

## Biomechanical Comparison between Fusion, TDR and Dynamic Stabilization

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### Introduction

For the treatment of many degenerative disc diseases of the cervical spine, spinal fusion still represents the standard treatment. However, long term clinical studies have shown evidence of an increased incidence of pathologies in the adjacent levels [1,2,3]. More specifically, an increased mobility and increased intradiscal pressure (IDP) in the adjacent segments after a cervical fusion were observed in biomechanical studies [4,5,6].

As an alternative to spinal fusion, more motion-preserving intervertebral disc-prostheses have been developed which permit some retained mobility in the affected level. Aim of this study was to biomechanically compare cervical fusion, total disc replacement and dynamic stabilization with regards to kinematic parameters, as well as their influence on the adjacent levels.

### Materials/Methods

Five ovine multi-segmental C2-C5 specimens were tested under pure moment loading by means of a sensor-guided serial robot ( $\pm 2$  Nm) while loaded with a follower load of 120 N. The tested motion consisted of flexion/extension, lateral bending and axial rotation. Initially, the physiological intact state of the specimens was investigated, and subsequently with a dynamic DCI™ implant (Paradigm Spine) placed at the C3/C4 level, an activ<sup>®</sup> C (Aesculap) disc prosthesis, and finally with a simulated fusion performed using a CeSpace<sup>®</sup> cage und CASPAR<sup>®</sup> plate (Aesculap).

The analysis was performed according to the Hybrid Test Method suggested by Panjabi [7]. The parameters total range of motion, inter-segmental range of motion (iROM), neutral zone, and intradiscal pressure (IDP) were compared.

### Results

In flexion/extension, the treated segment was dynamically stabilized by the DCI™ with some remaining residual mobility (iROM<sub>C3/4</sub> -20%). No significant change in kinematics (iROM<sub>C2/3</sub> -7%, iROM<sub>C4/5</sub> +15%) was observed in the adjacent levels (wilcoxon test). With the prosthesis, the physiological range of motion was almost preserved in the three levels with no significant change in the iROM. After fusion, iROM<sub>C3/4</sub> was decreased significantly ( $p=0.043$ ) by around -93%. In the cranial segment C2/3, the change in the iROM was also significant with +99% ( $p=0.043$ ).

In lateral bending, the treated segment was stabilized significantly (iROM<sub>C3/4</sub> -66%,  $p=0.043$ ) without significant changes in the kinematics and IDPs of the adjacent levels. The prostheses preserved the physiological motion in the three tested segments as well. After fusion the iROM in C3/4 was significantly reduced (-89%) without significant changes in kinematics in the adjacent levels.

### Discussion

Based on these biomechanical findings, we conclude that the DCI™ implant could indeed provide an alternative to fusion and total disc replacement in the cervical spine. In particular, the facet joint osteoarthritis and kyphotic deformity, as a contraindication to the arthroplasty, could be a clinical application of the dynamic DCI™. Indeed, initial clinical studies [8] have shown good results, but these are still to be verified in long-term studies.

### Acknowledgements

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### Literature

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