A31 The Use of High-Resolution Computed Tomography (CT) to Explore Age-Related Trabecular Change in Human Ribs

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Learning Overview: After attending this presentation, attendees will better understand the utility of micro-CT for visualizing the microstructural organization of trabecular bone within the human rib. This presentation will increase attendee knowledge of how trabecular bone properties vary in relationship to age throughout the medullary cavity.

Impact on the Forensic Science Community: This presentation will impact the forensic science community by increasing practitioner knowledge of age-related bone loss in the human rib that can be applied to research design and interpretation of age at death in forensic casework.

Rib histomorphometry is a reliable and often-used approach for estimating age at death based on the quantification of cortical bone, though recent efforts raise the question of incorporating trabecular bone in these assessments to improve reliability and repeatability. Despite this suggestion, trabecular bone's relationship to age in the rib, unlike cortical bone, has not been thoroughly examined. In the 2D sections traditionally used in age estimation, distinguishing trabecular from cortical bone in transitional areas can be difficult, whereas 3D analysis may more accurately capture this variation. The aim of this research is to use high-resolution CT to provide a more complete picture of trabecular bone microstructural changes within the rib and explore its utility for improving methods of estimating age at death. This information can help to determine the utility of using total bone area, rather than cortical area, measurements for improving the accuracy and repeatability of histological age-at-death estimates.

The sample consists of 40 males with ages ranging from 20–95 years from the modern Texas State Donated Skeletal Collection housed at the Forensic Anthropology Center at Texas State. Ribs were measured along the cutaneous surface and markers placed at 50% and 75% of the total length, beginning from the head. Ribs were scanned using a Northstar Inc. X5000 high-resolution CT system at both the 50% and 75% length zones with resolutions ranging from 35–49 microns. For analysis, 6mm Regions Of Interest (ROIs) were selected proximally to each marker and processed using Dragonfly V4.1 to isolate three trabecular Volumes Of Interest (VOIs): one each along the cutaneous cortex, the center of the medullary cavity, and the pleural cortex.

Using BoneJ, each VOI was analyzed for Bone Volume Fraction (BV/TV), Trabecular Thickness (TbTh), Trabecular Spacing (TbSp), Connectivity Density (ConnD), and Degree of Anisotropy (DA), within and between the 50% and 75% ROIs. Independent sample *t*-tests or Kruskal-Wallis tests were used to compare variables within and between regions dependent on normality. Within both the 50% and 75% regions, cutaneous VOIs had significantly more BV/TV than the medullary and pleural VOIs. There was significantly greater ConnD for the cutaneous VOIs than pleural VOIs in both the 50% and 75% regions, while there was significantly less TbSp in the cutaneous VOIs than either the medullary or pleural VOIs for both regions.

Between the 50% and 75% ROIs, the cutaneous and medullary VOIs at 50% had significantly more BV/TV than at the 75% region. The pleural VOIs showed no significant differences in BV/TV between locations. Overall, the 50% region has significantly more BV/TV than the 75% region ($p = 0.002$). Regression was used to examine the relationship of BV/TV with age and found that BV/TV has only weak correlations with age at both the 50% (R^2=0.088) and 75% (R^2=0.159) regions. Additionally, at the 50% region, both TbTh and DA are significantly larger than at the 75% region. Neither ConnD nor TbSp showed significant differences between the 50% and 75% regions.

Contrary to expectations, 3D quantification of trabeculae did not elucidate a strong relationship between trabecular bone loss and age in the rib. This may be a result of excessive resorption on the endosteal border leading to trabecularization of the cortex, so that subsequent decreases in cortical bone actually lead to an increase of trabecular bone, which potentially leads to trabecular conservation throughout life. If this trabecular conservation exists, then these findings suggest that in the rib cortical, assessment alone may be enough to account for bone loss with age in histomorphometric analyses, though further work is needed.

Micro-CT, Age-at-Death, Trabecular Analysis

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