UNIVERSITY OF PATRAS
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INFLUENCE OF TRABECULAR BONE ARCHITECTUREAND MATERIAL ON ULTRASOUND CHARACTERISTICS USING 3D-PRINTED TRABECULAR BONE MODELS

OBJECTIVE

Analysis of acoustic parameters SOS,BUA, and BSC in samples of cancellous bone from three different materials (PLA, TPU, PP) with varying densities (BV/TV) and SOS, BUA in samples with constant structure and different trabecular thickness (Tr.Th.) (0.2-0.4-0.5-0.6mm), fabricated using 3D printing. Backscatter 180° was measured using both focus and unfocus transducers.

This study aims to enhance the understanding of cancellous bone structure, with the purpose of predicting and addressing conditions such as osteoporosis, as well as selecting appropriate materials for biomedical applications.

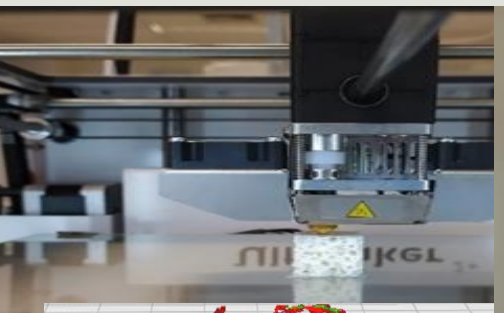
EXPIREMENTAL PROCEDURE

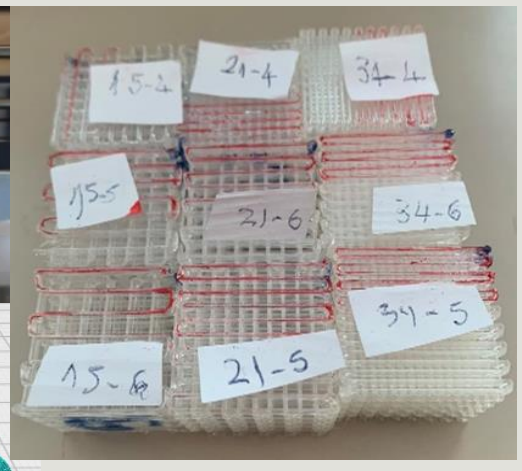
Bone and solid structure models were transformed into 3D designs for printing, with adjustments made to trabecular thickness and density. Subsequently, after printing, the samples were analyzed using ultrasound to calculate sound velocity, broadband ultrasound attenuation (BUA) via the Through-transmission method, and 180° backscatter via the pulse-echo method.

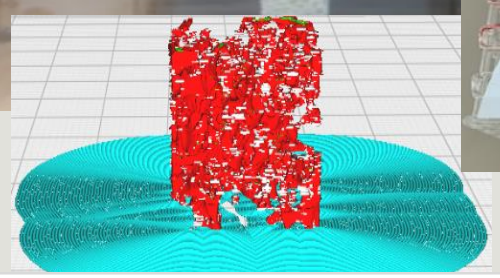
Speed of sound : $Csam = \frac{1}{\frac{1}{Cwat} + \frac{\Delta t}{d}}$

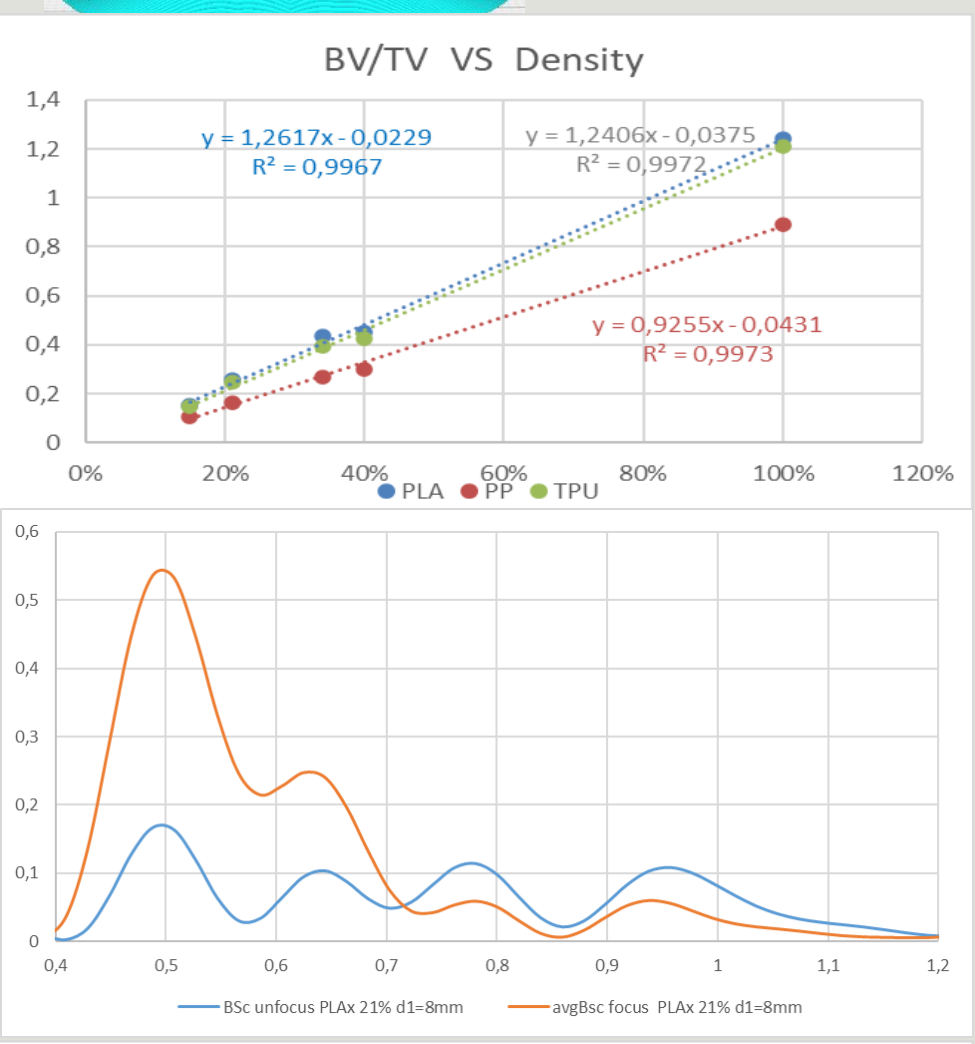
Broadband ultra sound attenuation : BUA = 20log(water/sample)

Backscatter BSC : $\mu_B(f) = \hat{\mu}_B(f) A_d(f) C(f) Factors(f)$









RESULTS-CONCLUSIONS

- 3D printing allows for the creation of different specimens with the same structure (e.g., cancellous bone or solid structure), examining the role of density in acoustic properties, providing information about structure and potential development of osteopenia and osteoporosis.
- High correlation of BV/TV with the apparent density of specimens in both cancellous bone and solid structure specimens.
- High correlation of BV/TV with SOS, BUA, and E in cancellous bone and solid structure specimens in all directions.
- Ultrasound scattering is greater in materials with higher density (d) and elasticity E (PLA) compared to materials with lower density and elasticity (PP) (TPU).
- High correlation of the backscatter coefficient (BSC) between the same regions of cancellous bone specimens with the same density using (Focus&Unfocus) Transducers, enabling the study of challenging bone areas in in vivo with (Focus transducers).
- High correlation of SOS and BUA in solid structure specimens (PLA) for Tr.Th. 0.2-0.4-0.5-0.6mm and in PLA, PP, TPU for Tr.Th. 0.2 mm.