INTRODUCTION: Ultrasound backscattering from the cartilage surface has been suggested to provide a sensitive index for diagnosing the degeneration of articular cartilage [1, 2]. For this aim, the ability of quantitative ultrasound 2D-imaging to reveal superficial degenerative changes in bovine articular cartilage in vitro was investigated. Furthermore, a novel quantitative ultrasound parameter for the quantification of the cartilage surface roughness was introduced in this study.

MATERIALS AND METHODS: Two groups of osteochondral samples were prepared from bovine patellae (1-3 years old). In group 1, collagenase type VII (44 h) was used for degradation of cartilage collagen, chondroitinase ABC (44 h) for specific digestion of proteoglycans and trypsin (90 min) for proteoglycan digestion with minor effect on the collagen (n = 6 per group). Quantitative ultrasound 2D-imaging was conducted for the cartilage surfaces before and after enzymatic digestions. Group 2 consisted of samples with normal and spontaneously degenerated cartilage appearance at tissue surface (n = 31). After ultrasound imaging, dynamic compressive moduli of the cartilage samples were determined in unconfined compression geometry using a high resolution material testing (10% prestrain, 10% strain, 2 mm/s ramp speed). Degenerative stages of the samples were quantified using a histological Mankin’s scoring method [3]. Subsequently, the samples were divided into four subgroups according to their degenerative stage: intact (Mankin score = 0), early degeneration (Mankin score = 1-2), moderate degeneration (Mankin score = 3-6) and advanced degeneration (Mankin score = 7-10).

A Dermascan-C 20 MHz ultrasound instrument (Cortex Technology, Hadsund, Denmark) was used for ultrasonic 2D-imaging of the samples. Region of interest, determined at the center of the sample, was 4.5 mm and 1 mm in the lateral and axial directions, respectively. Ultrasound reflection and backscattering from the cartilage surface were quantified by calculating ultrasound reflection coefficient in time-domain (R) and integrated reflection and backscattering coefficient in frequency-domain (IRBC) as a function of cartilage histological status (Mankin score). Spearman’s correlation analysis was used when comparing variables. (a) SEM images (100x) of samples digested with collagenase, chondroitinase ABC or trypsin. (b) SEM images (100x) of histologically intact (normal) sample and samples with early or advanced degeneration.

DISCUSSION: Quantitative ultrasound imaging of the articular surface is able to sensitively detect superficial degradation related to disruption of the collagen network. Furthermore, in spontaneous degeneration, cartilage integrity can be estimated using quantitative ultrasound. As a conclusion, quantitative ultrasound imaging, when applied in vivo, may significantly benefit clinical diagnostics of early osteoarthrosis as well as monitoring of tissue healing e.g. after cartilage repair surgery.

REFERENCES:

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