

Subsidence Propensity of Cervical Interbody Fusion Cages by Finite Element Analysis

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Abstract

Interbody fusion cages have been frequently used in cervical spine surgery to achieve a good fusion rate in the general spinal fusion procedure. The drastic difference of stiffness between the cage of the bone, geometrical factors and loading conditions were known to cause localized high pressure, leading to subsidence of the cage into the adjacent vertebral body and thus clinical problems, such as vertebral body tear, loss of stability and fusion failure. This study calculated the deformation of loaded cervical fusion cages with linear elastic 3D finite element models to quantitatively assess the subsidence propensity for conditions, which could be clinically encountered

ANSYS 7.0 was used to construct C4-C5-C6 intact vertebral body of motion segments including ligaments, discs, facet joints, etc.. The geometry of the cervical spine was obtained from CT scanning at 3mm per slide. Pro/E 2001 was used to build the fusion cage model which was next imported into the model of the cervical spine. Cases regarding (1) types of loading (2) the geometry of the cage (3) materials of the cage (4) bone mineral density and (5) positioning of the cage were analyzed. In addition, the range of motion was studied for FE model validation

The results showed extension had more subsidence propensity than flexion and lateral bending, while torsion had the least. For two clinically used cages, the porous screw-threaded design of BAK showed higher subsidence propensity and higher von-Mises stress at the bone/cage interface than the ring-shape SOLIS. Titanium showed higher subsidence propensity than carbon-fiber reinforced PEEK. Decrease of bone mineral density by 0.02 g/cm^3 from the normal value, simulating osteopenia, increased the subsiding deformation by ~20% in both types of cages. The upper disc fusion (C4-5) showed higher subsiding propensity than the lower disc fusion (C5-6).