INTRODUCTION

One cause of chronic low back pain is damaged or degenerated intervertebral discs. This condition is sometimes treated by fusing the symptomatic level. However, accelerated adjacent level degeneration is a well established risk. Implants that stabilize the symptomatic motion segment while preserving motion and allowing disc loading have become available.

The aim of this study was to quantify pressure changes in the intervertebral disc (IVD) due to the application of two nonfusion, dynamic stabilization systems: Universal Clamp (UC) and the Wallis device.

METHODS

Nine fresh frozen human lumbar spines (L1-sacrum) were obtained from the Mayo Anatomical Bequest Program following IRB approval. Specimens were thawed, kept moist with saline, and all non-ligamentous soft tissues were removed. Specimens were potted with the sacrum oriented in neutral position. Prior to experimentation, the UC bands were placed at L3 and L4. Placement of these devices did not interfere with testing procedures.

Potted specimens were attached to a custom spine testing apparatus previously described [1] (Figure 1) and tested to +/- 7.5 N-m torque for range of motion in flexion/extension (F/E), left/right lateral bending (LB), and left/right axial rotation (AR). Three-dimensional kinematic measurements were obtained using an Optotrak™ Certus optoelectric data acquisition system (Northern Digital Inc., Ontario, Canada) and accompanying software (The Motion Monitor™, Innovative Sports Training, Chicago, IL, USA). Active Optotrak marker triad sensors were rigidly fixed to each vertebral body.

A single miniature pressure transducer (Model 060s, Precision Measurement Company, Ann Arbor, MI) was inserted into the nucleus of each instrumented L3/L4 disc and the two adjacent discs (L2/L3, L4/L5). Insertion was accomplished by a telescoping needle arrangement that facilitated placement without injury to the transducer or wire interface. Pressure readings were amplified, filtered, and recorded simultaneously during range of motion measurements using the MotionMonitor™ software. Each transducer was calibrated in an air chamber prior to use.
Each spine was tested using the same protocol, while instrumented at L3/L4: (1) intact, (2) bilateral sublaminar Universal Clamps (UC), (3) UC system connected by a transverse rod (UCTR), and (4) Wallis. During conditions (1), (2), and (3), the UC bands remained attached to the specimen. For conditions (3) and (4), the L3/L4 supra- and interspinous ligaments were transected. When Wallis was tested (4), the UC bands were removed.

RESULTS AND DISCUSSION
Six specimens were removed from the analysis due to degenerated and/or dehydrated disc conditions that rendered the output data uninterpretable. Therefore, only results from three specimens are reported. Representative pressures for each specimen are shown in Figure 3.

Only total pressure range changes are reported here. At the instrumented level, L3/L4, pressure decreased in F/E with the UC (15%) and UCTR (31%) and increased with the Wallis (31%), as compared to intact. In LB, all devices resulted in an increase in pressure from that of intact (UC:9%, UCTR:2%, Wallis:1%). Pressure decreased with the UC (16%) and UCTR (15%) and increased with the Wallis (15%) in AR.

At the adjacent levels, similar pressure changes were found as at L3/L4. The largest pressure changes were exhibited in the L4/L5 discs, especially in AR. The UC decreased pressure by 10% and pressure increased with UCTR (32%) and Wallis (26%) in AR.

CONCLUSIONS
Each of the dynamic stabilization systems resulted in change of intradiscal pressure as compared to intact. However, the pressure trends, to increase as the spine moves into maximum range of motion, were similar for all devices. In general, the UCTR resulted in the smallest change in total pressure and Wallis the largest.

This study had several limitations. Disc pressure is very sensitive to axial loading. Only pure moment loading was applied in this study and not axial loading. Therefore, the actual pressure values recorded were due to the bending moment rather than internal disc pressure. Discal pressure is also sensitive to disc health and hydration. Since this was a human cadaver study, many discs were dehydrated or degenerated. Thus, the pressure transducers were often damaged due to the fibrous nature of the degenerated disc or there was inconsistent data due to dehydration.

REFERENCES

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