

## 4. Benefits of preoperative planning in degenerative indications

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### Background

Primary surgical aims of spinal fusion are improvement of pain, adequate decompression of nerve roots, stability with perfect implant positioning, and correction of deformities if necessary. Secondary goals are to achieve a solid fusion and to avoid recurrent pain and subsequent surgery. However, problems associated with fusion include implant-related complications such as screw misplacement, pseudarthrosis, and screw loosening, as well as biomechanical problems including adjacent segment disease (ASD). In fact, the ASD related revision rate 15 years after circumferential lumbar fusion is 37.5%<sup>1</sup>. Natural progression of the degenerative disease is often cited as the reason, but in many cases a common problem can be identified, namely hypolordosis of the fused segment.

### Which are major drivers for ASD?

There is evidence that age > 60 years is one risk factor for ASD. PLIF also increases the risk for ASD by a factor of 3.4 compared to TLIF<sup>2</sup> and an uncorrected mismatch between lumbar lordosis (LL) and pelvic incidence (PI) by a factor of 10<sup>3</sup>. A recent study shows that fusion in non-physiological kyphosis or hyperlordosis causes high stress on the adjacent intervertebral discs<sup>4</sup>. In a healthy spine, the lumbar vertebral segments are always in lordosis, and the lordotic angle increases from cranial to caudal. If a segment is placed in hypolordotic alignment, this will result in an anterior shift of the plum line or compensatory erection of the adjacent segments with hyperlordotic disc angles. This is a typical mechanism for ASD.

### How to prevent ASD?

The use of TLIF instead of PLIF is a possible option to reduce ASD rates. LL and PI should be matched and adjacent segments be protected from unnecessary stress by fusion in anatomical lordosis. Literature indicates that in the lower lumbar spine, fusion segments with a lordosis angle greater than 15° have significantly less ASD<sup>5</sup>.

### What do we need to plan a short lumbar fusion?

Upright lumbar spine radiographs showing the femoral heads are required to measure PI (sacral slope + pelvic tilt), LL, L4-S1 angulation and segmental angulation. From these data, one can calculate the angles to be obtained intraoperatively for a PI-matched LL (0.54 x PI + 27.6; acc. to Le Huec), optimal L4-S1 angulation (2/3 of LL) and segmental angulation (L5/S1: 40% of LL; L4/5: 27% of LL; L3/4: 18% of LL). For a rebalancing short TLIF, adequate release, anterior cage position, perfect cage height, and intraoperative measurement of lordosis are mandatory.

### Conclusions

Non-anatomic fusion is a possible trigger for ASD. The potential key to long-term success is restoration and anatomic distribution of LL. To achieve this, detailed preoperative planning is required for each fusion case.

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