Are we Altering the Cervical Spine Biomechanics for the Better or Worse?: A Biomechanical Study.

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Introduction

Anterior cervical arthrodesis and arthroplasty are the most commonly performed operations in the cervical spine. Disc height and lordosis are the most commonly surgically modified morphometric parameters. This study aims to examine seven major morphometric parameters independently for their effects on the spine biomechanics.

Methods

An experimentally validated parametric finite element model of the entire cervical spinal column was used to examine the biomechanics of the C5-C6 osteoligamentous spinal segment. Seven morphometric parameters were selected for testing: vertebral body size, spinous process-lamina complex size, facet parameters (height, length and slope), disc height, and cervical lordosis. A Latin Hypercube sampling method was used to generate models with randomized variations of the parameters. Four output responses were analyzed for each morphometric variation: range of motion (ROM), anterior longitudinal ligament (ALL) stretch, anterior capsular ligament stretch, and facet compression/distraction.

Results

Fifty 3D finite element models were generated and complex loading was simulated.

Lordosis was the most significant morphometric parameter, resulting in reduced ALL stretch, increased anterior facet stretch and increased posterior facet compression, in response to complex loading. Disc height increase had a secondary effect on increasing the range of motion.

Resultant ROM in models varied by 4 degrees, and was most affected by the changes in the AP diameter of vertebral body-facet complex, followed by disc height. ALL stretch ranged from 10 to 30%, and it was most affected by lordosis, followed by disc height. Anterior facet capsule stretch was influenced by lordosis, facet height and facet angle. Posterior facet compression was influenced by lordosis and facet angle.

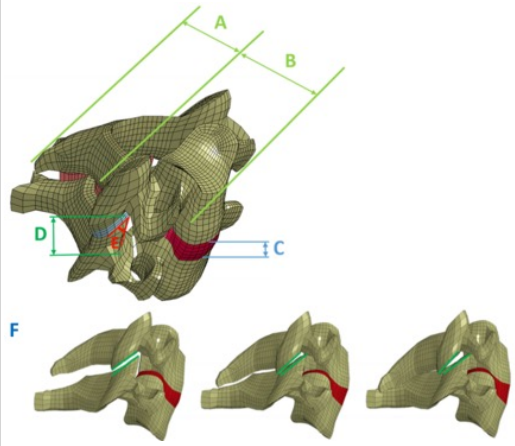
Conclusions

Iatrogenically or congenitally excessive cervical lordosis can lead to increased mechanical stresses for the facet joints, possibly predisposing them to facet arthropathy.
Oversized interbody devices (in height), such as artificial discs, may excessively increase range of motion.
Taller facets with more acute angles may be subject to higher mechanical stresses.
Surgeons should be mindful of the impact of changing morphometric parameters on the spine biomechanics.

Learning Objectives

1)Recognize major morphometric parameters of the cervical spine
2)Discuss the impact of morphometric parameters on the spine biomechanics
3)Identify potential impact of cervical surgery on spine biomechanics

Figure



Morphometric Parameters of the Finite Element Model. A) AP diameter of the spinous process-lamina complex; B) AP diameter of vertebral body-facet complex; C) disc height; D) facet height; E) facet angle; and F) cervical lordosis.