Comparative study between posterolateral fusion and transforaminal lumbar interbody fusion regarding their effect on the spinopelvic sagittal balance and outcome of chronic low back pain

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Abstract

Background: A balanced sagittal balance is essential for maintaining the upright position with minimum muscular effort. Maintaining a balanced sagittal balance after lumbar fusion surgery is important for the outcome of surgery.

Aim of work:

The aim of this study is to compare different lumbar fusion surgeries on their effect on the sagittal balance and to assess the effect of the post-operative sagittal balance on the outcome of back pain.

Patients and methods:

Patients were divided into two groups, Interbody fusion group and posterolateral fusion group. The sagittal balance was calculated pre and post-operatively for both groups. The outcome of back pain and disability indices were calculated for both groups post-operatively.

Results:

There was statistically significant difference between the two groups as regarding the lumbar lordosis angle post-operatively. The mean lumbar lordosis angle was higher in the interbody fusion group than the posterolateral fusion group. The 3 months VAS score post-operative was significantly better in the interbody fusion group than in the posterolateral fusion group.

Conclusion:

The interbody fusion group was better than the posterolateral fusion group as regards maintaining sagittal balance post operatively. Maintaining the sagittal balance post-operatively was correlated with better outcome of back pain.

Keywords: sagittal, balance, lumbar, fusion, back, pain

Introduction

Maintaining a balanced sagittal balance is important for maintaining upright position essential for bipedal locomotion with the least muscular effort. Lumbar fusion surgeries have a problem of disrupting the sagittal balance post operatively and hence having a worse outcome of back pain. ***(Wang et. Al,2013)***

Association between the sagittal balance and back pain is recently being recognized. The problem of persistence of back pain post-operatively is of increasing interest as it affects the outcome of surgery. ***(Wang et. Al,2013)***

The aim of this study: To compare transforaminal lumbar interbody fusion to traditional posterolateral fusion on their effect on sagittal balance, To compare the long-term outcome of back pain for the two types of fixation surgeries and To correlate the relationship between maintaining sagittal balance post-operative and the outcome of back pain.

Subjects and Methods

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

Inclusion criteria:

- Patients with degenerative spondylolisthesis indicated for spinal fusion surgery. 2.
- Patients with isthmic spondylolisthesis indicated for spinal fusion surgery.

Exclusion criteria:

- Patients indicated for lumbar surgeries without fusion
- Patients with traumatic lumbar fractures indicated for fusion surgeries
- Patients with spondylodiscitis indicated for fusion surgeries

All cases were operated upon in Kasr El-Aini Hospitals, Cairo University between March 2021 and September 2022.

Follow up was done immediate post-operative, at one week, 4weeks, 3 months post operatively to assess low back pain using visual analogue score (VAS) and degree of disability was assessed using Oswestry disability index score (ODI)

1. Whole spine x-ray images were subjected to a computer software which **calculated sagittal balance** according to the following parameters:

- Lumbar lordosis angle
- Pelvic tilt
- Pelvic incidence
- Sacral slope
- Spine vertical axis (SVA)

Fig.1: calculating sagittal balance

Data is then interpreted and the patients are either sagittally balanced, sagittal balance compensated, or sagittally imbalanced

Statistical analysis:

Data were coded and entered using the statistical package for the Social Sciences (SPSS) version 28 (IBM Corp., Armonk, NY, USA). Data was summarized using mean and standard deviation for quantitative variables and frequencies (number of cases) and relative frequencies (percentages) for categorical variables. Comparisons between groups were done using unpaired t test. Comparison between pre and post was done using paired t test ***(Chan, 2003a).*** For comparing categorical data, Chi square (□2) test was performed. Exact test was used instead when the expected frequency is less than 5 ***(Chan, 2003b).*** P-values less than 0.05 were considered as statistically significant.

All the data that are collected postoperatively are compared with those that were collected preoperatively

The patients are then divided into two groups: posterolateral fusion group and interbody fusion group.

The relationship between the effect of fusion surgery on the sagittal balance and the presence of persistent chronic low back pain will be clinically correlated

In case of improvement of back pain, the rate of improvement and were classified into a four-grade scale:

- Excellent, improvement of above 90%;
- Good, 75–89% improvement;
- Fair, 50–74%; and
- Poor, below 49%.

Results

A. Prevalence values:

- Age:

The mean age for the posterolateral fusion (PL) group was 43.90 years, while the mean age for the trans-foraminal interbody fusion (TL) group was 45.05 years.

- Sex distribution:

The PL group contained 9 males and 11 females, while the TL group contained 9 males and 11 females.

- Levels of fixation:

The PL group contained cases that underwent up to 4 levels of fixation while the TL group contained cases that underwent either single of double level fixation.

B. Sagittal balance parameters:

- The sagittal vertical axis (SVA):

The mean SVA pre in the PL group was 5.38mm and the mean post was 5.32mm, while the TL group showed mean SVA pre 5.38mm and the mean SVA post was 5.25mm.

- Lumbar lordosis angle:

The mean lumbar lordosis angle pre in the PL group 45.20° and the mean post was 44.30°, while the TL group showed mean lumbar lordosis angle pre 43.20° and the mean angle post was 52.05°.

- Sacral slope angle:

The mean sacral slope angle pre in the PL group 33.80° and the mean post was 34.05°, while the TL group showed mean sacral slope angle pre 33.70° and the mean angle post was 35.15°.

- Pelvic tilt:

The mean pelvic tilt angle pre in the PL group 32.00° and the mean post was 32.20°, while the TL group showed mean pelvic tilt angle pre 32.85° and the mean angle post was 34.25°.

- Pelvic incidence:

The mean pelvic incidence angle pre in the PL group 57.00° and the mean post was 54.58°, while the TL group showed mean pelvic incidence angle pre 53.50° and the mean angle post was 54.80°.

C. Evaluation of back pain and disability:

- VAS in the PL group:

The mean pre-operative VAS in the PL group was 7.25, while the post VAS was 4.05 and the 3 months post-operative VAS was 5.25

- VAS in the TL group:

The mean pre-operative VAS in the PL group was 8.10, while the post VAS was 4.65 and the 3 months post-operative VAS was 4.00

- Oswestry disability index (ODI):

The mean ODI pre in the PL group 48.80% and the mean post was 30.15%, while the TL group showed mean ODI pre 48.50% and the mean post was 28.60%

Table 1: mean age

	Mean age	SD	P-value
PL	43.90	7.68	0.624
TL	45.05	7.00	

Table 2: sex distribution

	Males		Females		P-value
PL	9	45%	11	55%	1
TL	9	45%	11	55%	

Table 3: levels of fixation

	1		2		3		4		P-value
PL	3	15%	11	55%	4	20%	2	10%	0.026
TL	8	40%	12	60%	0	0%	0	0%	

Table 4: sagittal vertical axis

	SVA pre		SVA post		P-value	
	Mean	SD	Mean	SD	Pre	post
PL	5.38	1.41	5.32	1.23	1.00	0.860
TL	5.38	1.46	5.25	1.38		

Table 5: Lumbar lordosis angle

	LL angle pre		LL angle post		P-value	
	Mean	SD	Mean	SD	Pre	post
PL	45.20	2.93	44.30	5.22	0.143	<0.001
TL	43.20	5.17	52.05	5.66		

Table 6: Sacral slope angle

	SS angle pre		SS angle post		P-value	
	Mean	SD	Mean	SD	Pre	post
PL	33.80	2.61	34.05	3.72	0.923	0.362
TL	33.70	3.79	35.15	3.82		

Table7: pelvic tilt

	Pelvic tilt pre		Pelvic tilt post		P-value	
	Mean	SD	Mean	SD	Pre	post

PL	32.00	8.66	32.20	8.64	0.765	0.447
TL	32.85	9.48	34.25	8.23		

Table 8: Pelvic incidence

	Pelvic incidence pre		Pelvic incidence post		P-value	
	Mean	SD	Mean	SD	Pre	post
PL	57.00	5.66	54.85	3.53	0.100	0.972
TL	53.50	7.34	54.80	5.13		

Table 9: VAS score

	PL group		TL group		P-value
	Mean	SD	Mean	SD	
VAS pre	7.25	1.37	8.10	1.64	0.173
VAS post	4.05	1.48	4.65	0.89	0.608
VAS 3 months	5.25	1.55	4.00	1.45	0.018

Table 10: ODI

	ODI pre		ODI post		P-value	
	Mean	SD	Mean	SD	Pre	post
PL	48.80	5.80	30.15	14.08	0.866	0.176
TL	48.50	5.39	28.60	11.20		

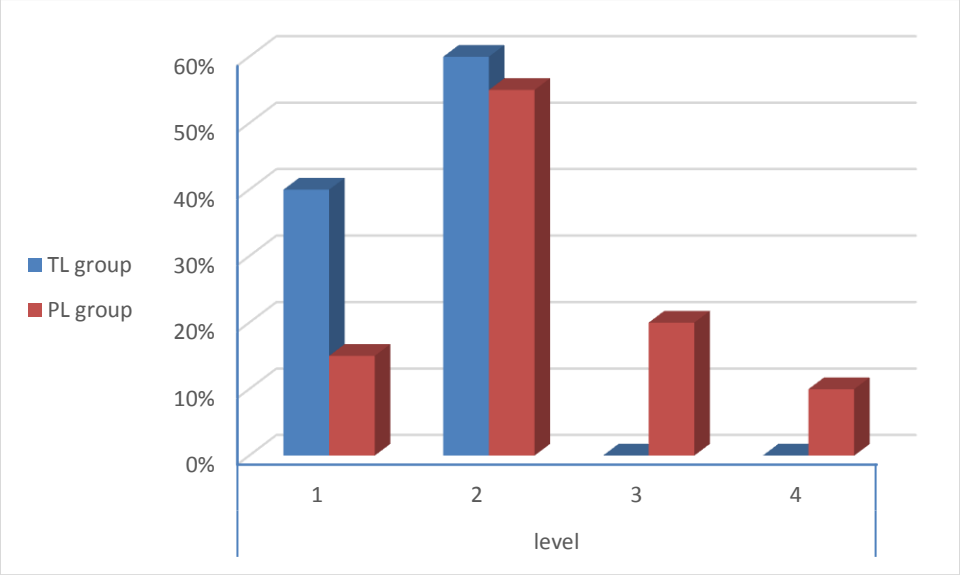

Chart 1: levels of fixation

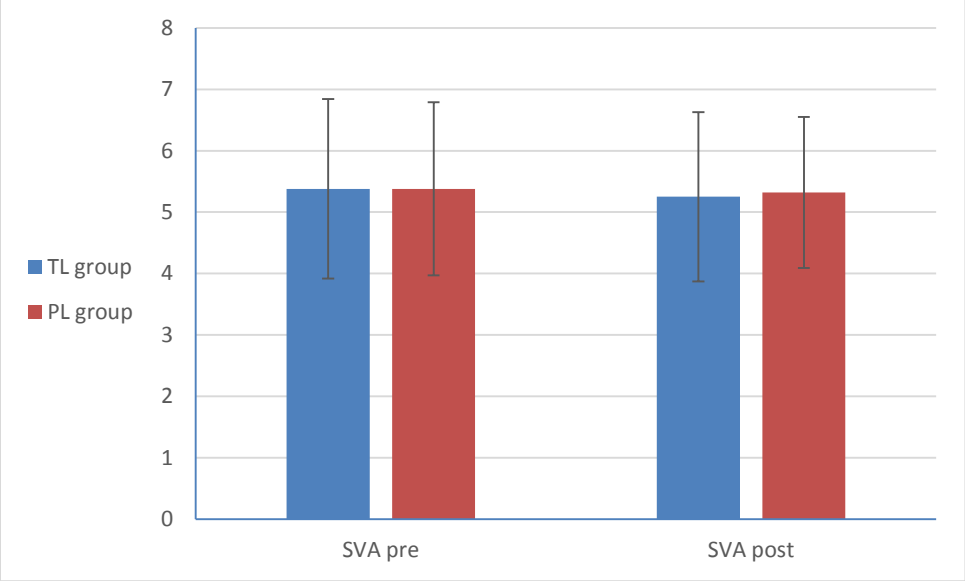

Chart 2: Sagittal vertical axis

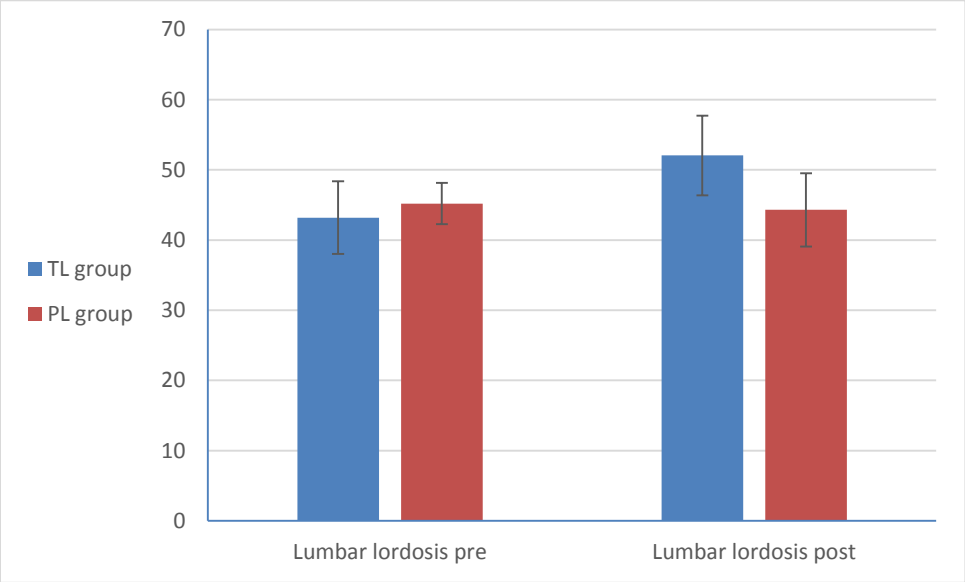

Chart 3: Lumbar lordosis angle

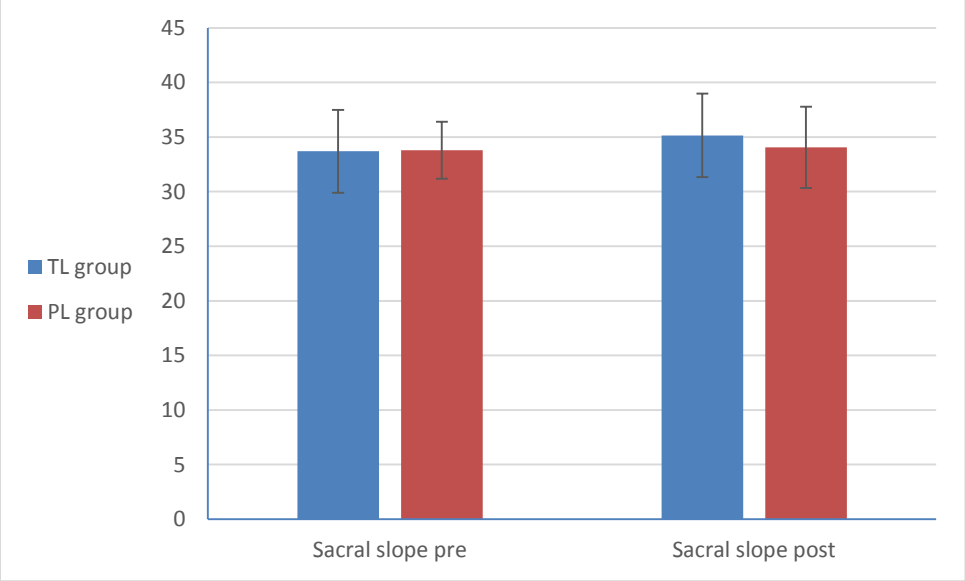

Chart 4: Sacral slope angle

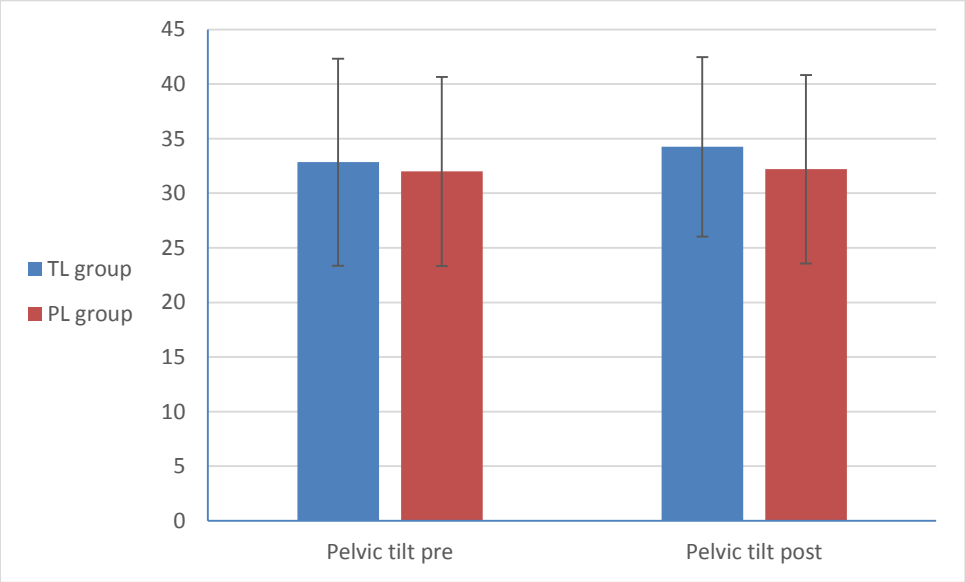

Chart 5: pelvic tilt

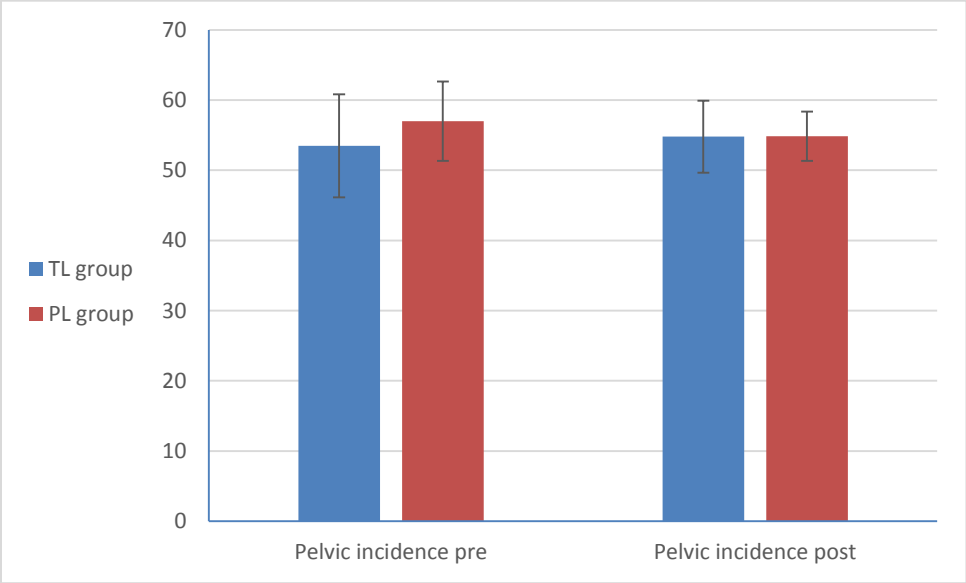

Chart 6: pelvic incidence

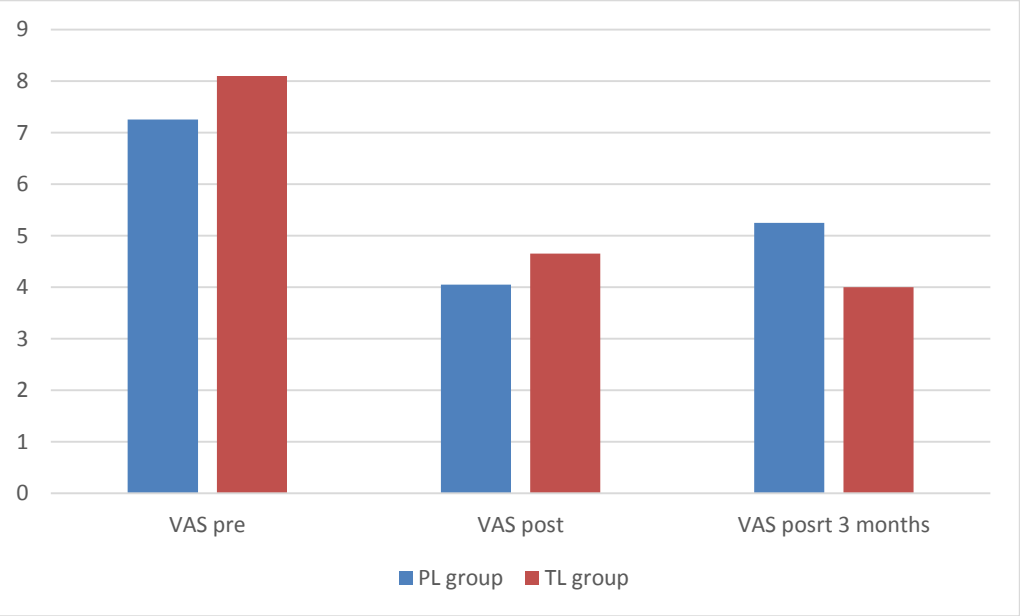

Chart 7: VAS score

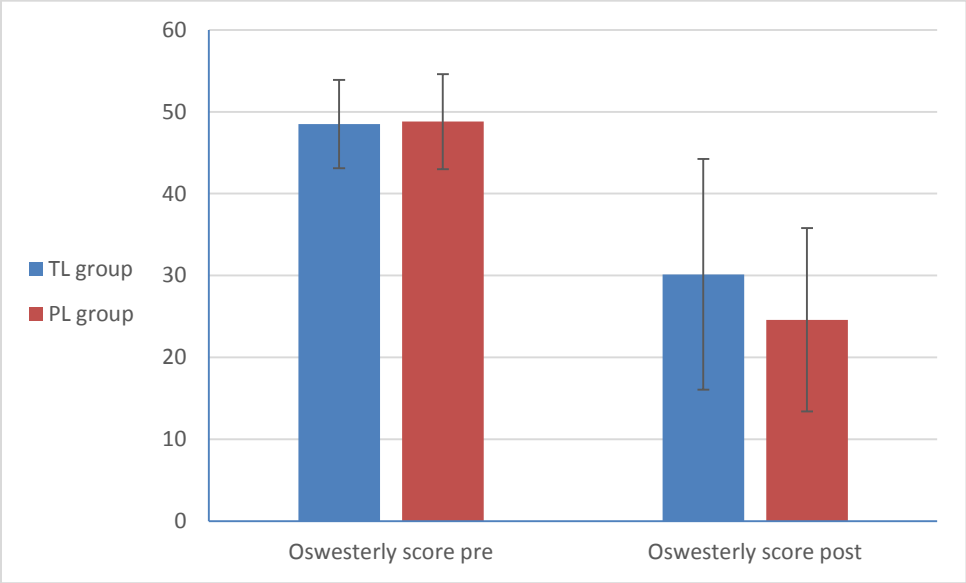

Chart 8: ODI

Discussion

Our study aims to assess the effect of different types of fixation on the spinal sagittal balance. It also assesses the correlation between the sagittal balance with the outcome of back pain post-operatively.

There was a statistically significant difference between the two groups in the number of levels included in fixation. The interbody fusion group was confined only to two levels of fixation, while the trans-pedicular screws group included cases which underwent up to 4 levels with 30% of the cases doing more than two levels.

A study by ***(Wang et. Al,2013)*** showed that lower number of levels included in fixation improved both SVA and lumbar lordosis angle post operatively and hence improved sagittal balance after surgery. This could implement that the better sagittal balance outcome in the interbody fusion group could be correlated with the fact that it included a smaller number of levels of fixation

Regarding the sagittal balance parameters our study resulted in minimal improvement in the SVA in both groups the mean SVA improved by 0.06cm in the posterolateral fixation group and improved by 0.13cm in the interbody fusion group. However, the percentage of improvement from the mean pre-operative SVA in both groups was found to be statistically insignificant.

This is in disagreement with the results found by ***(Wang et. Al,2013)*** which found improvement in the SVA value by 3.1cm and ***(Korovessis et. Al, 2019)*** which found improvement in the SVA value by 2.3cm. Therefore, both found statistically significant initial improvement in the SVA value after lumbar fixation surgeries

However, the study by ***(Korovessis et. Al, 2019)*** followed up SVA after fixation for 60 months and concluded that the initial decrease in the SVA after corrective fixation procedures returned back to the pre-operative values in more than half of the cases.

The main difference between the two groups was in the lumbar lordosis angle. The lumbar lordosis angle decreased in the posterolateral group by 1.10° it increased in the inter body fusion group by 8.85°. the difference between the two groups was statistically significant.

The increase in the lumbar lordosis in our study in the inter-body fusion group was less than the increase in the angle after surgery in the study by ***(Wang et. Al, 2013)*** which was 19.3°. But the increase was less than the increase in lumbar lordosis angle in the study by ***(Yson et. Al, 2014)*** which was 2.5° in the interbody

fusion group and this study showed an increase in the lumbar lordosis angle after posterolateral fixation but by 1.3°.

Regarding the outcome of surgery as regards the low back pain, the VAS score in the posterolateral group improved by 3.2 postoperative but this improvement decreased to 2 after 3 months. While the improvement in the interbody fusion group was 3.45 post-operative but the improvement continued to reach 4.1 after 3 months. This shows that the outcome after 3 months was significantly better in the interbody fusion group.

The study by ***(Keorochana et al, 2017)*** compared the outcome of back pain after pedicle screws fixation with interbody fusion fixation. It concluded that the posterolateral fusion group improved by 2.46 while the interbody fusion group improved by 4.67. These results are in agreement with our study. ***(Wang et. Al, 2013)*** also showed that after maintaining sagittal balance after surgery the VAS score improved by 4.1 which is also in agreement with our study.

This also agrees with our results of ODI post-operative which improved in the posterolateral group by 18.65% and improved in the interbody fusion group by 19.90%, however the difference between the two groups was statistically insignificant.

The study by ***(Yong Hu et. Al, 2019)*** compared the outcome of different posterior fusion modalities compared the outcome of TLIF to bilateral pedicle screws also concluded better outcome for the TLIF group as regards low back pain. This could be due to the fact that the sagittal balance was maintained better in this group.

The results in the interbody fusion group showed mean lumbar lordosis angle 52.05° and mean pelvic incidence 54.8°. The lumbar lordosis is 2.75° less than the pelvic incidence. When the lumbar lordosis is within ±9° from the pelvic incidence this shows that there is proper sagittal balance. This was correlated with a better long-term improvement in the low back pain.

Our study compared pedicle screws to TLIF, a study by ***(Pierre-Olivier Champagne et. Al, 2019)*** compered different types of interbody fusion on their effect on the sagittal balance post-operatively. The study concluded that all methods improved the lumbar lordosis angle and maintained better sagittal balance post-operatively. This is in agreement with our study that interbody fusion is better for the post-operative outcome of the sagittal balance. However, the study concluded that OLIF as a method for interbody fusion had the best results in means of correcting the sagittal balance post- operatively.

Conclusion

The interbody fusion group was better than the posterolateral fusion group in terms of maintaining the sagittal balance. This was because the interbody fusion group was significantly better than the posterolateral fusion group in maintaining the lumbar lordosis angle post operatively. This was correlated with better long term outcome in the low back pain and disability index in the interbody fusion group than the posterolateral fusion group. This shows that maintaining a balanced sagittal balance after lumbar fusion surgeries will result in better long term outcome for the improvement of back pain post-operatively.

Conflicts of Interest: The authors declare no conflict of interest.

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