

250

Biomechanical Investigation of a Cervical Dynamical Stabilization Device in Comparison to Fusion and TDR*D. Daentzer¹, C. Hurschler², M. Schwarze², A. Packheiser¹, S. Tak¹, B. Richter², B. Welke²*

¹Hannover Medical School, Department of Orthopaedic Surgery, Hannover, Germany, ²Hannover Medical School, Laboratory for Biomechanics and Biomaterials, Hannover, Germany

Introduction: In most degenerative disc diseases of the cervical spine the 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]. In addition, 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, motion-preserving intervertebral disc prostheses have been developed which permit some retained mobility in the affected level. Aim of the presented study is the biomechanical comparison between the cervical fusion, total disc replacement and dynamic stabilization with a new dynamic stabilization device just as the investigation of the influence of such treatments to the adjacent levels.

Materials/methods: Six ovine multi-segmental specimens (C2-5) were tested under pure moment loading by means of a sensor-guided serial robot (± 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 implant (DCI™, Paradigm Spine) placed at the C3/4 level, a disc prosthesis (activ C®, Aesculap), and finally with a simulated fusion performed using a cage (CeSpace®, Aesculap) and a plate (CASPAR®, 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. For the statistics a Wilcoxon signed-rank test for related samples was used.

Results: In flexion/extension, the treated segment was dynamically stabilized by the DCI™ with some remaining residual mobility (iROM_{C3/4} -58%). In adjacent levels the kinematics significantly changed in C2/3 (iROM_{C2/3} +117%) and in C4/5 without significant changes (iROM_{C4/5} +7%). 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_{C3/4} was decreased significantly by around -96%. In C2/3, the increase in the iROM was significant with +133% and also in C4/5 with +28%.

In lateral bending, the treated segment was stabilized significantly by the DCI™ (iROM_{C3/4} -71%) without significant changes in the kinematics 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 (-88%) with a significant increase in C4/5 (+39%).

Discussion: Based on these experimental findings, we conclude that from biomechanical perspective the DCI™ implant could indeed provide an alternative to fusion and total disc replacement in the cervical spine with an intermediate position. 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.

Literature:

- [1] Goffin J Spinal Disord Tech 2004;17:79-84
- [2] Gore Spine 1998;23:2047-51
- [3] Hilibrand J Bone Joint Surg 1999;81-A:519-28
- [4] Chang J Neurosurg Spine 2007;7:33-46
- [5] Eck Spine 2002;27:2431-34
- [6] Fuller Spine 1998;23:1649-56
- [7] Panjabi Clin Biomech 2207 ;22:257-65
- [8] Erdmann Unfallchirurg 2011;114(2):69