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Effect of Postoperative Sagittal Balance in Lumbar Fusion Surgeries on the Outcome of Chronic Low Back Pain

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Abstract

Background: Maintaining balanced sagittal balance after lumbar fusion surgery results in reducing muscular effort to maintain the upright position. This will improve the outcome of back pain post-operatively.

Aim of Study: This study aims to determine the outcome of back pain when maintaining postoperative sagittal balance.

Patients and Methods: The sagittal balance was calculated for patients undergoing lumbar fusion surgeries. Disability indices were calculated for the patients postoperatively to determine the outcome of back pain. The outcome of surgery is then correlated with the postoperative results of the sagittal balance.

Results: There was statistically significant correlation between the outcome of fusion surgery and maintaining a balanced postoperative sagittal balance. The mean lumbar lordosis angle was the main determinant of the postoperative sagittal balance value. The 3 months VAS score postoperative was significantly better when postoperative pelvic harmony is achieved.

Conclusion: Post operative sagittal balance was maintained when the lumbar lordosis angle was maintained postoperatively. Better outcome of back pain was associated with maintaining a balanced sagittal balance post operatively.

Key Words: *Sagittal – Balance – Lumbar – Fusion – Back – Pain.*

Introduction

HAVING a balanced sagittal balance is important to maintain the upright position essential for bipedal locomotion with minimal muscular effort. Lumbar fusion surgeries may disrupt the sagittal balance post-operatively and which will result in poorer outcome of back pain **[1].**

The effect of the sagittal balance and back pain is recently being recognized. Persistence of postoperative back pain after lumbar fusion surgeries is a problem of increasing interest as it affects the possibility of satisfactory outcome of surgery **[1].**

The aim of work:

This study aims to determine the outcome of back pain when maintaining postoperative sagittal balance.

Patients and Methods

This is a prospective study for 40 cases subjected to surgical lumbar fixation by randomized trial.

Inclusion criteria:

- Surgical candidates having degenerative spondylolisthesis that need lumbar fusion surgery.
- Surgical candidates having isthmic spondylolisthesis that need lumbar fusion surgery.

Exclusion criteria:

- Surgical candidates for lumbar surgery without fixation.
- Surgical candidates for lumbar fixation surgeries indicated for traumatic spine injuries.
- Surgical candidates for lumbar fixation surgeries indicated for spondylodiscitis.

All surgeries were done in Kasr El-Aini Hospitals, Cairo University from March 2021 till September 2022.

Patients were followed up immediately post-operative, after seven days, one month, 3 months post operative to assess low back pain.

Low back pain was assessed by the use of the visual analogue score (VAS) and to assess the degree of instability, the Oswestry disability index score (ODI) was used.

1- Patients were subjected to whole spine X-ray showing both heads of femurs and a computer soft-

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ware was used to calculate the sagittal balance using the following angles:

- Lumbar lordosis angle (LL).
- Pelvic tilt (PT).
- Pelvic incidence (PI).
- Sacral slope (SS).
- Spine vertical axis (SVA).

Fig. (1): Sagittal balance parameters.

Patients were the divided into two groups: Sagittally balanced group and sagittally imbalanced group.

Statistical analysis:

Coding and entering of data were done using version 28 of the statistical package for the Social Sciences

(SPSS) (IBM Corp., Armonk, NY, USA). Data was analyzed by calculating the mean with standard deviation for the number of cases and percentages were used for categorical variables. The unpaired *t*-test was used for comparisons between groups. The same method was used to compare the preoperative and post operative cases **[2]**. The Chi square ($\chi 2$) test was used to compare the categorical data. We used the Exact test when the expected frequency is less than 5. The result was considered to be statistically significant if the *p*-values were less than 0.05.

The postoperative data was compared to the similar category of the preoperative data.

The results of the patients then divided them into two groups: Sagittally balanced group and sagittally imbalanced group.

In case of improvement of back pain, the rate of improvement was classified into a four-grade scale: The following four grade scale was used in both groups to assess the outcome of improvement of low back pain.

The outcome of back pain is then correlated with the postoperative sagittal balance values. The scale of improvement is as follows:

- More than 90% improvement; Excellent.
- Range of improvement 75-89%; Good.
- Range of improvement 50-74%; Fair.
- Range of improvement 75-89%; Poor.

Results

A- Demographic values:

- *Age and sex distribution:*

The mean age for the cases was 44.47 years old. 18 of the cases were males and 22 were females.

- *Levels and types of fixation:*

Fixation without interbody fusion was up to 4 levels of fixation while fixation associated with interbody fusion was only single and double level. 50% of the cases did posterolateral fixation without interbody fusion and 50% associated interbody fusion using TLIF with the pedicle screws.

B- Sagittal balance parameters:

- *The sagittal vertical axis (SVA):*

The mean value for the SVA pre operative was 5.38mm and the mean postoperative value for the SVA was 5.30mm.

- *Lumbar lordosis angle:*

The mean value for the lumbar lordosis angle preoperative was 45.20° and the mean postoperative value for the lumbar lordosis angle was 48.17°.

- *Sacral slope angle:*

The mean value for the sacral slope angle preoperative was 33.75° and the mean postoperative value for the sacral slope angle was 34.6°.

- *Pelvic tilt:*

The mean value for the sacral slope angle preoperative was 32.43° and the mean postoperative value for the sacral slope angle was 33.23°.

- *Pelvic harmony:*

Pelvic harmony post operative (post operative lumbar lordosis angle was within 9° of the pelvic incidence angle) in 82.5% of the cases. It was not maintained in 17.5%.

C- Evaluation of back pain and disability:

- *VAS in the PL group:*

The mean value for the VAS preoperative was 7.68 and the mean postoperative value for the VAS was 4.35°. The mean value for the three months postoperative VAS was 4.63.

- *Oswestry disability index (ODI):*

The mean value for the ODI preoperative was 48.65% and the mean postoperative value for the ODI was 29.4%. The mean value for the three months post operative ODI was 24.4%.

Table (1): Number of levels of fixation.

	1		2		3		4		*p*-value
No interbody fusion	4	20%	10	50%	3	15%	3	15%	0.025
Interbody fusion	12	60%	8	40%	0	0%	0	0%	

Table (2): SVA value.

	SVA pre		SVA post		*p*-value	
	Mean	SD	Mean	SD	Pre	Post
No interbody fusion	5.38	1.42	5.32	1.26	1.0	0.861
Interbody fusion	5.38	1.44	5.25	1.36		

Table (3): LL angle.

	LL angle pre		LL angle post		*p*-value	
	Mean	SD	Mean	SD	Pre-operative	Post-operative
No interbody fusion	45.20	2.95	44.32	5.28	0.146	<0.001
Interbody fusion	43.20	5.19	52.04	5.70		

Table (4): SS angle.

	Sacral slope angle pre-operative		Sacral slope angle post-operative		*p*-value	
	Mean	SD	Mean	SD	Pre	Post
No interbody fusion	33.82	2.51	34.25	3.62	0.943	0.352
Interbody fusion	33.30	3.49	32.15	3.52		

Table (5): Pelvic tilt angle.

	PT angle pre-operative		PT angle post-operative		*p*-value	
	Mean	SD	Mean	SD	Pre	Post
No interbody fusion	32.05	8.86	32.25	8.44	0.755	0.487
Interbody fusion	32.90	9.58	34.30	8.53		

Table (6): VAS score.

	No interbody fuson		Interbody fusion		*p*-value
	Mean	SD	Mean	SD	
VAS pre-operative	7.35	1.39	8.50	1.66	0.175
VAS post-operative	4.15	1.50	4.85	0.89	0.610
VAS 3 months	5.35	1.56	4.10	1.47	0.021

Table (7): ODI.

	ODI pre-operative		ODI post-operative		*p*-value	
	Mean	SD	Mean	SD	Pre-operative	post-operative
No interbody fuson	48.55	5.83	30.35	14.18	0.856	0.216
Interbody fusion	48.30	5.45	28.50	11.26		

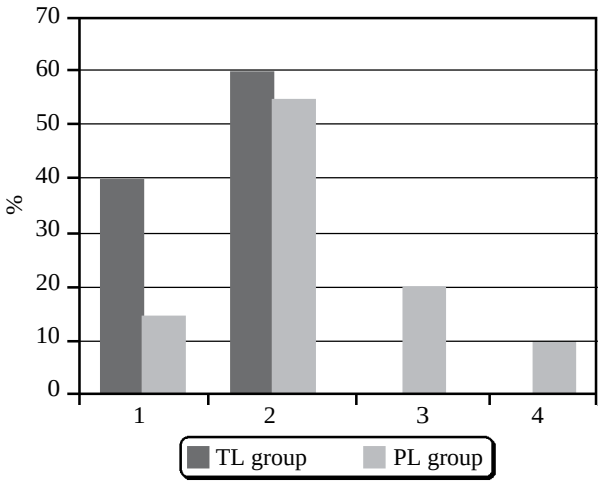

Fig. (2): Levels of fixation.

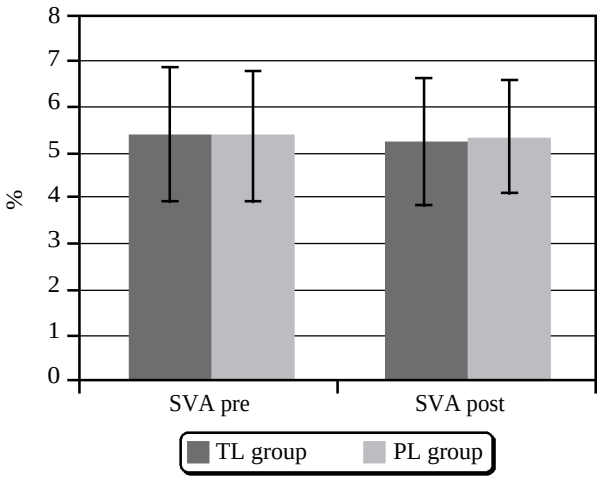

Fig. (3): SVA values

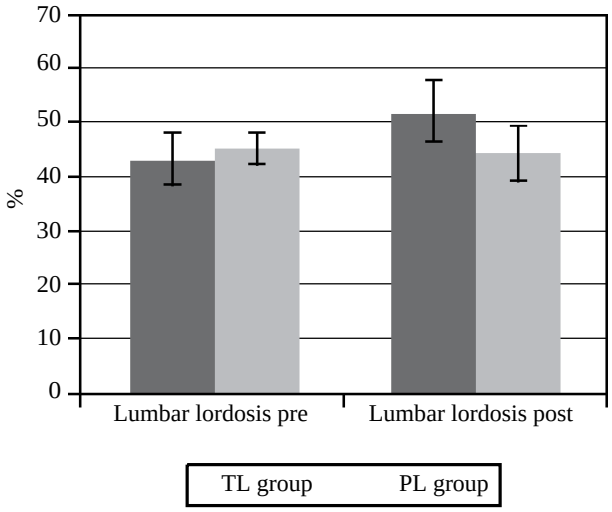

Fig. (4): LL angle.

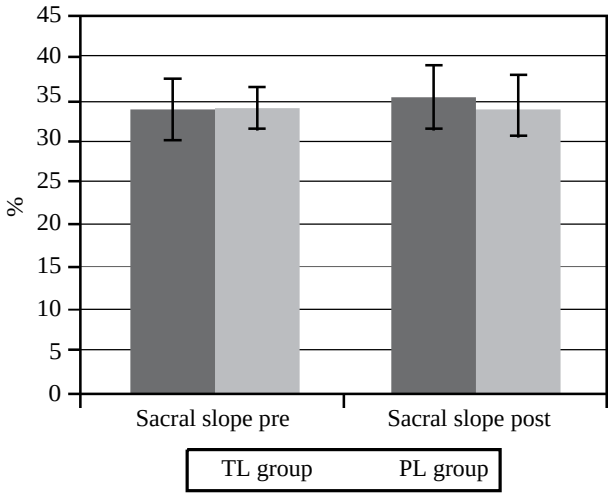

Fig. (5): SS angle.

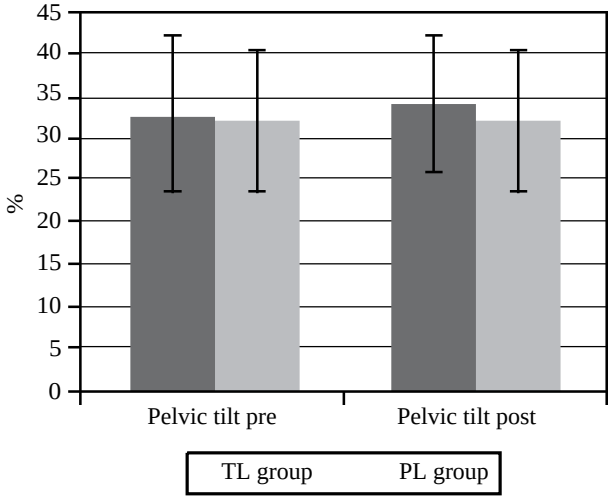

Fig. (6): PT angle.

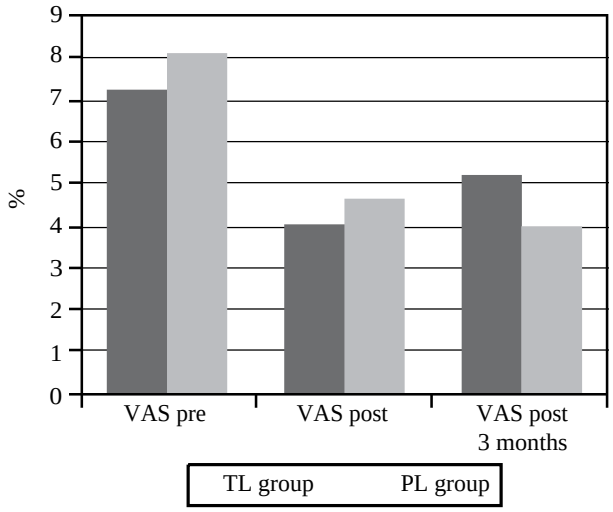

Fig. (7): Visual analogue score.

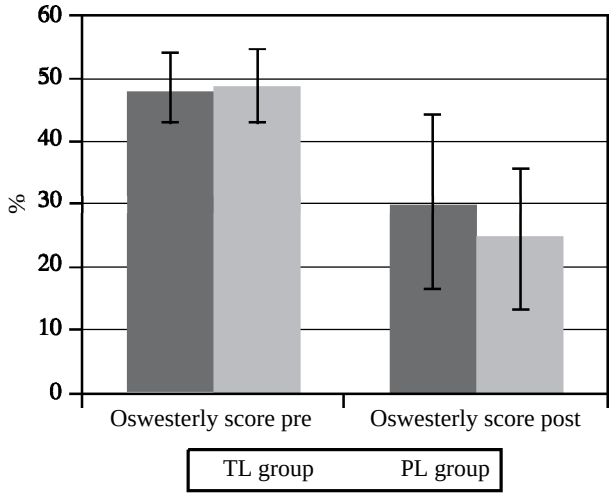

Fig. (8): ODI.

Discussion

The aim of our study is to correlate the outcome of postoperative back pain and maintaining a balanced postoperative sagittal balance.

There was another factor that affects the outcome of back pain which is the levels included in fixation. When interbody fusion was used the levels included in fixation were only one or two levels. While when interbody fusion was not included, up to four levels of fixation were included. The difference between the outcomes in the two groups was statistically significant.

Wang et al., **[1]** results concluded that when the number of levels included in fixation is lower, this was associated with better SVA and lumbar lordosis angle post operatively and therefore this was asso-

ciated with more balanced sagittal balance post-operatively.

The SVA improved in our study by a mean of 0.08cm which is a minimal improvement. The percentage of improvement proved to be statistically insignificant. There was also no significant difference in outcome of SVA whether interbody fusion was used or not.

However, the study by Wang et al., **[1]** resulted in improvement by 3.1cm postoperatively, the study by Korovessis et al., **[3]** also found postoperative improvement of SVA by 2.3cm which are both significantly different results than our study.

Moreover, the study by Korovessis et al., **[3]** showed that 60 months post-operative, the SVA values almost returned to the preoperative results and the change in the SVA was only temporary.

There was a statistically significant difference when interbody fusion was used and when it was not used in the post-operative lumbar lordosis angle value; post-operative lumbar lordosis angle decreased by 1.15°, while when interbody fusion was used the angle increased post-operatively by 8.10°

The pelvic incidence was within 9 degrees of the postoperative lumbar lordosis angle value in more than 80% of the cases, this was correlated with better outcome of postoperative low back pain. Therefore, we found that maintaining postoperative pelvic harmony was important in achieving better outcome for surgery.

The VAS improved by 3 points post operatively in these cases and the improvement continued to reach 4 points after 3 months. The 3 months improvement was also significantly better when interbody fusion was used.

The study by Keorochana et al., **[4]** concluded that not using interbody fusion resulted in worse prognosis than when using interbody fusion. The VAS score improved by 2 points when interbody fusion was used.

This was explained in our study that when using interbody fusion, the lumbar lordosis angle is maintained resulting in maintaining postoperative pelvic harmony which was correlated with better outcome of back pain.

Studies by Shiba Y. et al., **[5]**, (Pierre-Olivier Champagne et al., **[6]** also compared different methods for lumbar fixation and both concluded that maintaining post operative lumbar lordosis was associated with better long-term outcome of back pain.

Conclusion:

Maintaining post operative balanced sagittal balance was associated with better outcome of low back pain after surgery. The main factor associated with maintaining a balanced sagittal balance was preserving the lumbar lordosis angle and hence maintaining the pelvic harmony. This was achieved better when interbody fusion was used as a method of fixation.

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علاقة التوازن السهمى ما بعد اجراء جراحة تثبيت الفقرات القطنية بمستوى الام اسفل الظهر من ما بعد اجراء الجراحة

المقدمـــة: الحفـاظ علـى التـوازن السـهمى بعـد جراحـات تثبيـت الفقـرات القطنيـة يعـد مـن التحديـات التـى تواجـه جراحـة المـخ والأعصـاب .

الأهـداف: مقارنـة وسـائل تثبيـت الفقـرات القطنيـة فـى درجـة حفاظهـم علـى التـوازن السـهمى ودراسـة العلاقـة بـين التـوازن السـهمى بعـد الجراحـة ونتيجـة آلام أسـفل الظهـر.

الوســائل: تم حسـاب التـوازن السـهمى قبـل وبعـد الجراحـة للحـالات فـى المجموعتـين ومتابعـة درجـة تحسـن آلام أسـفل الظهـر ومقارنتهـا بنتيجـة حسـاب التـوازن السـهمى بعـد الجراحـة .

النتائـج: وجدنـا أن اسـتخدام الأقفـاص الكربونيـة وشـرائح ومسـامير الظهـر أفضـل مـن اسـتخدام الشـرائح والمسـامير فقـط لتثبيـت الفقـرات فـى الحفـاظ علـى التـوازن السـهمى بعـد الجراحـة. وان الحفـاظ علـى التـوازن السـهمى بعـد الجراحـة يـؤدى إلـى نتيجـة افضـل لآلام أسـفل الظهـر.