Preliminary Study of the Effects of Calcification on the Structural Behavior of Costal Cartilage

John Lamp[1], Richard Kent[1], Jason Forman[1]

[1]UVA School of Engineering and Applied Science

ABSTRACT

Injury-predictive finite-element models of the human body are emerging as an important tool to evaluate vehicle safety systems. Current models, however, do not take age related changes in the thorax into consideration. One of the most striking age-related thoracic changes is calcification of the costal cartilage, which both increases with age and exhibits distinctly gender-specific patterns of deposition and growth. Because they act as a bridge between the ribs and the sternum, the costal cartilages play a considerable role in distribution of stress and strain in the ribcage under load. The purpose of this project was to assess the extent to which moderate calcifications affect the structural (force-deflection) characteristics of the costal cartilage. Finite element simulations were performed to test three models of an individual costal cartilage segment. Each model consisted of a small segment of the ventral-most portion of a rib, followed by a complete length of a single costal cartilage, followed by a small segment of adjacent sternum bone. Two of the models incorporated calcification patterns representative of a typical male and female; the third, designated as the control, contained no calcification. Each specimen model was subjected to boundary conditions characteristic of a 15mm posterior sternum displacement. At this deflection, male pattern calcification exhibited a 37.5 % increase in resultant force on the costal (rib) border (through the model cross-section) when compared to the control, while the female pattern calcification experienced a 28.8% increase in costal border resultant force. These data suggest that the presence of calcification may have a considerable effect on the structural behavior of the costal cartilage and, thus, the distribution of loading throughout the ribcage.