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QUANIFICATION OF BONE MATURITY USING SCANNING ACOUSTIC MICROSCOPY

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INTRODUCTION: During growth, bone undergoes continuing changes of its structure, which are accompanied by changes in mechanical properties. Treatment strategies may be influenced by both components. Skeletal maturity of an individual is clinically assessed using radiographs of the hands. This site often does not correspond to the site of interest, mechanical characteristics are not addressed by this method, and the technique includes the hazards of radiation. Using ultrasound it seems possible to bypass such drawbacks. It was thus the goal of the present study to investigate ultrasound as a possible alternative to the radiological technique.

METHODS: Buccal cortical bone of the lower jaw of three age groups of pigs (2-3, 4-6, 18-24 months) was compared in three planes. Acoustic impedance, transmission velocity, stiffness, and bulk modulus of each pixel (30µm)[1] were assessed using a reflection scanning acoustic microscope. Microradiographs were used for quantifying the density of pores.

RESULTS: The average conduction velocities, acoustic impedance, stiffness and bulk modulus increased with age. In the frontal plane the values were significantly higher than in the other planes, and group differences were most significant in this plane. Microradiographically, major porosities were found in the youngest age group, which caused a high amount of backscatter from different depth levels. This significantly influenced microscopic ultrasound-reflection and resulted in non-realistically high values of ultrasound velocity.

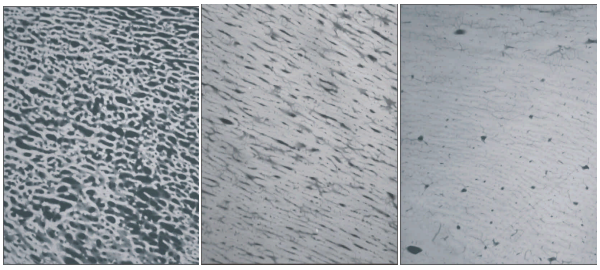

Fig. 1: Increasing bone density with age (left to right) The high porosity of young bone disturbs the ultrasound reflection characteristics.

DISCUSSION & CONCLUSIONS: In young bone high porosity leads to major scatter of ultrasound, which makes the method less precise than in the more compact structures of advanced age groups. Impedance is correlated with bone mineral density[1,2,3], while the conduction velocity shows mainly information on bone structure[4,5,6]. For assessment of bone maturation, transmission velocity is best measured parallel to and within osteons (frontal plane). Backscatter could be used for quantification of bone architecture, and thus bone maturation, when analysing the reflection spectrum for extremely fast conduction speeds. Transmission as well as backscatter measurements do not seem to be sensitive enough for verifying bone maturation in vivo.

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