INFLUENCE OF A VERTEBRAL MISALIGNMENT AFTER TOTAL DISC REPLACEMENT ON FACET JOINT FORCES, CAPSULE TENSILE FORCES AND CLINICAL OUTCOME

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Introduction

Total disc replacement (TDR) is a commonly executed therapy concept for painful degenerative disc disease. However, facet joint degeneration (FJD) at the index level has been frequently reported after the implantation of an artificial disc. The progression of FJD at the index level was accompanied by a reduced range of motion (RoM; [Siepe et al, 2010]). To date, there is no biomechanical explanation why FJD and reduced RoM are associated with each other. In the present study, it is hypothesised that a surgery-related misalignment of the vertebrae adjacent to an artificial disc reduces RoM and increases facet joint or capsule tensile forces.

Methods

A probabilistic finite element analysis was performed using a validated lumbosacral spine model [Zander et *al*, 2009] with an artificial disc at level L5/S1. A surgery-related misalignment is reflected by an anterior or posterior displacement of the vertebra L5 relative to the sacrum. In this study the misalignment was varied between -2 and +2 mm. Besides the misalignment clinically important factors such as the gap size of facet joints, the transection of the posterior longitudinal ligament, and the spinal shape [Roussouly et *al*, 2005] were varied in 400 calculations using Latin hypercube sampling. Each combination was loaded with pure moments in the anatomical main planes.

Results

An anterior or posterior misalignment alters the segmental lordosis and loading at the index level. The misalignment of the L5 vertebra reduced the RoM in all anatomical main planes by up to 2° (Fig. 1) and it has by far the greatest effect on facet joint forces or capsule tensile forces. In extension, lateral bending, and axial rotation an anterior misalignment increases facet joint forces to values between 280 and 380 N, while flexion caused maximum forces of approximately 200 N (Fig. 2). The maximum facet capsule forces were increased by a posterior misalignment to values between 120 and 230 N.

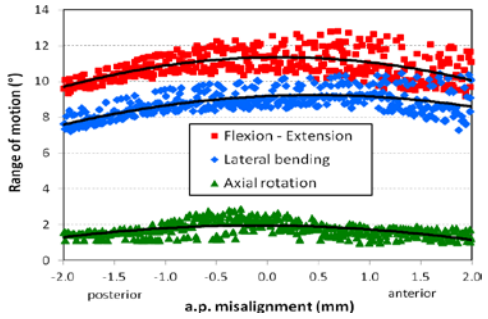

Figure 1: Effect of an anterior or posterior misalignment on RoM. The trendlines have their maximum for small a.p. misalignments.

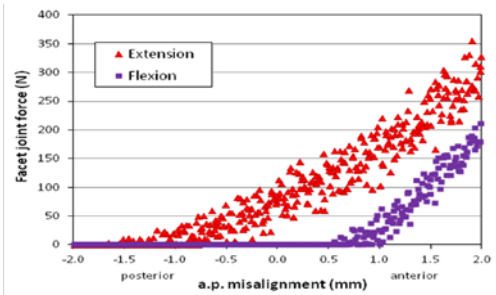

Figure 2: Influence of a misalignment on contact facet joint forces for flexion and extension.

Discussion

A misalignment reduces the RoM and strongly increases facet joint forces or capsule tensile forces, which corroborates the hypothesis. It might therefore be an important reason for unsatisfactory clinical results. In a related clinical study on patients with TDR the misalignments were radiologically measured and patient's satisfactory was evaluated. Using these data, the numerical predictions were confirmed and it was shown that a misalignment affects the clinical outcome.

References

Siepe et *al*, Spine, 35:1991-2003, 2010.
Zander et *al*, Clin Biomech, 24:135-42, 2009.
Roussouly et *al*, Spine 30:346-353, 2005.