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Repair of critical-sized cartilage defects with engineered constructs generated without cell expansion

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Resurfacing damaged joint cartilage with engineered tissue is a promising approach for defect repair. We have recently developed a method to create large engineered constructs (>3 cm^2) directly from a small cell population (~20,000) without the use of cell expansion. The isolated cells are cultivated in a continuous flow bioreactor which elicits the extensive growth of new, scaffold-free cartilaginous tissue. The aim of the present study was to evaluate the efficacy of repairing critical-sized cartilage defects in a rabbit model using this approach. Allogenic constructs were implanted into critical-sized defects created in the trochlear groove, fixed using a combination of fibrin glue and sutures. The effectiveness of defect repair and construct remodeling were then evaluated up to 6 months post-operatively. Engineered constructs retained their chondrogenic phenotype and effectively repaired the defect site with near seamless integration with the surrounding native cartilage. The implanted tissues also extensively remodeled biochemically and obtained properties similar to that of native cartilage. Interestingly, the quality of repair was found to be dependent on the expression of superficial zone markers (biglycan and PRG4) in the engineered constructs prior to implantation. The results of this study demonstrate that biological joint resurfacing can be achieved without the need of cell expansion methods and their associated problems with retaining the appropriate phenotype of the expanded cells. However, the quality of repair appears to be dependent on the properties of the developed constructs and specifically the ability to generate a superficial zone-like layer in the engineered tissue.

Biography

Stephen Waldman is an Associate Professor and Canada Research Chair at Queen's University. He has been jointly appointed between the departments of Chemical Engineering and Mechanical & Materials Engineering since 2003. His research program is centered on the development of functional orthopaedic tissues (cartilage, ligament and IVD) with specific focus on the effects of biochemical and biomechanical stimuli. He has published over 60 journal articles, serves on the editorial boards of three biomedical engineering journals, and has served on several grant panel review committees of the Canadian Institutes of Health Research in the areas of regenerative medicine and biomedical engineering.

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