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Numerical modelling and in-vitro studies of ultrasound signal loss across fractures in cortical bone mimics

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The propagation of 200 kHz ultrasonic waves along cortical bone mimics and across a simulated fracture has been investigated using a Finite Difference numerical model. The first arrival signal (FAS) transit time and peak amplitude have been calculated as a function of range at 200kHz in order to help understand the factors that determine the propagation across a fracture. The variation in the amplitude of the first peak of the reradiated wave is studied as a function of the gap width and shape. The results compare well with experimental measurements made in vitro using an axial transmission technique on cortical bone mimics and bovine cortical bone samples. The effects of various stages of the healing process have also been considered by introducing different fracture geometries into the plate model. Changing the geometry to an external callus with different mechanical properties causes the signal loss across the fracture to reduce significantly. The most significant changes are observed to occur from the initial inflammatory stage to the formation of a callus and in the remodelling stage after a significant reduction in the size of the callus has taken place.