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The Benefits of Objective, Quantitative Image Analysis of Histological Sections in Tissue Engineering Studies

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Introduction: Recently we showed the potential of a self-regulating mechanical loading regime to form constructs with cartilage-like histology and high stiffness[1]. Histology usage in tissue engineering is predominately qualitative, restricting utility and data exploitation/interpretation. Our aim was to determine any correlation of metrics derived from objective and quantitative image analysis with functional characteristics of cartilage constructs.

Materials and Methods: Sections of tissue engineered cartilage[1] were stained with either Alcian blue/Sirius red, Harris's haematoxylin or antibodies for type I or type II collagen, and scanned to produce ultra-high-definition images. Percentage coverage and mean and median staining intensity were determined using custom software, and compared with compressive moduli. In addition to this, a novel method of nuclei detection and degree of eccentricity (circular vs elliptical) was developed.

Results: Positive correlations with moduli were found for type II collagen staining (R^2:0.56-0.59) and Alcian blue staining (R^2:0.85-0.87), mirroring previous biochemical data. Nuclei became more circular as constructs became more developed; inferring a chondrocyte phenotype.

Discussion and Conclusions: Quantitative image analysis provides added value to resource intensive, routine histology and correlates with functional properties of tissue engineered constructs, increasing data utility and aiding interpretation.

Reference: Finlay et al., In Vitro Engineering of High Modulus Cartilage-Like Constructs, Tissue Engineering: Part C, 22:4, 2016.