SS1-05

Quantifying the Micro-Structural Parameters of Human Skull Using Micro-CT and Their Correlation with Low-Frequency Ultrasound Attenuation

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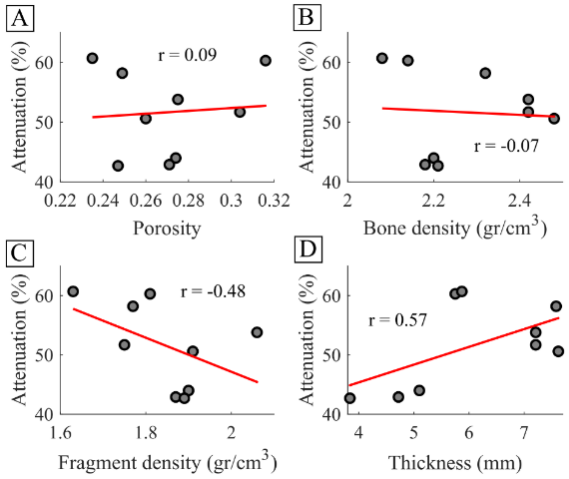
Skull CT scans are essential to predict resulting aberration and attenuation prior to treatment. However, the CT resolution required is often overlooked. We evaluated the position-dependent microstructural properties of an ex-vivo human skull using µCT-scans at a 40, 80 and 118 µm resolution, and performed accuracy assessment of the resulting attenuation.

The Left Parietal Bone (LPB) of a male cadaver skull was divided into 9 fragments. Each fragment was scanned using a µCT imaging system at a 40, 80 and 118 µm resolution. 2D slices were processed in MATLAB© by adjusting sharpening, binarizing, masking and applying rectangular kernels, to extract the porosity, thickness, inner /outer table, Diploë thickness and density. We then used the clinical setup designed for non-invasive blood-brain barrier opening, to estimate the attenuation of 0.25-MHz ultrasound propagation through each of the skull fragments.

Our findings indicated that the attenuation varied greatly across the different parts of the human skull, ranging from 42.7% to 60.7%. We have not found a significant correlation between attenuation and the examined metrics. However, there was a negative correlation between the fragment density and attenuation (r=-0.48) and a positive correlation between thickness and attenuation (r =0.57).

Lower attenuation (<50%) was observed from the fragments with thickness within the range of 3.9 to 6mm and the density in the range of 1.8 to 2.1 gr/cm3. Therefore, fragments that fit these criteria would be associated with lower transcranial attenuation. We also observed that a minimum of 80µm resolution was needed to extract micro-structural parameters.



Correlation between attenuation and (A) porosity, (B) bone density, (C) fragment density, and (D) thickness.