

Investigating the mechanical effect of the sagittal angle of the cervical facet joint on the cervical intervertebral disc

Rui Weng (深圳, Chine), Dongxin Lin (Fuzhou, Chine), Yaoshuai Yu (Guangzhou, Chine), Peng Tan (Shenzhen, Chine), Yikai Li (Guangzhou, Chine), Xuecheng Huang (Shenzhen, Chine)

Introduction

Facet tropism is defined as the asymmetry between the left and right facet joints relative to the sagittal plane. Published clinical studies have found that facet tropism is associated with cervical disc herniation. However, the relationship between the facet orientation and the side of cervical disc herniation remains controversial. Therefore, this study used the finite-element technique to investigate the biomechanical effects of the sagittal angle of the cervical facet joints on the cervical intervertebral disc.

Materials and Methods

The finite-element model was constructed using computed tomography scans of a 26-year-old female volunteer. First, a cervical model was constructed from C3 to C7. The model was verified using data from previously published studies. Second, the facet orientation at the C5–C6 level was altered to simulate different sagittal angles of cervical facet joints. Five models, F70, F80, F90, F100, and F110, were simulated with different facet joint orientations (70°, 80°, 90°, 100°, and 110° facet joint angles at the left side, respectively, and 90° facet joint angles at the right side) at the C5–C6 facet joints. In each model, annular fibres stress and facet cartilage pressure were studied under six pure moments and two combined moments.

Results

Comparing the stress of the annulus fibres in flexion combined with right axial rotation and in flexion combined with left axial rotation in the same model, no difference in the maximum stress of the annulus fibres was noted between these two different moments in the F90 model, whereas differences of 12.80%, 8.84%, 14.95% and 33.32% were noted in the F70, F80, F100 and F110 models, respectively. The same trend was observed when comparing the maximum stress of the annulus fibres in each model during left and right axial rotation. No differences in annular fibres stress and facet cartilage pressure were noted among the five models in flexion, extension, lateral bending, left axial rotation, and flexion combined with left axial rotation in this study. However, compared with the F70 model in flexion combined with right axial rotation, the annulus fibres stress of the F80, F90, F100, and F110 models increased by 5.53%, 13.03%, 35.04%, and 72.94%, respectively, and the pressure of the left facet joint of these models decreased by 5.65%, 12.10%, 18.41%, and 25.74%, respectively. The same trend was observed in the right axial moment.

Conclusion

Facet tropism leads to unbalanced stress distribution on the annulus fibres at the cervical intervertebral disc. The greater the sagittal angle of the facet joint, the greater the annular fibres stress on this side. We hypothesised that the side with the larger sagittal angle of the facet joint exhibits a greater risk of disc herniation.



Figure 2. The three-dimensional finite-element model of C3-7.

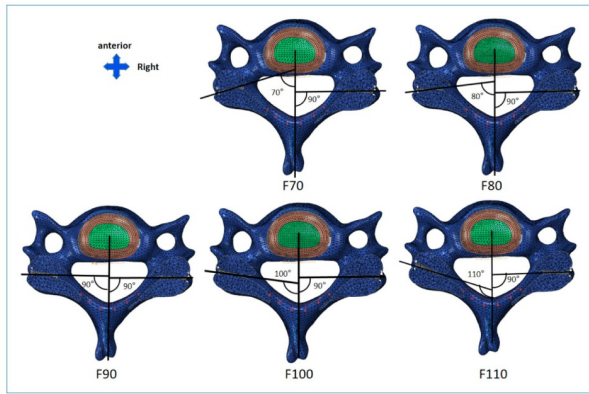


Figure 3. Axial cutting images (superior view) of five finite-element models of the facet joint on C5-6. In the F70 model, the left facet joint angle is 70°, and the right facet joint angle is 90°. Similarly, in the F80, F90, F100 and F110 models, the left facet joint angles are 80°, 90°, 100°, and 110°, respectively, whereas the right facet joint angle is 90°.