Biomechanical investigation of a new facet fusion implant
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Introduction
It is assumed that a high stiffness of a spinal motion segment should be obtained with implants as a major prerequisite in order to achieve bony fusion. Therefore, fusion with cages is often combined with additional internal fixators. This instrumentation, however, causes soft-tissue trauma, which motivates the development of less invasive surgical techniques. Regarding this effort, a new biodegradable facet fusion implant has been developed that can be inserted directly into the facet joint space and then melted and anchored in this position using an ultrasonic welding process (BoneWelding® technology). The implant inhibits segmental movement directly at the joint and should make an additional internal fixator dispensable.

The aim of this in vitro study was to determine the biomechanical behavior of the new method during flexibility testing in comparison to the stabilization with an internal fixator (Figure 1).

Material and Methods
For fusing the facet joints, a biodegradable polymer (PLDAL) is inserted percutaneously into the facet joint space. The material melts at the contact area between bone and implant using ultrasonic energy and yields into the trabecular structures of the facet joints. The new method, developed by SpineWelding AG (Schlieren, CH), was compared in this in-vitro study to the commonly used stabilization method with an internal fixator. For the tests, three L2-3 and three L4-5 segments with a median age of 75 years were used. After implanting an anterior cage (Syncage, Synthes CH), the segments were additionally stabilized with an internal fixator (CD Horizon® Legacy, Medtronic), which was later replaced by the new facet fusion implant (Figure 2).

After implantation, the flexibility of both methods was measured in all three motion planes at ±7.5 Nm in a custom built spine tester (Figure 3).

Results
The internal fixator as well as the new facet fusion implant showed a significant reduction of the Range of Motion (RoM) in all three motion planes. The median values of the RoM after inserting the facet fusion implant were 23% of the intact RoM during flexion/extension, 25% during lateral bending, and 60% during axial rotation. The differences between fixator and facet fusion implant, however, were marginal and not significant (Figure 4).

Conclusion
The BoneWelding® technology provides an interesting alternative for minimal invasive stabilization of spinal motion segments and seems to achieve similar primary stability compared to an internal fixator. Exemplary histological investigations showed that the melted polymer anchored into the trabecular structures of the bone and achieved the bonding of the facet joints. The behavior of the implant during long term cyclic loading still has to be clarified.

Acknowledgement
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Figure 1: Left: Lateral view of the facet fusion implant with an ultrasonic-sonotrode and a frontal view of the facet fusion implant without an ultrasonic-sonotrode. Right: Position of the facet fusion implant.

Figure 2: Test procedure.

Figure 3: Left: Inserted implant in a human specimen. Right: The flexibility of the specimens was measured by the spine tester.

Figure 4: Range of Motion (RoM) and the Neutral Zone (NZ) of six specimens.

Figure 5: Histological view of the implanted facet fusion implant.