A method to extrapolate the geometrical properties of human ribs using micro-CT and clinical-CT images.

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INTRODUCTION

Thermal injuries are second only to head injuries as the cause of death in road traffic accidents. Finite Element (FE) models are the future of thermal injuries investigation.

Current FE models of the human thorax need improvement:
- More accurate geometry of the ribs
- More biotribological response of ribs
- Including rib fracture mechanics

AIM of the WORK: Implement a method to extrapolate the geometrical properties of human ribs using micro-CT and clinical-CT images.

METHODS: Specimens, Imaging, Data & Geometry Processing and FE model

1. Whole rib clinical CT
   - Extraction of twelve left ribs
   - Instrumentation and preparation

2. CT images
   - Geometrical properties
     - Cortical Area
     - Trabecular Area
     - Overall Area
     - Principal Moments of Inertia
   - Properties distribution along the ribs and comparison
     - Clinical-CT vs. Micro-CT

3. FE beam model
   - Beam geometry
     - Rib centroid
     - FE beam elements, fully adjustable
     - Assigned geometrical properties based on the rib's sectional analysis
     - RCs on two joints
   - Material properties
     - Elastic, perfectly plastic (without failure)
     - Young's modulus $E = 10.18$ GPa
     - Poisson ratio $\nu = 0.3$
     - Yield stress $\sigma_y = 98$ MPa

4. RESULTS cont.

Fig. The example of the properties distribution for the 5th rib when applying functions. Distribution results are also available for the ribs 3 and 4.

DISCUSSION

- Using a beam model allows adjustment of each rib geometric parameter separately;
- Thresholds are required in hand-calculation which is time-consuming;
- Study was conducted on the single ribs only — standard evaluation for the whole ribs;
- The biggest issue is the x-ray images threshold and export — a few extra pixels can significantly change geometry parameters changing the area, moments of inertia and the shape.

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