TEMPERATURE CHANGES IN BONE BY THERAPEUTIC ULTRASOUND: AN EXPERIMENTAL SETUP WITH PHANTOMS AND BOVINE EX Vivo SAMPLE

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RESUMO

Heat distribution in multilayered tissues after therapeutic ultrasound (TUS) stimulation has been investigated in the last decades. However, there are still some concerns regarding wave parameters, dosage and physiological responses, leading to the need for further research. Thermal effect of ultrasound is mainly due to a phenomenon called absorption, in which the mechanical energy is converted into heat. Heating is related to the distribution of intensity in the absorbed beam and the frequency-dependent absorption coefficient (characteristic of each type of tissue). The aim of this study was to assess temperature changes in bone samples and phantoms (mimicking materials) caused by TUS. It was used a sample of bovine ex vivo femur and two cortical bone phantoms (Sawbones®, USA): a 4-mm thick plate and a 5-mm thick cylinder put under a custom-made two-layered soft tissue phantom, and a TUS probe (1-MHz, intensity SATA of 1 W/cm², continuous or 50%-pulsed regimen) was used in contact with it, in a fixed or moving configuration, for 5-minutes stimulation. A thermometer captured temperature values with two K-type thermocouples: one in the bone-soft tissue interface, and the other between the two soft tissue layers. Everything was inside a water bath at 36.5°C and experiments were repeated five times. Wilcoxon tests (p < 0.05) were used for statistical analysis. It can be observed that fixed transducer leads to a higher increase in temperature compared to moving transducer, mainly for the continuous mode. The 50%-pulsed regimen raised maximum temperatures to more than 40°C. Significant differences were observed (p < 0.05) when comparing the setup continuous mode plus moving transducer in bone-soft tissue interface, and comparing the setup continuous mode plus fixed transducer in soft tissue-soft tissue interface. Fixed transducer may be deleterious since it may lead to great temperature increases. Pulsed regimens seem to heat with less intensity compared with continuous applications. Heating by TUS on phantoms may differ from bone samples because of their different thermal constants and geometries.