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Ansto



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A comparison of collagen fibre orientations in articular cartilage measured using SAXS and DTI

Background: Diffusion Tensor Imaging (DTI) is a popular technique used to study collagen fibre architecture in articular cartilage. Interpretation of DTI images, however, is limited to the predominant alignment of fibres only¹. Dispersion of fibre orientations can be measured using Small angle X-ray scattering (SAXS). Here, we present a comparison of SAXS and DTI measurements in cartilage. We propose that the SAXS measurements be used to refine DTI-based studies of cartilage microstructure.

Methods: Sixteen matched pairs of articular cartilage samples and eight ligament samples were excised from bovine knee joints. Three cartilage and two ligament samples were treated with trypsin to remove proteoglycans. The diffusion tensor was reconstructed from DTI images and Fractional Anisotropy (FA) was calculated¹. The remaining cartilage samples for SAXS measurements were halved depth-wise to represent the transitional zone (top half- with fibres having no particular alignment) and radial zone (bottom half- with fibres predominantly aligned perpendicular to the articular surface)^[2]. Ten cartilage (both halves) and four ligament samples were dehydrated before SAXS data acquisition. 2D SAXS patterns were processed to extract azimuthal intensity distributions of scattered X-rays. Intensity distributions obtained from each cartilage sample of interest and a reference ligament sample were deconvolved to obtain the distribution of fibre orientations within the cartilage sample^[3].

Results: Fractional anisotropy increases with depth from the articular surface and collagen fiber orientation distributions obtained from SAXS are narrower in the radial zone, corresponding to greater alignment of collagen fibres in the radial zone. This direct correspondence between DTI and SAXS measurements varied from sample to sample, indicating the need for further analysis.

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Conclusion: SAXS shows promise as a complementary tool to DTI for the study of cartilage microstructure. Follow-up studies using SAXS patterns obtained at different locations of the cartilage sample can provide a spatial view of the collagen fibre orientation distributions, making comparisons with spatially varying fractional anisotropies more straightforward.

- References:** 1. de Visser, S. K. et al. Osteoarthritis Cartilage 16, 689–97 (2008).
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Keywords or phrases (comma separated)

collagen fibre orientation, cartilage, DTI, SAXS, FA

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Yes

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Yes

Are you an ECR? (<5 yrs</br>since PhD/Masters)

No

What is your gender?

Female

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