• Effect of Postereolateral Disc Replacement on Kinematics and Stress Distribution in the Lumbar Spine: A Finite Element Investigation

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ABSTRACT INTRODUCTION

Artificial disc may serve as an alternative treatment modality for DDD, capable of preserving motion and restoring normal kinematics of the spine. Major surgical complications associated with the anterior approach include vascular injury and retrograde ejaculation in the primary surgery and potentially life threatening revision surgery. The concept of posterolateral approaches for TDR is gaining ground for treatment of indications such as radiculopathy and stenosis in the spine.

METHODS

A validated L4-L5 FE (ABAQUS 6.5) spine model was used [Fig 1]. The PLDA device was implanted through the posterolateral approach with a total/partial unilateral facetectomy, and lateral implantation [Fig 2]. The L4-L5 segments were tested by applying a 10 Nm pure moment at the upper surface of L4 to mimic flexion/extension, lateral bending and axial rotation. A 400 N follower load was applied between L4-L5 segments. The range of motion (ROM) at L4-L5 and the stresses at different portions of the L4-L5 segment were recorded. The analysis was repeated for different sized footprints.

RESULTS:

Figure 1. Intact L4-L5 FEA model (A) and the positioning of the ligaments (B).

Figure 2. Geometry of L4-L5 segment after total facetectomy (A), partial facetectomy (B), and after lateral disc replacement (C).

Figure 3. ROM at the implanted level for different footprints after total unilateral facetectomy

ROM under different loading conditions and footprints after total facetectomy were showed in figure 3. Similar ROM was also observed in the partial facetectomy and lateral disc replacement. The values of subsidence of the endplates were in the range of 0.15-0.3 mm which was not substantial. The stress conditions inside two endplates in contact with the implant smallest implant T712 are shown in the figure 4. The maximum stress is at the level of 0.5-1 MPa.

Figure 4. Mises stress distribution within the endplates for T712.

DISCUSSION

The aims of the current study were to quantify the kinematics of PLDA implantation and also to evaluate the stress distribution following PLDA implantation.

Simulation results show that the PLDA device allows a full range of motion under different loading conditions and can mimic the actual motion of this lumbar segment. There is no evidence indicating that the different footprint designs cause significant differences in terms of ROM under the same loading conditions.

Additional in vitro studies are currently underway to study the PLDA implanted spine kinematics under physiologic compressive loads to further validate the performance and safety of the device.

REFERENCES


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