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Effect of inclination of articular surface on ultrasonic surface reflection and surface roughness in diagnosing cartilage degeneration

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High-frequency Quantitative Ultrasound Imaging is a potential method for detecting early osteoarthrotic changes in articular cartilage. However, uncontrolled inclination of the ultrasound transducer or the curvature of the cartilage surface can jeopardize the reliability of the method.
Visually intact and mechanically degraded osteochondral bovine patellae samples were imaged using a scanning acoustic microscope equipped with a 50 MHz ultrasound transducer. The surfaces of the sample and transducer were adjusted to a known relative inclination in three sequential scans (0, 2 and 5 degrees). Surface reflection was evaluated in time and frequency domains and surface roughness in time domain as a function of the inclination.
Inclination of the surface of the sample had a greater effect on the reflection than on the roughness value. Despite the inclination-induced error, the degraded sample could be distinguished from the intact one at all inclinations with both the reflection and roughness parameters. However, as the inclination affected the reflection parameters significantly more, their reliability at greater inclinations is questionable. Furthermore, the proportion of scattering vs. reflection may change as a function of inclination. Provided that the amount of scattering varies against cartilage surface fibrillation, this can affect the reliability of ultrasound diagnostics significantly.