A 3D Study on the Collagen Structure of Articular Cartilage with Different Physiological States.

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Collagen fibres possess great tensile strength [1]. Thus, the collagen fibres and their orientation in the superficial zone of articular cartilage are particularly critical to wear resistance and durability of articular cartilage [2]. Using 2D microscopy, the collagen fibres in the superficial zone of articular cartilage have been traditionally suggested to align tangentially to the surface of articular cartilage. Using a 3D image technique developed [3] and fibre optical laser scanning confocal microscopy (Optiscan Pty Ltd, Melbourne, Australia), we studied the 3D structure of the collagen fibres in the superficial zone of normal articular cartilage, aged cartilage, cartilage with surface disruption and fibrillated cartilage.

Some cartilage was physically peeled off the lamina splendens to create surface disruption. The cartilage specimens were cut as approximately 3mm in diameter and 3mm high cylinders and were stained using picric sirius red staining method. After thoroughly washed by 9g/L saline water, the specimens were examined using a reflectance mode within a fibre optic laser scanning confocal microscope. A 60x oil/1.4NA lens and a laser of 50% 488nm and 50% 514nm were used.

Normal articular cartilage contained interwoven collagen bundles near the articular surface, and the collagen fibres in the superficial zone were predominantly orientated in a way spatially oblique to the AC surface. With aging, the interwoven collagen bundlers were gradually disappeared, and the collagen fibres in the superficial zone intended to align in a direction perpendicular to the articular surface. The interwoven collagen bundles were totally disappeared from the cartilage with surface disruption, and the collagen fibres in the superficial zone of the cartilage predominantly aligned in a direction perpendicular to the AC surface. The fibrillated cartilage has a distinctive macro appearance and collagen structure.

References: