BIOMECHANICAL ALTERATIONS AFTER SPINAL FUSION TREATMENT AND THEIR RELATION TO CAGE SUBSIDENCE

Siddarth Ananth Swaminathan (1), Luis Becker (2), Nima Taheri (2), Matthias Pumberger (2), Hendrik Schmidt (1), Sara Checa (1)

1. Berlin Institute of Health at Charité – Universitätsmedizin Berlin, Julius Wolff Institute, Germany

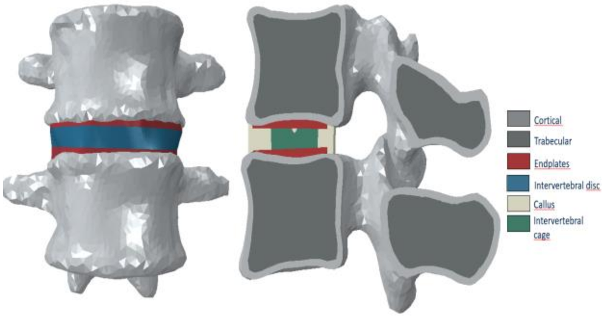
2. Center for Musculoskeletal Surgery, Charité - Universitätsmedizin Berlin, Deutschland

INTRODUCTION

Endplate fractures with cage subsidence after spinal fusion are a severe complication after discectomy and cage implantation which can lead to revision surgery (1). Cage subsidence may occur intraoperatively due to surgical damage of the endplate, but likewise occur postoperatively after an asymptomatic time interval (2). Accordingly, different underlying patho-mechanisms might be assumed. The aim of this study is to investigate the biomechanical changes that occur in the involved vertebral bodies after spinal fusion and to investigate their potential link to the risk for cage subsidence.

MATERIALS AND METHODS

A finite element model of an L1-L2 intact lumbar spine was developed from CT scans (Fig. 1a). The model includes the cortical shell, trabecular bone, intervertebral disc, cartilaginous endplates and 7 major ligaments. A lumbar fusion was simulated by removing the intervertebral disc and inserting an intervertebral cage (Fig. 1b). Linear elastic homogeneous properties were used for vertebral bodies, cartilaginous endplates, callus and intervertebral cage while hyper-elastic properties were used for annulus fibrosus and annulus pulposus. The contact between the facet joints was modelled as a frictional surface-surface contact. A compressive load of 500N was applied on the cranial face of the L1 segment, while the caudal face of the L2 segment was restrained of movement. A mechano-regulation algorithm simulating the spinal fusion process [3] was implemented to predict the bone tissue distribution after complete fusion.



(a) *(b)*

Figure 1: (a) Finite element model of intact L1-L2 segment (b) Finite element model of the L1-L2 segment after surgery including a callus and an intervertebral cage.

RESULTS

Compressive strains in the adjacent vertebral bodies were different in the intact model compared to the fusion model post-surgery (Fig. 2). Lower strains in the adjacent vertebral body were predicted in the intact compared to the fusion model. In addition, compressive strains were different between the post-surgery situation and after the bone fusion had occurred. Lower strains were predicted after complete fusion (Fig. 2), however strains were still higher than in the intact case.

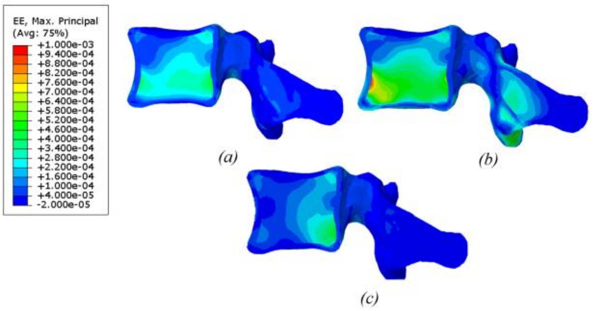


Figure 2: Principal strains (a) Intact L1 segment before surgery (b) Surgical L1 segment post-surgery (c) Surgical L1 segment at the end of the fusion process.

DISCUSSION AND CONCLUSION

Cage subsidence after spinal fusion remains a clinical challenge. Here, we developed a computer model to investigate the mechano-biological regulation during spinal fusion and its potential link to cage subsidance. Preliminary results show increased vertebral strains after spinal fusion and cage implantation, which may explain the risk of cage subsidence especially in the short term. In the future, we will investigate how these biomechanical alterations relate to tissue degeneration processes after fusion surgery.

REFERENCES

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