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## ORIGINAL ARTICLE

# The Effect of Restoration of Lumbar Spine Lordosis During Fixation on Clinical Outcome of Patients

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### ABSTRACT

**Background:** Inadequate restoring of lumbar lordosis during lumbar fusion surgery may result in mechanical low back pain, sagittal unbalance and adjacent segment degeneration<sup>(1)</sup>.

**Objective:** The aim of this work is to study the effect of restoration of adequate lumbar spine lordosis on patient's outcome.

**Patient & Methods** the study was included 24 patients with degenerative lumbar spine disorder, who underwent surgical decompression with fixation and fusion after the failure of conservative management for back pain with or without radicular pain. From June 2018 to April 2019 in Zagazig university hospital.

**Results:** significant improvement was gotten after 6 weeks and 12 weeks follow up VAS (Visual Analog Scale) comparing with pre-operative VAS ( $P < 0.001$ ). Also, the 12<sup>th</sup> weeks postoperative ODI (Oswestry Disability Index) was significantly improved compared with the pre-operative ODI ( $P < 0.001$ ). The degree of lordosis LL (Lumbar Lordosis) post-operative was significantly corrected, increased by 24.5%. And found a significant statistic correlation between correction of LL and clinical outcome ( $P < 0.001$ ).

**Conclusion:** The need for restoration of lordosis during lumbar and lumbosacral fusion is now well-documented in the literature. Instrument the spine in a lordotic position signifies to leave the spine in a painless and balanced position, Improve the outcome. Optimal lumbar lordosis is different for each individual and depends on the spino-pelvic organization of the subject. Analysis of the spinopelvic parameters, especially measurement of pelvic incidence, is a crucial step to determine the theoretical lordosis and therefore the amount of lordosis to restore.

**Key words:** lumbar spine fixation, lumbar lordosis, pelvic incidence, VAS, ODI



### INTRODUCTION

Many factors contribute to producing the normal lumbar lordosis, including that the L5 vertebra is wedge-shaped, with the anterior aspect of the vertebral body being approximately 3 mm higher than the posterior aspect. The intervertebral discs in the lumbar area are also wedge-shaped, especially at the L4-L5 and L5-S1 segments; the intervertebral disc at the L5-S1 interspace has been measured to be 6-7 mm higher anteriorly than posteriorly<sup>(1)</sup>. Lumbar fixation and fusion (vertebral arthrodesis) is one of the most commonly performed procedures in spinal surgery and a well-established treatment for spinal instability resulting from a variety of conditions. Hibbs and Albee were two spine surgeons in 1911, negative health related quality of life and increase the disability<sup>(4)</sup>.

who performed first spinal stabilization surgery<sup>(2)</sup>. Adequate lordosis can be evaluated from the measurement of the pelvic incidence and from the analysis of special organization of the lumbar spine with 67% of the lordosis given by the L4-S1 segment and 85% by the L3-S1 segment<sup>(3)</sup>.

Symptomatic adjacent segment disease (ASD) has been reported to occur in up to 27 % of lumbar fusion patients. A previous study identified patients at risk according to the difference of pelvic incidence and lordosis. Patients without restoration of adequate lumbar lordosis have been found to have a 20 times higher risk for adjacent segment disease ASD, flat-back syndrome. Sagittal misalignment in adult spinal deformity recently has gained increasing attention for its association with

### PATIENTS AND METHODS

Technical design: This prospective study was

carried out in Neurosurgery Department, Zagazig University hospitals at the period from June 2018 to April 2019. The study included 24 cases of lumbosacral instability need fixation and fusion selected according to the inclusion and exclusion criteria listed below. They were 15 females and 9 males of ages ranging from 34-61 years. All were candidate for open posterior lumbosacral surgery.

Written informed consent was obtained from all participants and the study was approved by the research ethical committee of faculty of medicine zigzag university. The work has been carried out in accordance with the code of Ethics of the world medical association (Declaration of Helsinki) for studies involving humans. Inclusion criteria:

Patients admitted to neurosurgery department for lumbar fixation and fusion. Exclusion criteria: Age less than 18 years and above 70 years, Active infections (sepsis, osteomyelitis, discitis and epidural abscess), Patient with knee or hip deformity. Operational design: A-Preoperatively: patients were assessed as regards to: Personal history Complaint of the patient. Present history. Past history. General examination. Neurological examination; Motor examination. Sensory examination. Reflexes. (VAS) visual analogue scale. (ODI) Oswestry Disability Index. Routine labs work up: Radiologically:

X-ray lumbosacral spine (AP & LATERAL & Dynamic views): to identify and grading of instability and to identify the Degree of lumbar lordosis. Lateral pelvic x-ray to identify the pelvic parameters Pelvic Incidence (PI), Sacral Slope (SS), Pelvic tilt (PT). Magnetic resonance imaging (MRI) Calculation of optimum lordosis to restore during surgery: Preoperative Planning and preparation is essential. The first step is to calculate the value of the PI (Pelvic Incidence). The knowledge of the PI permits to determine the expected theoretical values of the lumbar lordosis to be achieved during surgery which is determined by individual spine parameter<sup>(1) (3)</sup>. Barrey and Roussouly reported six classes of PI, ranging from I to VI, each of them with increase of the PI by 10°, with the corresponding normal expected values of the LL according to the PI. PI 40 corresponding to LL 55 and PI 50 corresponding to LL 60 and PI 60 corresponding to LL 65 and PI 70 corresponding to LL 70. About 40% of the lumbar lordosis was located between L5 - S1 and 67 % of the lumbar lordosis was located between L4 and S1 and that 85 % of the lordosis by the L3-S1 segment<sup>(1)(3)</sup>. Relationships between the components of the lumbo-pelvic complex. To determine the amount of lordosis to restore, we have to introduce the concept of theoretical lordosis deriving from the need for congruence between spinal and pelvic parameters<sup>(1)</sup>. The surgical technique:

Midline skin incision above the spinous processes followed by dissection of the subcutaneous layers and the thoracolumbar fascia is incised with Bovie cautery. Once decompression is achieved, the herniated and degenerated disc is then identified by mobilizing the thecal sac using a small nerve root retractor. Further disc is exposed toward the midline. Discectomy is then completed. The endplates are prepared for arthrodesis and fusion. Disc endplate shavers are used to shave of the endplates placing sequentially bigger shavers in the disc space until resistance is encountered. Metal PLIF spacer is placed along the disc space for measurement purposes and a lateral lumbar X-ray obtained to confirm the choice of the cage height. Anteroposterior and lateral X-rays are used to verify that the cages are in an adequate position. A lateral fluoroscopic X-ray used to locate the pedicle before screw placement. Lateral fluoroscopy used during this process to visualize the path of the probe. An appropriate tap is then introduced followed by the appropriate sized polyaxial-screw. Intraoperative fluoroscopy is used to monitor appropriateness. The initial configuration of the spinal rod is usually straight and intraoperative contouring of the rods is required in order to match the physiologic lordotic spinal curve, the amount of rod contouring depends on the amount of lordosis required to achieve. The rod bender tool is used for rod contouring. By using French benders intraoperative contouring tool. The French bender uses a lever mechanism to bend the rod around arc. The degree of rod bending depends on the previous calculation of the target degree of lumbar lordosis and the level of lumbar spine segment of fixation and fusion. Then the rod is connecting with the screws. C-arm x-ray lateral view obtained to confirm the target degree of lordosis is achieved or not by using the (surgimap)<sup>(12)</sup> application, if not rod re-contouring is necessary. The screws are connected with the rod by using set screws that are tightened to the appropriate amount of torque. The wound is closed in layers with suction drain underlying the lumbodorsal fascia.

C- Postoperatively: All patients were assessed as regards to: Clinically: General examination, Neurological examination; Motor. Sensory. Reflexes, Visual analogue scale (VAS) first day post op and 6 weeks post op and 12 weeks post op, Oswestry Disability Index (ODI). Radiologically: X-ray (AP / LATERAL): to assess lumbar alignment after fixation and degree of lumbar lordosis.

Statistical analysis Data collected throughout history, basic clinical examination, laboratory investigations and outcome measures coded, entered and analyzed using Microsoft Excel software. Data were then imported into Statistical

Package for the Social Sciences (SPSS version 20.0) (Statistical Package for the Social Sciences) software for analysis. According to the type of data qualitative represent as number and percentage, quantitative continues group represent by mean  $\pm$  SD, the following tests were used to test differences for significance; difference and association of qualitative variable paired by Mac Nemmar . Differences between quantitative paired groups by paired t test. P value was set at  $<0.05$  for significant results &  $<0.001$  for high significant result.

### RESULTS

**Table (1):** Co- morbidity distribution among studied group:-

54.1% were with no co-morbidity and 45.9 % with comorbidity majority were HTN 20.8%, DM 16.7% and DM & HTN 8.4%

**Table (2):** Fixation level distribution among studied group:-

Fixation level was distributed as 29.2% for L4-5 & L5-S1, L4-5-S1 33.4% and L3-4-5 with 8.3%.

**Table (3):** Change assessment among studied group: -

We found no significant improvement between pre and immediate post OP VAS but Significant improvement increase between VAS pre and 6 weeks post op and 12 weeks post op. ODI significantly improved from pre to 12 weeks, lordosis score significantly increased.

**Table(4):**Post-operative complication distribution among studied group

12.5 % were complicated from studied group

**Table (5):** Relation between post-operative complication and other parameters

No significant difference or association Relation between post OP complication and other parameters.

**Table (1):** Co- morbidity distribution among studied groups: -

		N	%
Co-morbidity	No	13	54.1
	D.M	4	16.7
	D.M-HTN	2	8.3
	HTN	5	20.8
	Total	24	100.0

**Table (2):** Fixation level distribution among studied group: -

		N	%
Fixation level	L3-4-5	2	8.3
	L4-5	7	29.2
	L4-5-S1	8	33.4
	L5-S1	7	29.2
	Total	24	100.0

**Table (3)** Change assessment among studied groups: -

	Mean	Std. Deviation	Paired t	P
VAS pre	68.0769	12.50641	1.669	0.121
Immediate post VAS	63.0769	8.04634		
VAS pre	68.0769	12.50641	3.121	0.009*

	Mean	Std. Deviation	Paired t	P
Post-6W-VAS	56.1538	7.67948		
VAS pre	68.0769	12.50641	12.865	0.00**
Post-12W-VAS	37.3077	12.18185		
ODI-PRE	17.8462	5.85118	4.416	0.001**
POST-12W-ODI	13.8462	4.09279		
Lordosis PRE	43.1538	4.54324	-10.579	0.00**
Lordosis POST	52.4615	3.35697		

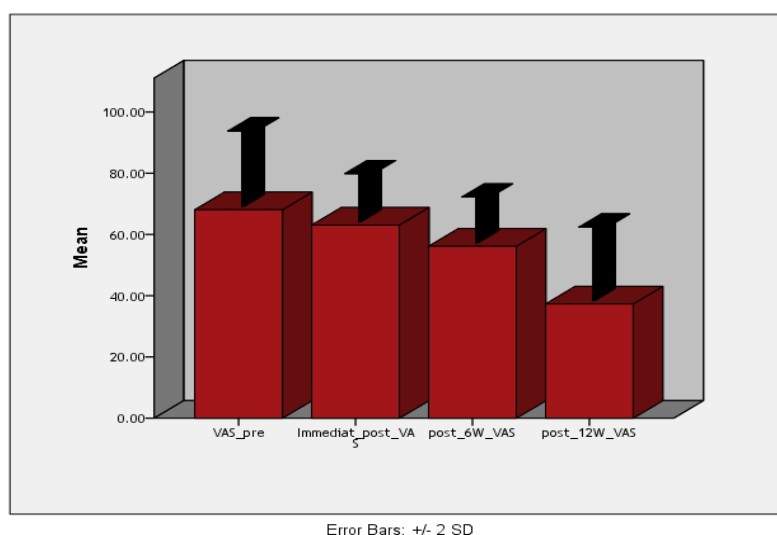
**Table (4): Post-operative complication distribution among studied group:-**

		N	%
Post op complication	No	21	87.5
	Yes	3	12.5
	Total	24	100.0

**Table (5) :Relation between post-operative complication and other parameters:-**

			Not complicated	Complicated	t/X <sup>2</sup>	P
Age			47.7±8.95	50.0±6.55	0.408	0.691
Sex	Female	N	15	2	2.05	0.2
		%	63%			
	Male	N	9	1		
		%	37 %			
Comorbidity	No	N	13	1	4.19	0.24
		%	54%	8%		
	D.M	N	4	1		
		%	16.7%	25%		
	D.M-HTN	N	2	0		
		%	8.3%	0 %		
	HTN	N	5	1		
		%	20.8%	20%		
Fixation level	L3-4-5	N	1	1	6.84	0.16
		%	8.3%	50%		
	L4-5	N	6	1		
		%	29.3%	14.2%		
	L4-5-S1	N	7	1		
		%	33.4%	12.5%		
	L5-S1	N	7	0		
		%	29.2%	0.0%		
PI			43.1±3.41	42.66±4.04	0.186	0.856
VAS pre			68.5±10.55	66.66±20.81	0.214	0.835

	Not complicated	Complicated	t/X <sup>2</sup>	P
Immediate post VAS	65.0±7.45	56.66±7.63	1.691	0.119
Post 6W VAS	57.0±8.23	53.33±5.77	0.710	0.492
Post 12W VAS	38.5±9.7	36.33±10.36	0.628	0.543
ODI_PRE	16.6±5.8	22.0±7.0	1.049	0.317
POST_12W_ODI	14.2±4.6	16.0±5.5	0.583	0.572
Lordosis PRE	42.9±4.58	44.0±5.29	0.354	0.730
Lordosis POST	52.5±3.06	52.33±5.03	0.072	0.944



**Figure (1):** VAS Changes assessment among studied group

## DISCUSSION

The study included 24 patient with radiological and clinical finding of degenerative lumbar spondylolisthesis, who underwent surgical decompressive laminectomy with fixation and fusion after the failure of conservative management for back pain with or without radicular pain. From June 2018 to April 2019 in Zagazig university hospital. All patients had a history of failure of conservative treatment for almost six months. The aim of the surgery is decompression thus to achieve the best spinopelvic sagittal alignment during fixation and fusing of the level involved.

**Patient population** All patients included in this study selected according to the inclusion and exclusion criteria. They were 9 male 37.5% and 15 female 62.5%. The mean age was 48±8 years, range from 34y to 61y. Patients were evaluated preoperatively and observed during surgery and followed after surgery for a period of 6 weeks and further evaluation after 12 weeks. Fixation level was distributed among the study group as L4-5 level 7 patients (29.2%), L5-S1 level 7 patients (29.2%), L4-L5-S1 level 8 patients (33.4%) and L3-L4-L5 were 2 patients (8.3%). The PI Among the study group was distribution as the mean 43.29±3.26° (range 38°-50°). The preoperative degree of lumbar lordosis LL was mean 43.5±4° (range 23°-51°). Increasing postoperative by 24.5%

to mean 52.46°±3.3 (range 41°-58°). While the post-operative LL and PI-LL ratio of patients were evaluated and considered acceptable according to the normative range that introduced by Schwab. Barrey . Change assessment among the studied group Our results are in accordance with previous studies showing that restoration of lumbar spine lordosis is strongly correlated with improvement of clinical outcome using the ODI and VAS as measurements to evaluate the clinical outcome. In this study, we found mild improvement of immediate post-operative VAS comparing with the pre-operative VAS (P=0.121), But the significant improvement was gotten after 6 weeks and 12 weeks follow up VAS comparing with pre-operative VAS (P<0.001). Also, the 12th weeks postoperative ODI was significantly improved compared with the pre-operative ODI (P <0.001). The degree of lordosis LL post-operative was significantly corrected, increased by 24.5%. And found a significant statistic correlation between correction of LL and clinical outcome (P <0.001).In agreement with our study. Eskilsson, et al. 2017<sup>(5)</sup> have reported that the most crucial factor for a good outcome is the sagittal balance. And found that spinopelvic measures of sagittal balance had the strongest correlation with the clinical outcome. Kawakami, et al. 2002<sup>(6)</sup> Follow-up assessment found a significant correlation between



the correction of lumbar lordosis and recovery rate. Severe low back pain and lower recovery rate were observed in patients with an in situ fusion. And a fund that significant poorer outcome was observed in patients with in situ fixation and fusion than post-operative balanced patients. In 2011 Chale, Roussouly<sup>(7)</sup> evaluates the sagittal spino-pelvic alignment in prospective cohorts of 198 patients with chronic LBP and 709 control group. When comparing Patients with chronic LBP and controls, In particular, there was a greater proportion of chronic LBP patients with low LL, suggesting the relationship between this specific pattern (loss of LL) and the presence of chronic low back pain. Another study by bourghli et al. 2011<sup>(8)</sup> in prospective study included 30 patients to evaluate surgical management of low grade isthmic spondylolisthesis showed good clinical outcome with restoration of correct values of lumbar spine alignment dependent spino-pelvic sagittal balance parameters. In this study the mean lumbar lordosis measured from L1 through S1 changed significantly compared to preoperative values increasing by 24.5% than the pre-operative degree. The mean degree of pre-operative LL was  $43.15^{\circ} \pm 4.5^{\circ}$  (Range  $23^{\circ}$ - $51^{\circ}$ ). And mean post-operative degree of LL was  $52.46^{\circ} \pm 3.3$  (Range  $41^{\circ}$ - $58^{\circ}$ ). Increasing by  $10.57^{\circ}$   $P=0.00^*$  that represent a significant improvement of LL degree.

In agreement with our study Boissière et al.<sup>(9)</sup> in study included 53 patients with an average age of 61 years (range 27–79). And the mean Lumbar lordosis was  $34^{\circ}$  preoperative and  $46^{\circ}$  postoperative, Increased by 37% find more significant correlation between correction of LL and clinical outcome, and reported that the LL/PI ratio was a predictor for the need of surgical intervention. And considered that the LL/PI ratio mismatch is an indicator for sagittal balance correction and restoration of lordosis. In our study the mean pre-operative VAS of patients was  $6.8 \pm 1.2$  (Range 9-5) and improved immediately after surgery to  $6.3 \pm 0.8$  by 7.35% (Range 7-4). ( $P=0.121$ ). Then it's more significantly improved after 6 weeks follow up by 17.5% to mean  $5.6 \pm 0.7$  (Range 7-2) ( $P=0.009$ ). And more significantly improvement of VAS was obtained after 12 weeks follow up by 45.5% to mean  $3.7 \pm 1.2$  (Range 5-1) ( $P=0.00^{**}$ ). VAS improvement were also associated with post-operative degree of lumbar lordosis LL. That indicate positive correlation between VAS improvement and LL correction. But no correlation of VAS improvement with age and sex and comorbidity and PI. Similarly the ODI significantly improved after 12 weeks post-operative by 22.5% from  $17.8 \pm 5.8$  (Range 46 - 8) preoperative to  $13.9 \pm 4.09$  (Range 24-2) following

the corrective lumbar lordosis ( $P=0.00^{**}$ ). ODI improvement was significantly correlated with postoperative degree of lumbar lordosis, but no correlation with age and sex and comorbidity and PI. In agreement with our study Kim et al., 2011<sup>(10)</sup> in retrospective study find the mean VAS for patients was 6.83 before surgery and this improved after surgery to 2.50 the mean ODI was 46.4% before surgery, improved after surgery to 21.5% mean VAS at last follow up assessments improved by 53.3%. VAS improvements found to be significantly related to postoperative lumbar lordosis ( $P=0.003$ ). Similarly, ODI improvements were also found to be significantly associated with postoperative lumbar lordosis ( $P=0.024$ ). Pavlov et al. 2004<sup>(11)</sup> were operate 52 patients for outcome assessment and restoration of lumbar lordosis. Prospectively followed for 4 years. The final ODI at 4 year follow up observation significantly different ( $P=0.00^*$ ) than the mean preoperative value of 45 dropped to 24 points. VAS scores showed a very similar pattern ( $P=0.00^*$ ). This pattern was not significantly different for single- or double-level patients. There was no effect of sex, age, body mass index, or length on clinical outcome.

## CONCLUSION

To conclude, the need for restoration of lordosis during lumbar and lumbosacral fusion is now well-documented in the literature and well-admitted by spine surgeons. Instrument the spine in a lordotic position signifies to leave the spine in a painless and balanced position, Improve the outcome. Optimal lumbar lordosis is different for each individual and depends on the spino-pelvic organization of the subject. Analysis of the spinopelvic parameters, especially measurement of pelvis incidence, is a crucial step to determine the theoretical lordosis and therefore the amount of lordosis to restore.

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