

# **STRESSES ON MOVABLE CORE AND LOADS ON FACETS ARE HIGHER BY IMPLANTING A CERVICAL ARTIFICIAL DISC PROSTHESIS AS COMPARED TO BONE GRAFTING FUSION TECHNIQUE – A FINITE ELEMENT MODEL STUDY**

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## **INTRODUCTION**

The fusion technique is a common procedure adopted by many surgeons in the treatment of various kinds of degenerative disc pathologies. It has been shown that the fusion grafting is good for decompressing the degenerative level and better fusion results are achieved at the expense of increased construct stiffness. At the same time, the increased flexibility and intradiscal pressures of the non-operated segments raised more concerns about the degeneration of adjacent levels. Recent advancements have shown that by using a movable core between endplates at the degenerative segment restores the motion, both at the operated and non-operated levels. Previous studies have compared the biomechanical response of the adjacent levels after fusion bone grafting and artificial disc placement showing better motion preservation by adopting the later technique. More in depth understanding is still required on the biomechanics of operated level that how the motion, stresses on the core and loads on the facets correlate with the stability of the surgical construct. Many investigators have emphasized the motion preservation by using the artificial disc but to the best of our knowledge, no study exists in the cervical spine literature showing the stresses on the movable core between the endplates and the load on the facets at the implanted level.

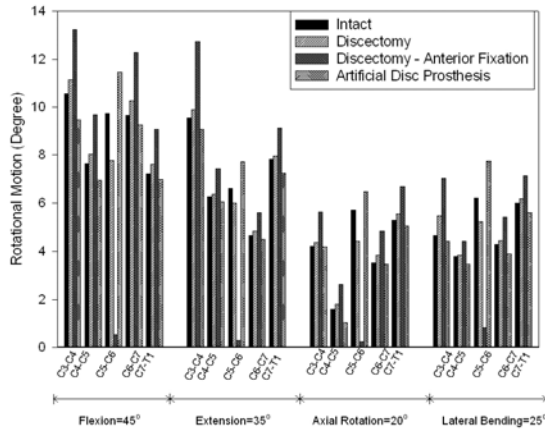
The objective of the present study was to compare the biomechanics of the operated level with bone grafting fusion and artificial disc prosthesis. The rotational motion, stresses on the implant, and loads on the articulating facets were studied.

## **METHODS**

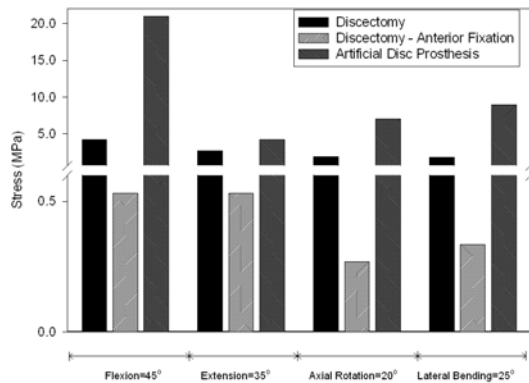
A three-dimensional finite element (FE) model of a C3-T1 segment of the cervical spine was developed from the CT scan of a 38-year old normal female subject. The intact model was previously validated with the published specimen studies. Three surgical models with the implant at C5-C6 level were developed from the intact model – discectomy with stand-alone graft, discectomy with anterior fixation, artificial disc prosthesis (movable core between endplates). The discectomy fusion was performed by using an inter-body graft. The discectomy with anterior fixation was built with the bone graft and stabilizing the anterior column with a plate (titanium) having rigid screw trajectory. The artificial disc prosthesis consisted of a movable core (polyethylene) between endplates (cobalt-chrome). The grafts were centrally placed covering up-to 50% endplate area. Two unicortical screws (titanium) each at the cephalad and caudal ends of the anterior plate were placed parallel to the endplates. The screws of 16 mm long with an outer and inner diameter of 3.5 and 2.5 mm were used. The artificial disc prosthesis was centrally placed with a diameter of 10 mm and

thickness of 4 mm. The material properties of the spinal structures and implants were adopted from the literature. The physiologic rotations based on literature data were prescribed on the C3 vertebra (flexion=45°, extension=35°, axial rotation=20°, lateral bending=25°). The inferior surface of the T1 vertebra was fixed. A constant pre-load of 73.6 N was applied using two isotropic truss elements connecting each of the lateral edges of the vertebral bodies to mimic the follower load technique. The analysis was performed using the commercially available FE code, ADINA.

## RESULTS AND DISCUSSION



**Figure 1:** Inter-segmental rotational motion from C3 to T1 with bone grafting fusion (without and with anterior fixation) and artificial disc prosthesis at C5-C6 level



**Figure 2:** Stresses on the implant at C5-C6 level

The results of the present study showed a decrease in the motion of operated level and an increase in the motion of non-operated levels with fusion grafting (without and with anterior plate fixation) as compared to the intact case (Figure 1). When using the artificial disc prosthesis, an increased motion at the implanted level and a decreased motion at the adjacent segments were observed. The inter-segmental rotational motions of the model with artificial disc prosthesis were much closer to the intact values as compared to the models with bone graft. This finding agreed well with the previous studies in the literature.

Figure 2 shows the stresses on the implant – bone graft and polyethylene. The yield stress of the polyethylene is about 12-15 MPa. The stresses on the polyethylene core were too high (exceeding or close to the yield point) as compared to the stresses on the bone graft. Also, the loads on the facets at operated segment were found to be much higher by using the polyethylene core than bone graft. Furthermore, the stresses in the discs and loads on the facets of the adjacent segments were lower by implanting polyethylene core (values close to intact) as compared to the bone graft at C5-C6 level.

## SUMMARY

The present study showed that even though the motion was preserved at all levels by using the artificial disc prosthesis than the traditional fusion grafting technique, the higher stresses on the core and loads on the facets at operated level could lead to further wear of core and degeneration of facets.

## ACKNOWLEDGEMENTS

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