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Bulk waves velocities are dependent on frequency in cortical bone

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Any model of ultrasound propagation in cortical bone requires the knowledge of the effective elastic properties of bone at, let's say, the mm scale. It is well known that the porous network of cortical bone interacts with ultrasonic waves and plays a major role in the mechanical behaviour. The purpose of the present work is to emphasize that, in cortical bone, there is some variation of the effective bulk wave velocities, and consequently of the elastic properties, with frequency in the MHz range due to the effect of the porous network. A Finite Difference Time Domain (FDTD) code is used to simulate the ultrasonic propagation of compression and shear waves, transverse to, and along the bone axis, in cortical bone volumes reconstructed from micro-computed tomography (microCT). The resolution of the microCT data allowed to model the 3D networks of resorption cavities and Haversian pores. It is found that, for porosities typically above 5-6 %, the effective phase velocity is dependent on the frequency. Preliminary results indicate that the influence of the frequency is more important in the range 1-5 MHz.