An in vitro investigation of the dependence on sample thickness of the speed of sound along the specimen

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To measure the speed of sound (SOS), most quantitative ultrasound (QUS) devices use the transmission mode, whereby two transducers are placed on opposite sides of the sample. This mode is limited to a few specific skeletal sites because of the varying configuration of bone geometry and varying amounts of overlying soft tissue at most other sites. The aim of this study was to address the dependence of SOS measured along the sample on the thickness and composition of the bone sample.Bovine samples from mid-femur and trochanter, and perspex phantoms were used. We prepared the perspex samples in the shapes of blocks and cylinders to investigate the effect of wall thickness on SOS. The thickness of the blocks was decreased in decrements of 1 mm; a 22 mm diameter hole was drilled through the cylindrical samples and the hole size was gradually increased. The second configuration was also used with the bovine samples. For each experimental set-up five SOS measurements were acquired, with the probe aligned along the sample and a mean value computed. All measurements were taken with castor oil as the coupling agent, and in the cylindrical cases, the oil was used to fill the tube.The measurement precision determined as the root mean square coefficient of variation (RMSCV) was determined to be 0.14% and 0.65% for perspex and bovine samples respectively. The measured SOS on the perspex phantom (2760+/-4 m/s) was within the published values for bulk velocity. It was observed that for both perspex and bovine samples the SOS was independent of sample wall thickness greater than the wavelength (2.2 mm, 2.7 mm and 3.5 mm for perspex, trochanter and mid-femur respectively). The SOS decreased with sample wall thickness smaller than the wavelength in concordance with theoretical predictions. The SOS values obtained for bovine samples reflected either totally cortical (mid-femur) or a composite of cortical and cancellous bone (trochanter).

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