CHEMOMETRIC PREDICTION OF TENSILE MECHANICAL PROPERTIES OF ARTICULAR CARTILAGE FROM FTIR SPECTRA

J. Oinas[1,2*], L. Rieppo[1,2], M. Finnilä[1,2,3], J. Iivarinen[3,4], R. van Weeren[5], HJ Helminen[4], P.A. Brama[6], R.K. Korhonen[3], S. Saarakkala[1,2,7]

*[1]Research Unit of Medical Imaging, Physics and Technology, Faculty of Medicine, Univ. of Oulu, Finland, [2]Medical Research Center, Univ. of Oulu and Oulu Univ. Hospital, Finland, [3]Department of Applied Physics, Univ. of Eastern Finland, Kuopio, Finland, [4]Institute of Biomedicine, Univ. of Eastern Finland, Kuopio, Finland, [5]Department of Equine Sciences, Univ. of Utrecht, Utrecht, Netherlands, [6]School of Veterinary Medicine, University College Dublin, Ireland, [7]Department of Diagnostic Radiology, Oulu Univ. Hospital, Finland, *e-mail: joonas.oinas@oulu.fi*

INTRODUCTION: The biomechanical properties of articular cartilage (AC) arise from its structure and composition[1]. Fourier transform infrared (FTIR) spectroscopy and polarized light microscopy (PLM) provide detailed information about the composition and structure of AC. In the present study, tensional mechanical properties of equine AC tissue were evaluated using aforementioned methods.

METHODS: Equine osteochondral samples (N = 19) were prepared for the study. For testing of mechanical tensile properties, five 150-µm-thick sections parallel to the surface of AC were cut with a microtome from each sample. 5-µm-thick depth-wise sections were prepared from the adjacent tissue block for the FTIR and the PLM. Young's Modulus (YM) and the breaking energy (W) were predicted using the partial least squares regression (PLSR)[2]. Both, the FTIR spectra alone and the combination of the FTIR spectra and the PLM data, which indicates the collagen orientation, were used as predictors. Further, competitive adaptive reweighted sampling (CARS)[3] was used to select the optimal variables for the PLSR models. Pearson correlation coefficients of the PLSR models were compared using appropriate statistical analysis[4].

RESULTS AND CONCLUSION: Using the spectral data alone, the correlation coefficients between the predicted values and the reference values were r_{YM} = 0.82 and r_W = 0.67 (Fig. 1A&B). When the combination of the FTIR spectra and the PLM data was used, the correlation values were r_{YM} = 0.89 and r_W = 0.74. (Fig. 1C&D). The difference between the correlation coefficients was statistically significant for YM (p < 0.05), but not for the W (p = 0.10). These results indicate that the more accurate prediction was obtained when the data from the AC constituent and the structure was used simultaneously for the PLSR model.

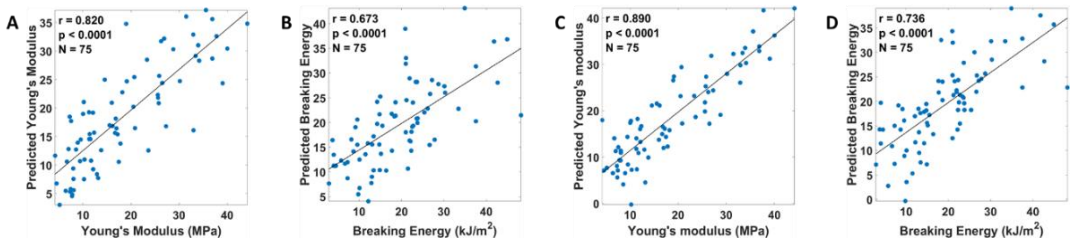

Fig. 1. Scatter plots between the reference values and the predicted values of the YM and the W. In (A) & (B), the FTIR spectra were used alone, and in (C) & (D), both the FTIR and the PLM data was used.

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