ECM Hydrogel Coating Mitigates the Foreign Body Response to Polypropylene Mesh

Denver M. Faulk[1], Ricardo Londono[3], Mathew T. Wolf[1], Christian A. Ranallo[1], Christopher A. Carruthers[1], Justin D. Wildemann[1], Christopher L. Dearth[2,4], Stephen F. Badylak[1,2,4]
[1]Department of Bioengineering, [2]Department of Surgery, and [3]School of Medicine, University of Pittsburgh, Pittsburgh, PA
[4]McGowan Institute for Regenerative Medicine, Pittsburgh, PA

Statement of Purpose: Surgical mesh devices composed of synthetic materials, such as polypropylene, are frequently used in a variety of clinical applications including ventral hernia repair and pelvic floor reconstruction[1]. The benefits of such devices include high mechanical strength, quick incorporation into host tissue, and reduced hernia reoccurrence rates[2]. However, such mesh devices elicit a foreign body response with associated complications of fibrosis and patient discomfort[3]. In contrast, surgical mesh devices composed of naturally occurring extracellular matrix (ECM) are associated with constructive tissue remodeling and minimal fibrosis[4], but often lack the robust mechanical strength of synthetic materials. It has previously been shown that coating a polypropylene mesh with ECM hydrogel mitigates the short term host foreign body response to the synthetic components of the device[5]. However, the long term response and downstream remodeling events remain to be characterized. The primary objective of this study was to assess the effects of an ECM hydrogel coating on the long term host response to implanted ECM coated synthetic mesh materials.

Methods: Tested devices included uncoated and ECM hydrogel coated heavy-weight BARD™ polypropylene mesh, uncoated and ECM hydrogel coated light-weight BARD™ Soft polypropylene mesh, and uncoated light-weight ULTRAPRO™ mesh. These devices were implanted in a rat partial thickness abdominal defect overlay model. The two time points investigated were 14 days and 6 months. Histomorphologic scoring of the tissue remodeling response as well as macrophage phenotype characterization were performed at 14 days. Histomorphologic assessment, collagen deposition characterization, and biaxial testing were performed at 6 months.

Results: After 14 days, fewer cells were present directly adjacent to and between mesh fibers in the ECM coated devices compared to the uncoated mesh devices. Additionally, the ECM coating resulted in a decreased number of pro-inflammatory M1 macrophages directly around the mesh fibers in comparison to the uncoated mesh devices. At 6 months the ECM coating decreased the density and augmented the size of collagen deposited between mesh fibers when compared to the uncoated mesh devices (Figure 1). Biaxial testing showed no difference between groups for longitudinal or circumferential strain. Lastly, histomorphologic analysis at 6 months showed the ECM reduced the total cellularity as well as the foreign body giant cells around mesh fibers for the heavy-weight BARD™ mesh.

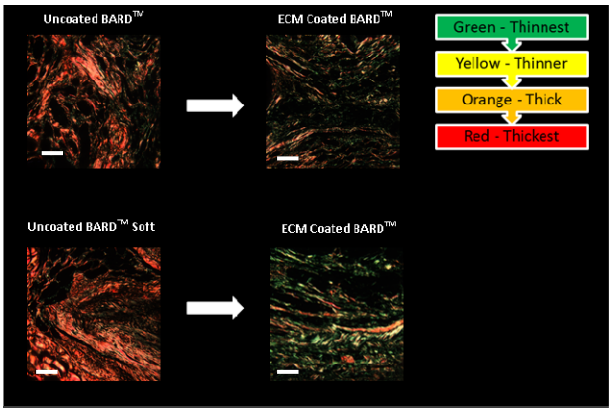

Figure 1. Collagen deposition between mesh fibers at 6 months post-implantation: Representative images of picrosirius red staining of collagen area between uncoated and ECM coated BARD mesh fibers at 6 months using polarized light microscopy. The color hue of the collagen fibers represents the relative collagen thicknesses (in order of thinnest to thickest): green, yellow, orange, and red. Scale bar represents 100 µm.

Conclusions: This study confirms and extends previous findings that an ECM hydrogel coating of a synthetic surgical mesh material can largely mitigate the foreign body host response and associated chronic fibrotic response that is characteristic of these materials. Importantly, this study demonstrates that these beneficial results are long lived and ultimately result in a more constructive tissue deposition in the long term. Specifically, the ECM coating decreases pro-inflammatory M1 macrophages at 14 days, which is associated with decreased collagen deposition at 6 months. These findings are promising and may lead to improved clinical outcomes as well as other regenerative medicine applications.

References:

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