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Ultrasonic attenuation in trabecular bone: Theoretical approach and experimental measurement

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Abstract : The aim of this paper is to determine how different parameters such as porosity, scatter size and frequency affect the ultrasonic attenuation process during the acoustic wave propagation through the trabecular bone. In this study, a theoretical model combining absorption and scattering is proposed to predict attenuation in trabecular bones. The total theoretical attenuation coefficient is computed as the sum of the contributions of scattering and absorption. The obtained results have been compared with experimental data achieved on bovine cancellous bone samples filled by water. The porosity of the used samples varies between 40 % and 75 %. A transmission technique is used. This method only requires the measurement of the specimens thickness and recording of two pulses: one without and one with the specimen inserted between the transmitting and receiving transducers. The theoretical model used in this paper appears to give appropriate results compared with experimental measurements. The obtained results show that viscous losses are not sufficient to describe the attenuation intrabecular bone. This study indicates that scattering is the primary mechanism responsible for attenuation in trabecular bone and confirms the strong dependence of the attenuation of the size of the scatterer, the bone porosity and of the ultrasound frequency.

Keywords : Cancellous bone, Ultrasound, Attenuation, Scattering, Propagation modeling