A24 Reassessing Blunt Force Trauma to True Rib Heads Utilizing Tension-Compression Theory

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After attending this presentation, attendees will better understand the influence that biomechanical factors have on fracture propagation of blunt force trauma rib heads. This will be achieved by the explanation and analysis of tension and compression.

This presentation will impact the forensic science community by providing preliminary answers to the unanswered question of how rib heads react during blunt force impact. This investigative study will help both forensic anthropologists and pathologists begin to better interpret rib fractures when presented with an unknown scenario.

Rib trauma is commonly used as a last interpretative resort in cases where repetitive trauma is present. This may largely be due to the complicated nature of rib anatomy and physiology complicating individual rib trauma analyses. There appears to be a lack of understanding of ribs on a biomechanical level when mapping and interpreting incomplete and buckle fractures from males and females of various ages.[1] An additional rib study reported that age and sex have little effect on blunt force fractures, suggesting that the study of geometric properties of ribs is imperative for further understanding of blunt force rib fractures.[2]

Introductory research investigating rib cortical area, section modulus, linear structural stiffness, and skeletal robusticity found the expected, in that robust bones are more resistant to bending and therefore more structurally sound when force is applied.[3] While the aforementioned study has taken steps in understanding the biomechanical properties of rib fractures, rib head, neck, and tubercle biomechanical studies have yet to be examined specifically and in terms of tension and compression. It is felt that the complex anatomical positioning of rib heads, accompanied by their robust nature, must reveal a significant diagnostic biomechanical pattern of blunt force fracture propagation in the thoracic region.

In this pilot study, ten rib head, neck, and tubercle fractures from five individuals were used. Only true thoracic ribs (ribs four through eight) from males and females with reported blunt force trauma to the chest were used for this study. The sample consists entirely of individuals examined by a member of this study. Scenarios for age at death and cause of death of each individual were previously recorded. Each fracture was analyzed macroscopically using a Leica® MZ16A microscope with 3.5x to 40x magnification capability. Tension and compression were identified on all fracture surfaces during analysis to assess the forces and behavior of the bone as it fractured.

Analysis of the ten ribs heads revealed consistent anatomical fracture patterns. Of the rib heads analyzed, 90% exhibited fractures originating medial to the rib angle, continuing around the tubercle, and propagating into the rib head. The remaining 10% of rib heads analyzed displayed only a hairline fracture between the head articular facet and tubercle, suggesting the blunt force impact was not great enough to fully radiate the fracture. The preliminary research has discovered that rib head fractures avoid more dense cortical bone (stress resistors), like that found at the tubercle, in all scenarios. The behavior of the fractures observed in this study is a result of the anatomical structure of the rib, including the immovable attachments to the vertebrae body and transverse process. The surrounding musculoskeletal and cartilaginous tissues also absorb the impact energy.

In conclusion, this research delves into the examination of blunt force rib head, neck, and tubercle fractures in an effort to better understand how ribs, as individual bones and as a unit, react to force. The ultimate goal of this study is to introduce effective means of interpreting blunt force trauma of the ribs by diagnosing tension and compression in each fracture. The increased accuracy of trauma analysis through biomechanically recognized bone bending can only contribute to an accurate understanding of bone bending and failure.

Reference(s):

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3. Murach M.M., Schlecht S.H., Agnew A.M. Robusticity in the axial skeleton: an example of the rib. *Proc Am Assoc Phys Anthropol*, 2015, St. Louis, MO.

Biomechanics, Blunt Force, Ribs

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