• BIOMECHANICAL BEHAVIOR OF A NEW NUCLEUS PROSTHESIS MADE OF KNITTED TITANIUM FILAMENTS

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ABSTRACT INTRODUCTION:
Degenerative disc disease is more and more treated using motion preserving techniques. Besides disc prostheses, nucleus prostheses are popular in this field. These are made of materials such as hydrogels or silicone to simulate the physiological compressive behavior of the nucleus. Clinically, the main problem using such implants is their dislocation tendency which can cause severe complications. It would therefore be desirable to have a nucleus prosthesis available, which does not tend to dislocate but at the same time allow physiological movements and a physiological axial compressive behavior. Based on these needs, a nucleus prosthesis was developed, which is made of knitted titanium filaments and, due to its rough surface, is assumed to be well anchored to the endplates (Buck, Germany) (Fig. 1).

The aim of the present in vitro test was to investigate whether this prosthesis is able to restore and maintain the segmental flexibility and the axial compressive behavior of the intact disc and to check its dislocation tendency under complex cyclic loading.

METHODS:
A first prototype of the prosthesis was implanted into six lumbar calf segments from anterior after fenestration of the annulus. The nucleus pulposus and the cartilaginous endplates were removed, and, after implantation, the annulus fenestration was sutured (Fig. 2).

The flexibility was tested in a spine tester under pure moment loads of +/-7.5 Nm in flexion/extension, lateral bending and axial rotation. The axial deformation of the specimens was measured in a materials testing machine under an axial load of 1000 N.

The dislocation tendency was tested under complex cyclic loading: 100,000 sinusoidal axial loading cycles between 100 and 600 N were applied at 5 Hz via a lever arm of 30 mm, which continuously turned around the specimens. This caused an additional and continuously changing bending moment.

The flexibility tests and axial deformation tests were carried out in the intact condition, after implantation and after 20,000; 40,000; 60,000 and 100,000 loading cycles.

RESULTS SECTION:
In flexion, the range of motion (ROM) significantly decreased from 4.3° (median value) in the intact condition to 3.2° after implantation whereas in extension it increased from -2.9° to -6.4°. This asymmetry (stabilization in flexion and destabilization in extension) was probably caused by a somewhat too large implant height. In lateral bending implantation had almost no effect on ROM (Fig. 3), whereas in axial rotation a small increase by 0.8° to each side was found. In all loading planes cyclic loading caused the ROM to increase by 0.1 to 1.8°.

DISCUSSION:
The knitted nucleus prosthesis tested in this study did not dislocate even during complex cyclic loading. Also, the segments maintained their axial deformability after implantation and during cyclic loading.

The flexibility tests, ROM could be restored in lateral bending but increased in axial rotation due to implantation. This increase, which was less than 1°, could be explained by the annulus defect needed to implant the prosthesis - a problem which also applies for other prostheses. In flexion/extension, ROM could also not completely be restored: in flexion a decrease was recorded while in extension an increase was found. In this loading plane the performance of the new prosthesis could probably be improved if a smaller implant was used.

Overall, theses first results seem to be promising, however pre-clinical tests on human specimens still need to be carried out.

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