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Study design: Biomechanical effect of implantation of pedicle based dynamic stabilization systems (PBDS) were investigated using the nonlinear three-dimensional finite element model of L3-L4. The NFlex, Dynesys, and PEEK rod were chosen as the representative PBDS and compared with the intact and rigid rod fixation model of functional spinal unit.

Objective: To investigate the effect of implantation of PBDSs to spinal functional unit and to evaluate the differences in biomechanical characteristics according to PBDS materials and design.

Methods: Intact osteoligamentous L3-L4 finite element model was created with 1-mm computed tomography scan of a cadaveric spine and known material property of each element. Three models implanted with non-metallic (Dynesys and PEEK) and metallic with variable interpedicular distance (NFlex), were developed. The implanted model predictions were compared with that of the intact and rigid fixation model. Range of motion, force on the spinal ligaments, force on the facet joint, stress on the vertebral body and vertebral endplate with flexion/extension, lateral bending, and axial rotation under 400 N compressive preload were compared among the models.

Results: The PBDS implanted models showed decreased range of motion in flexion/extension, lateral bending, and axial rotation compared with that of the intact. Under 6-Nm moment, the range of motion was decreased in order of rigid fixation, PEEK rod, Dynesys, and Nflex except axial rotation. Decrease in flexion ROM is more than extension ROM. In case of NFlex, ROM was 32% in flexion and 38% in extension of intact spine. Instantaneous axis of rotation (IAR) was moved posteriorly over posterior bodyline in rigid and PEEK rod fixation. Nflex and Dynesys moved posterior part of intervertebral disc, but moved downward to lower vertebral body in Dynesys. The forces on each ligament were different among the models with various loading conditions. Force on the facet was much larger in Dynesys implanted model, but rigid or PEEK rod fixation revealed no facet contact force.

Conclusion: By the result of this study it is obvious that implanted segment with PBDSs have limited range of motion compared to intact spine and changed IAR with different implants. These changes give definite non-physiologic stress to adjacent functional spinal unit when they implanted. Although the Nflex system showed less limited ROM and less moved IAR, but it was not same as intact spine. Clinical implementation has to done under careful considerations of biomechanical effect of current PBDSs. More sophisticated design is mandatory to lessen the unwanted effect on adjacent segments.