An In-Vitro Investigation of the Dependence on Sample Thickness of the Speed of Sound Along the Specimen

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The article describes the effect of cortical thickness on Speed Of Sound measurement using Omnisense.

Introduction

Quantitative ultrasound (QUS) has been shown to be a valid technique in the non-destructive evaluation of the elastic properties of bone tissue in vitro. Since the work of Langton et al. in 1984, there has been increasing interest in the assessment of bone status in vivo. QUS is particularly attractive because it is simple, relatively inexpensive, portable, non-invasive and free of ionizing radiation. As such, QUS has much greater potential for widespread application than standard bone densitometry approaches.

The Technology

Omnisense generates pulsed acoustic waves at a center frequency of 1.25 MHz (bandwidth 0.7 - 1.8 MHz). Four sets of transducers are embodied within the probe. A pair of transducers acts as transmitters, while the other pair acts as receivers. When ultrasound waves are incident on a specimen (bone), depending on the angle of incidence, the waves are reflected, refracted and transmitted. The refracted wave which propagates along the sample can be measured. The transit time is defined as the time it takes for the first detectable signal above noise to arrive at the receiving transducer. According to Snell's Law and the Principle of Minimal Action, the first signal to arrive always follows a path which is characterised by the shortest propagation time.

Study Design

The study examined the dependence of SOS measured along the sample by Sunlight Omnisense™ on the thickness and composition of the bone sample. The measurements were carried out using Perspex* phantoms and bovine mid and trochanteric femurs.

Results

SOS was found to depend on the sample thickness (when the thickness is smaller than the wavelength, approx. 2 mm), shape, and global composition, all of which define a sample's overall strength. These results concur with the theoretical predictions.

Conclusion ▶▶

This study measured the sensitivity of the Omnisense device to sample thickness. Omnisense's proven sensitivity means that it will also be sensitive to the changes in thickness of cortical bone that accompany aging and lead to osteoporosis.

*Perspex was used for its well-known and documented ultrasound properties

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