THE FIRST INDIVIDUALIZED 3D PRINTED TITANIUM CAGE FOR CERVICAL FUSION: COMPUTERIZED SIMULATION, SURGICAL PLANNING, MANUFACTURING AND IMPLANTATION

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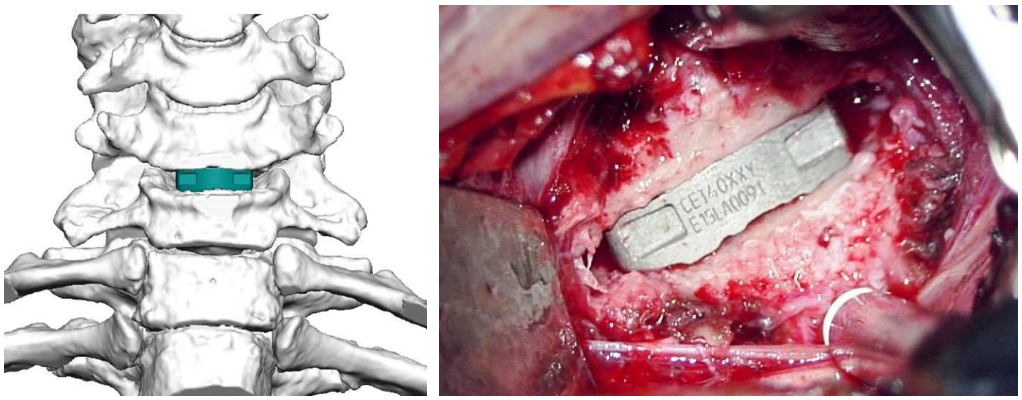
AIM: Most cervical fusion cages mimic the anatomy of the intervertebral disc space not adequately. Our idea was to respect the individual patient's anatomical situation and manufacture an individual cage with a perfect fitting accuracy. The production of individualized cages might be the next step for further improvement of spinal implants due to their improved load bearing surface. We present the simulation, planning, manufacturing, and implantation of an individualized, 3D printed cervical cage.

METHODS: In a scientific-industrial co-operation with 3D-Systems Corporation, Rock Hill, SC 29730, USA and EIT Emerging Implant Technologies GmbH, Tuttlingen, Germany, the computer-assisted planning, manufacturing, and implantation of the individualized cervical cage was performed. A 3D model of the patient´s cervical spine obtained from CT data was rendered. This computerized model is the basis for the exact simulation of the operation. The newly developed 3D planning algorithms and special reconstruction software implemented in a high-end image-processing computer allow a virtual surgical procedure. An interactive computerized simulation was performed to simulate the cage implantation and check the accuracy of fit. These data are the basis for the production of the cage. This custom-made cage is manufactured of trabecular titanium by selective laser melting (3D printing procedure).

RESULTS: The pilot project of the worldwide first implantation of an individualized cervical cage ever resulted in a high accuracy of fit of the 3D printed implant. During surgery the cage 'found' its correct position after suspending distraction due to its unique endplate design. Thus, it can be assumed that the individualized cervical implant provides excellent primary fitting accuracy and stability. Postoperative radiological images confirmed the high-precise surgical implantation.

CONCLUSION: Preconditions for the manufacturing of individualized cervical fusion cages using specific patient data are given. The implantation is uncomplicated. The improved load-bearing surface will lower the rate of implant dislocation and subsidence. The production of individualized cages at a reasonable price has to be figured out by spine surgeons and the industry.



Virtual surgical planning and implantation of the 3D cage model and corresponding intraoperative photography showing the perfect fit of the individualized titanium cage in situ after implantation.