A Novel Anterior Transpedicular Screw Artificial Vertebral Body System For Lower Cervical Spine Fixation: A Finite Element Study

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Introduction: A finite element model was used to compare the biomechanical properties of a novel anterior transpedicular screw artificial vertebral body system (AVBS) with a conventional anterior screw plate system (ASPS) for fixation in the lower cervical spine.

Methods: Computed tomography images were obtained from a 38-year-old female volunteer. A model of the intact cervical spine (C3-C7) was established. AVBS or ASPS constructs were implanted between C4 and C6. The models were loaded in flexion, extension, lateral bending, and axial rotation. The Von Mises stress distribution in the internal fixators was evaluated, as well as the range of motion (ROM) and facet joint force. The models were generated and analyzed by Mimics14.0, Geomagic Studio 2013, and ANSYS 14.0 software.

Results: The intact model of the lower cervical spine (C3-C7) consisted of 286,382 elements and 414,522 nodes. The model was validated against previously reported cadaveric experimental data. In the ASPS model, stress was concentrated at the connection between the screw and plate and the connection between the titanium mesh and adjacent vertebral body. In the AVBS model, stress was evenly distributed. Maximum stress was 144.47 MPa in the ASPS vs. 17.73 MPa in the AVBS under axial compression; 243.53 MPa in the ASPS vs. 119.97 MPa in the AVBS under flexion; 258.1 MPa in the ASPS vs. 67.86 MPa in the AVBS under extension; 222.4 MPa in the ASPS vs. 104.93 MPa in the AVBS under left rotation; and 215.4 MPa in the ASPS vs. 103.91 MPa in the AVBS under right rotation. Compared to the intact cervical spine model, the ROM of the whole specimen after fixation with both constructs decreased by approximately 3 degrees; ROM of adjacent segments increased by approximately 5 degrees. Facet joint force of the fixed groups were higher than those of intact group and fixed group, especially in extension and lateral bending.

Discussion: AVBS fixation represents a novel reconstruction approach for the lower cervical spine.

Significance: AVBS provides better stability and lower risk for internal fixator failure compared with traditional ASPS fixation.