtained, it has been reported that surgery can improve spinopelvic balance<sup>(17)</sup>.

In our study, although the amount of slip displacement and slip angle could be corrected with surgery, we could see that LL, LSK and SS could be improved, but this was not significant. It is certain that the surgeon benefits from a balanced distribution of load between the spine and the pelvis. This seems to be effective in preventing the development of the clinical features of the patient and the development of postoperative complications.

In conclusion, isthmic spondylolisthesis is a clinically manifestation in the middle age group, especially in women. The surgery is effective recovery of the clinical features of these patients and improving the lumbosacral alignment. The most obvious improvement in the balance between spine and pelvis is the slip displacement and slip angle.

### Conflict of Interest

The authors declare that they have no conflicts of interest concerning this article.

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