Effect of New Dynamic Stabilization System on the Segmental Motion and Intradiscal Pressure

P. Guérin1,2, O. Gille1, P. Sylvain3, S. Campana3, J.-M. Vital3, W. Skalli2

1Spinal Unit Department - Bordeaux University Hospital, Orthopaedic Surgery, Bordeaux, France, 21LBM, CNRS, Arts et Metiers ParisTech, Paris, France, 3Spinal Unit, University Hospital of Bordeaux, Orthopaedic Surgery, Bordeaux, France

Introduction: Dynamic posterior stabilization is an alternative to fusion in the treatment of lumbar degenerative diseases. The aims of such techniques are to preserve motion at the joint and restore normal segmental kinetics to the spine. The purpose of this in vitro study was to analyze the influence of new lumbar posterior dynamic stabilisation device (PDSD) on lumbar intersegmental range of motion (ROM) in all the three motion planes, and intradiscal pressure (IDP) in flexion-extension.

Methods: Seven fresh frozen lumbar cadaveric spines (L3-S1) were extracted with intact discoligamentous complexes. The specimens were loaded in a spine tester (pure moments of ± 10Nm - steps of 1Nm) in all the three principal motion planes. Four situations were studied: Intact, Instrumented, Injured plus instrumentation, Injured. Injury performed included a section of supra and interspinous ligaments, ligamentum flavum, resection of the lower portion of the overlying lamina and upper portion of the underlying lamina.

The implant has three rigid titanium alloy elements: a movable piston rod and a fixed attached to the spine by a pedicle screw, a hollow cylindrical body containing two viscoelastic silicone implants. L4-L5 functional unit ROM was recorded using a three-dimensional opto-electronic based motion analysis system (Polaris™). EOS® low dose stereoradiography was performed before testing for three dimensional reconstruction.

Three miniature pressure transducers were placed and secured in the intervertebral disc space of L4-L5 (anterior annulus:AA, nucleus pulposus:NP, posterior annulus:PA). Amplified ODP were recorded synchronously. Wilcoxon matched-pairs signed rank tests were run to assess significant differences between the four tested conditions. Statistical results at p< 0,05 were considered significant.

Results: The mean ROM was 9,9± 2,8 (6,9-14) in flexion-extension (FE), 8,3±1,7° (5,5-10,4) in lateral bending (LB) and 6,3±1,2 (4,4-7,8°) in axial rotation (AR). Additional implantation of the system led to a significant reduction in ROM compared to the intact spine: 17% in FE (p=0,009), 23,4% in LB (p=0,009) and 13,6% in AR (p=0,02). Injury led to a significant increase in ROM compared to the intact spine: 39,4% in FE (p=0,014), 12,6% in LB (p=0,009) and 16,4% in AR (p=0,009). Injury and dynamic stabilization led to a decrease in ROM compared to the intact spine: 9,7% in FE (p=0,054), 17,1% in LB (p=0,009) and 5,2% in AR (p=0,155).

In extension, IDP significantly decreased in the AA (-24,81% p=0,045) and in the NP (-20,91% p=0,032) for instrumented spine. IDP significantly decreased in the AA (-24,81% p=0,045) and in the NP (-20,0% p=0,022) for injured spine plus instrumentation.

In neutral position, IDP significantly decreased in NP (-19,39% p=0,014) for instrumented spine. IDP significantly decreased in the AA (-12,8% p=0,045) and in the NP (-21,43% p=0,014) for injured spine plus instrumentation.

Discussion: The PDSD allowed segment stabilization in all three motion planes. The influence of dynamic stabilization system seems to depend on the biomechanical characteristics of the implant itself. Pressure measurements were here performed in three different disc locations, which provided complementary information compared to most in vitro studies where pressure changes are evaluated in the nucleus only. Load sharing with the intervertebral disc after implantation was found primarily in the neutral position and in extension.