Development of decellularized meniscus using closed sonication treatment system: potential scaffolds for orthopedics tissue engineering applications

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Abstract

Purpose: Meniscus is a fibrocartilagenous tissue that cannot effectively heal due to its complex structure and presence of avascular zone. Thus, tissue engineering and regenerative medicine offer an alternative for the regeneration of meniscus tissues using bioscaffolds as a replacement for the damaged one. The aim of this study was to prepare an ideal meniscus bioscaffold with minimal adverse effect on extracellular matrix components (ECMs) using a sonication treatment system.

Methods: The decellularization was achieved using a developed closed sonication treatment system for 10 hrs, and continued with a washing process for 5 days. For the control, a simple immersion treatment was set as a benchmark to compare the decellularization efficiency. Histological and biochemical assays were conducted to investigate the cell removal and retention of the vital extracellular matrix. Surface ultrastructure of the prepared scaffolds was evaluated using scanning electron microscope at 5,000x magnification viewed from cross and longitudinal sections. In addition, the biomechanical properties were investigated through ball indentation testing to study the stiffness, residual forces and compression characteristics. Statistical significance between the samples was determined with p-value = 0.05.

Results: Histological and biochemical assays confirmed the elimination of antigenic cellular components with the retention of the vital extracellular matrix within the sonicated scaffolds. However, there was a significant removal of sulfated glycosaminoglycans. The surface histoarchitecture portrayed the preserved collagen fibril orientation and arrangement. However, there were minor disruptions on the structure, with few empty micropores formed which represented cell lacunae. The biomechanical properties of bioscaffolds showed the retention of viscoelastic behavior of the scaffolds which mimic native tissues. After immersion treatment, those scaffolds had poor results compared to the sonicated scaffolds due to the inefficiency of the treatment.

Conclusion: In conclusion, this study reported that the closed sonication treatment system had high capabilities to prepare ideal bioscaffolds with excellent removal of cellular components, and retained extracellular matrix and biomechanical properties.

Keywords

Author Keywords: sonication; meniscus; scaffolds; decellularization; tissue engineering; regenerative medicine
KeyWords Plus: ULTRASOUND; CAVITATION; MATRIX; DETERGENTS; IMPACT; BUBBLE; REPAIR

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1 of 1

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