Intraoperative and postoperative segmental lordosis mismatch: analysis of 3 fusion techniques

Luca Ricciardi[1], Vito Stifano[1], Luca Proietti[2], Andrea Perna[2], Giuseppe Maria Della Pepa[1], Giuseppe La Rocca[1], Alessandro Olivi[1], Filippo Maria Polli[1]

[1]Department of Neurosurgery, Catholic University, Rome, Italy
[2]Department of Spinal Surgery, Catholic University, Rome, Italy

Introduction

Lumbar lordosis (**LL**) and sagittal spinal alignment strongly correlate with a patient's quality of life, and most patients affected by lumbar degenerative disorders have a significant **loss of lordosis (LoL)** at either the affected segment or globally at the lumbar spine. Surgical restoration or improvement of LL is a major target in spinal surgery. Despite ongoing efforts to develop more precise surgical plans, **surgical procedures fail to achieve the planned LL in approximately one-third of the cases**.

Objective

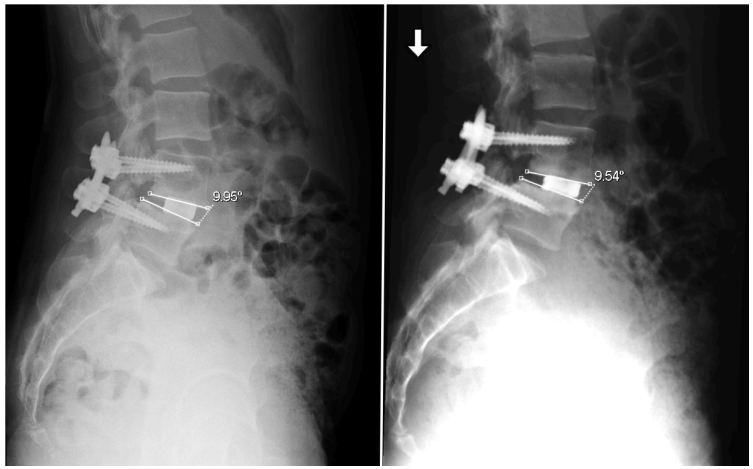
Measure the difference between intraoperative and postoperative single segment lordosis angles, that is the **segmental loss of lordosis (sLoL),** in patients who underwent single-level arthrodesis for lumbar degenerative diseases.

Materials and methods

We retrospectively reviewed all adult patients affected by **single-segment** degenerative disk disease (**DDD**) who underwent:

- open posterolateral instrumentation (**PLI**) **alone** (**Group I**);
- **PLI** + transforaminal lumbar interbody fusion (titanium **TLIF** with 12° of lordosis) (**Group II**);
- **PLI** + extreme lateral lumbar interbody fusion (titanium **XLIF** with 10° of lordosis) (**Group III**).

Figure 1



We measured **segmental lordosis** (**SL**) (fFgure 1) on intraoperative digital x-ray lateral projection images taken **immediately post fixation** (image on the left) with the patients in a prone position and on **postoperative upright** lateral view digital x-ray images taken before patient discharge (image on the right)

We used Gretl free source software and appropriate statistical tests for statistical analysis and a P value < 0.05 was considered significant.

Results

93 patients (34 M, 59 W), mean age 57 (43–77) years, mean BMI 23 (18–29);
Group: - **I** (**PLI alone**): 26 pts (28%);
- **II** (**PLI+TLIF**): 43 pts (46%);
- **III** (**PLI+XLIF**): 24 pts (26%).

Table 1. Mean **intraoperative and postoperative lordosis values** in each group according to the three techniques at each segment.

Level	Group	No of patients	IO mean (°)	PO mean (°)	mean sLoL (°)	mean sLoL (%)
L3–L4	I	7	6.77±0.93	6.01±0.79	0.76±0.21	11.1±2.58
	II	9	6.70±1.27	6.12±1.04	0.58±0.29	8.32±3.72
	III	13	8.35±1.95	8.08±1.85	0.27±0.20	3.05±2.22
L4–L5	I	8	12.65±1.53	11.11±1.48	1.54±0.13	12.28±1.51
	II	20	8.23±1.01	7.45±0.93	0.78±0.28	9.43±3.31
	III	11	10.46±4.16	10.00±4.05	0.46±0.21	4.71±2.23
L5–S1	I	11	13.95±1.59	12.68±1.54	1.27±0.34	9.17±2.65
	II	14	15.78±2.35	14.76±3.07	1.02±0.50	6.31±2.71

IO: intraoperative; PO: postoperative; sLoL: segmental loss of lordosis

Figure 2. Loss of lordosis (**LoL**) for the indicated techniques at each vertebral level.

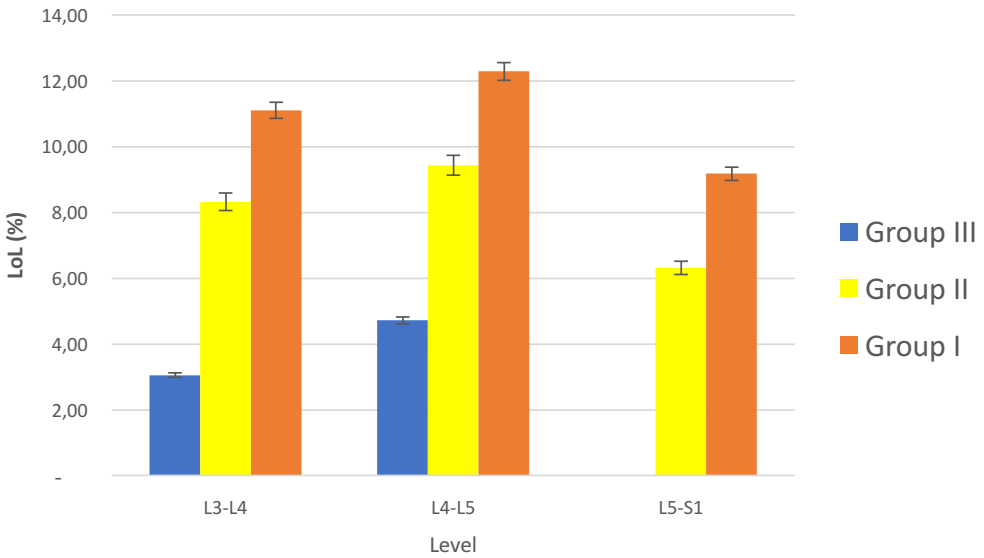


Table. 2. Statistical analysis comparing **loss of lordosis** at each level and according to surgical technique

Segment	Group II vs I	Group III vs I	Group III vs II
L3-L4	0.12	<0.001	<0.001
L4-L5	0.03	<0.001	<0.001
L5-S1	0.01	\	\

Discussion

Interbody cages clearly reduce postoperative mechanical stress on screws and rods, limiting LoL.

Group III (pPLI + XLIF) shows the **lowest LoL** in all segment treated.
Group II (pPLI + TLIF) showed lower LoL than **Group I (PLI alone)** in all segments ($P < 0.05$), except L3-L4 ($P = 0.12$).

PLI alone had a **higher rate of LoL**, underscoring the importance of LoL in longer fixation with PLI alone, which could lead to a *systematic radiologic undercorrection*, although this may not be clinically relevant.

Our study is the **first to quantify the discrepancy between intraoperative and postoperative segmental lordosis**.

A better understanding of this phenomenon at a single level could allow us to elucidate the mechanical and biologic factors that determine the overall sagittal outcome.

Our study has several limitations. This was a retrospective study of a small number of cases, and the correlation between the variation of SL and LL of the sagittal vertical axis was not investigated. Furthermore, the evaluation of sagittal vertical axis might help determine the distribution of the axial load, which could contribute to the LoL, but most of our patients did not undergo a full spine x-ray examination. According to our study's purpose, there is no follow-up investigation, both clinical and radiologic, even if it could be useful to evaluate many factors, such as prosthesis subsidence and subsequent additional LoL.

Conclusions

Correction of lumbar lordosis remains a major challenge in spinal surgery.

The well-documented mismatch between the preoperatively planned segmental lordosis correction and final result impacts the radiologic outcome and depends on the chosen surgical fixation technique and on the vertebral segment involved.

In this study, the **pPLI + XLIF fixation technique showed the smallest loss of lordosis**, while **PLI alone showed the greatest one**.

Further studies are needed to better understand this phenomenon and could help identify factors that could **improve the planning** of intraoperative segmental and global corrections.