Evaluation of viscoelasticity in early degenerative cartilage using apparent diffusion coefficient

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***Objective*:** Apparent diffusion coefficient (ADC) of cartilage has been shown to correlate mainly with water content in cartilage. As water content of cartilage correlate with viscoelasticity of cartilage, ADC can be a useful measure for the mechanical strength of cartilage. The aim of this study was to investigate the correlation between ADC and viscoelasticity measured by indentation testing.

***Methods*:** ADC of porcine knee (n =20, age 6 months) articular cartilage was measured by using a 3-Tesla MRI . Relaxation time and viscosity coefficient were measured using an indentation device The ADC of the samples was acquired using a single shot spin echo-echo planar image sequence with the following parameters: TR/TE 4000/47 ms, FOV 120×120 mm, matrix 256×256, slice thickness 3.0 mm, *b* values 0, 700, 1000, and 1500 s/mm^2 (Total scan time 1 min 48 sec). Four sites in each specimen, medial and lateral femoral condyle as well as medial and lateral trochlea were analyzed for both MR imaging and indentation testing. Region of interest was drawn over the whole area of superficial layer.

***Results*:** Morphological sagittal image and ADC mapping with distortion correction were shown in figure 1. ADC was correlated with relaxation time and viscosity coefficient (R^2=0.7532 and 0.6894, respectively, p<0.01, Fig. 2-3). The mean relaxation time values and the mean viscosity coefficient values shows on table 1. All of these differences were statistically significant (p<0.05).

***Discussion and Conclusion*:** Cartilage plays a critical role in joint function, where it acts as a shock absorber during joint loading. The significant correlation observed between ADC and viscoelasticity lends support to the notion that ADC can be also useful for the evaluation of degenerative cartilage. Further studies including knees with degenerative cartilage and incorporating biochemical and histological analysis are needed to confirm this. In conclusion, a significant correlation between ADC and viscoelasticity was observed, indicating that ADC can serve as a non-invasive method of assessing cartilage viscoelasticity.

***References*:** Mlynárik V et al. J Magn Reson Imaging 2003; 17(4): 440-4. Li LP et al. Medical Engineering & Physics 2008; 30: 182–189. Li X et al. Osteoarthritis and Cartilage 2007; 15(7): 789-797

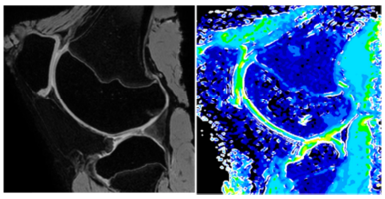

Fig. 1 MR image and ADC mapping with distortion correction

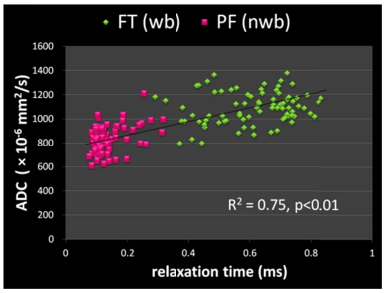

Fig. 2 Correlation between ADC and relaxation time

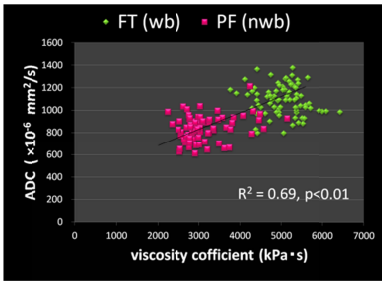

Fig. 3 Correlation between ADC and viscosity coefficient

Table 1. ADC and mechanical property of cartilage

P<0.05

	Weight bearing region	Non-weight bearing region
ADC-map ($\times10^{-6}$ mm^2/s)	1088±125*	835±110*
Relaxation time (ms)	0.61 ± 0.17*	0.14± 0.08*
Viscosity cofficient (N・s/m^2)	5043± 787*	3100 ± 806*