Head-To-Head Comparison of Histologic and Functional Properties of Rat Bladders Augmented With Blood Vessel Matrix Versus Small Intestine Submucosa

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INTRODUCTION: Small Intestine Submucosa (SIS) is the most widely explored biological matrix for genitourinary reconstruction. We compared the urodynamic and histologic properties of SIS (4 ply; Cook Urological) with a novel decellularized blood vessel matrix (BVMx) in a rat bladder augmentation model.

METHODS: Sprague-Dawley rats underwent open bladder augmentation with a 14mm disc of BVMx (n=10) or with SIS (n=5). At 3 months, all animals underwent open cystometrography (CMG). Thereafter, the bladders were harvested, examined grossly and microscopically with Hematoxylin and Eosin, and Trichrom staining.

RESULTS: Grossly, SIS augmented bladders contracted to a size less than the original native bladder, and bladder volume was significantly reduced with a thickened bladder wall. BVMx bladders maintained or exceeded the bladder volume measured immediately after augmentation, without contraction of the matrix. The BVMx was completely covered on the external side with newly formed tissue. CMGs demonstrated an average of 70±5.8 bladder contractions and 22±3.6 micturitions per 60 minutes for the SIS augmented bladders, versus 8±1.4 contractions, all accompanied with micturitions, in the BVMx group ($p < 0.01$), indicating a better bladder compliance in the BVMx group. Histology showed nearly complete degradation of the SIS and a thickened and inflamed bladder wall. In contrast, BVMx underwent minor degradation after 3 months. The BVMx was covered with multi-layers of uro-epithelial cells as well as with smooth muscle cells and fibroblasts that have migrated onto the matrix. Both groups occasionally exhibited urinary stone formation.

CONCLUSION: BVMx augmentation demonstrated acceptable and superior urodynamic and histologic properties compared to SIS augmentation in a rat model. The BVMx bladders have larger volumes and are more compliant than SIS. In addition, BVMx bladders exhibited less degradation and better repopulation by uro-epithelial and smooth muscle cells. Large animal experiments are underway to assess the translational validity of this model for clinical applications.