

BIOMECHANICAL STABILIZATION OF THE MULTI-LEVEL CORPECTOMY CONSTRUCT USING ANTERIOR AND POSTERIOR INSTRUMENTATION – A FINITE ELEMENT MODEL STUDY

Mozammil Hussain¹, Ahmad N. Nassr², Raghu N. Natarajan^{1,2}, Gunnar B.J. Andersson², Howard S. An²

¹ University of Illinois at Chicago, Chicago, IL, USA

² Rush University Medical Center, Chicago, IL, USA

E-mail: hussmoz@iit.edu

INTRODUCTION

Long segment decompression and strut reconstruction with either an anterior or posterior instrumentation have been shown to promote arthrodesis and minimize bone graft related problems. Numerous surgical techniques to supplement the stability of the multi-level construct have been well documented in the literature using the anterior screw-plate system or posterior screw-plate/rod system. These surgical techniques have their own advantages and disadvantages that should be decided by the surgeon carefully before operating on the patients. Anterior instrumentation is a preferred traditional technique due to good neural decompression, strengthening of anterior column, and excellent arthrodesis rate. However, recent failures associated with the multi-level strut reconstruction using anterior screw-plate advocated the need to supplement the construct with posterior instrumentation.

The objective of the present study was to compare the stability of the construct using the rigid anterior screw-plate and/or posterior screw-rod system. Furthermore, the stability of superior motion segment was compared to the inferior motion segment to determine the direction of propagation of the adjacent segment disease.

METHODS

A three-dimensional finite element (FE) model of a healthy C3-T1 segment was developed from the CT scan of a 38-year old woman. Two-level corpectomy was performed and a bone graft was centrally placed in between the C4 inferior endplate and C7 superior endplate covering up to 50% area of the opposing endplates. A contact gap of 0.1 mm was used to simulate the immediate-postoperative condition. Three types of stabilization models were built from the two-level corpectomy model. Firstly, an anterior stabilization model was created by using an anterior plate with rigid screw trajectory from C4 to C7. Two uni-cortical screws each at the cephalad and caudal ends of the anterior plate were placed parallel to the endplates. Secondly, the posterior stabilization model was enhanced by using a vertical rod with rigid screw trajectory from C4 to C7. Two uni-cortical screws at each segment were placed in the posterior lateral mass. Thirdly, the combined anterior-posterior stabilization model was created by using an anterior screw-plate together with the posterior screw-rod system. The anterior and lateral mass screws of 16 mm length with an outer and inner diameter of 3.5 and 2.5 mm were used. The material properties of the spinal structures and instrumentations were adopted from the literature. The moment loads were created by applying appropriate equal and opposite loads on the superior surface of C3 keeping the inferior surface of T1 fixed. A constant preload of 73.6 N was applied using two

temperature truss elements connecting the lateral edges of the vertebral bodies to mimic the follower load technique. The analysis was performed using the commercially available finite element code, ADINA. The range of motion of the corpectomy construct and adjacent segments using three stabilization models were compared under a moment load of 1.5 Nm with preload.

RESULTS AND DISCUSSION

The validation studies of the healthy C3-T1 intact segment and two-level corpectomy with anterior instrumentation were described previously (Hussain *et al* 2006).

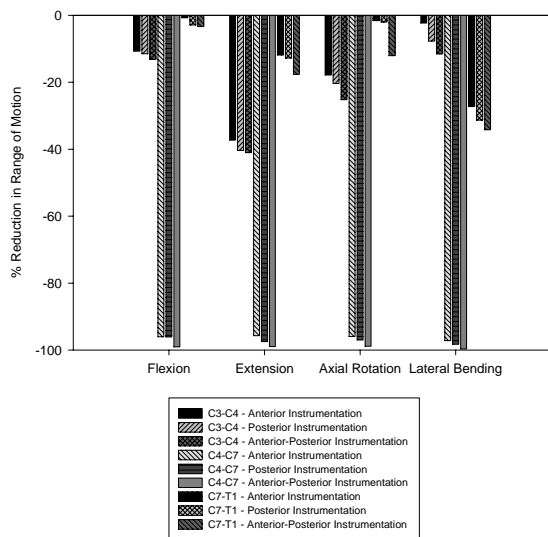


Figure 1: Comparison of the percentage reduction in range of motion using the anterior and/or posterior instrumentation for the corpectomy construct and adjacent segments.

The stability of the construct was highest by using the combined anterior-posterior instrumentation. When anterior instrumentation was compared to the posterior instrumentation alone, the former

was found to be less stable (figure 1). This finding was consistent with the cadaveric study of Singh *et al* 2003. However, they found no significant statistical difference between the biomechanical stability of the combined instrumentation and posterior instrumentation alone which was not true with our results.

Higher percentage reduction in the range of motion of the superior motion segment was observed as compared the inferior motion segment except for the lateral bending motion. The increased stability of the construct with the increased instrumentation was simultaneously accompanied by the increased stiffness of the adjacent segments which might lead to disc degeneration.

SUMMARY

The stability of the corpectomy construct and adjacent segments follows the order as: combined anterior-posterior instrumentation, posterior instrumentation alone, and anterior instrumentation alone. The adjacent segment degeneration was found to propagate superior to the corpectomy construct. The possibility of adjacent segment degeneration follows from the enhanced stability of the corpectomy construct.

REFERENCES

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