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The role of bone marrow on acoustic properties of cancellous bone - finite difference time domain modelling study

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Quantitative ultrasound (US) parameters are related to structure and properties of cancellous bone. The effect of bone marrow on US propagation, *i.e.* absorption and scattering, is still poorly understood. However, substitution of fatty marrow with water is known to significantly affect the US parameters. The present study investigates the role of marrow on US parameters, using microtomography based 3D-finite difference time domain (FDTD) modelling.
Eleven human cancellous bone samples were analysed with a micro-CT system (SkyScan 1072) to determine microstructure and morphology. Wave 3000 Pro software (Cyberlogic Inc.) was used for simulations. Models were created to simulate experimental US measurement geometry with focused 1MHz transducers. Simulations were repeated before and after replacing the marrow with water.
The voxel size of the simulation mesh significantly affected sample structure and simulations. US attenuation and speed decreased and increased, respectively, when marrow was replaced with water ($p<0.01$). US reflection at sample surface and backscattering from internal structures increased ($p<0.01$) when marrow was replaced with water.
Contribution of bone marrow was stronger in samples with low bone volume fraction. This implicates that inter-individual differences in the composition of marrow may significantly affect measured ultrasound parameters, especially when investigating osteoporotic bone with low density.