THE EFFECTS OF VARIOUS DECELLULARIZATION PROTOCOLS ON MECHANICAL AND STRUCTURAL PROPERTIES OF PORCINE AORTIC VALVE LEAFLETS

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Decellularized valves can be readily used for aortic valve replacements since they are removed of major immunogenic cellular components and have the necessary mechanical strength and inherent functional design. In this study, the effects of existing decellularization methods on the mechanical and structural properties of valve leaflets were investigated in order to establish the functional limits of the decellularized valvular extracellular matrix (ECM). Three major decellularization protocols using an anionic detergent (SDS), an enzymatic agent (Trypsin), and a non-ionic detergent (Triton X-100) were evaluated. We found that overall extensibility represented by areal strain under 60 N/m increased after decellularization (Native: 68.9±10.0%, SDS: 106.0±41.8%, Trypsin: 110.9±28.1%, Triton-X: 163.1±31.9%). Moreover, flexural behavior of valve leaflets changed tremendously after decellularization. Unlike native valve leaflets, which demonstrated a nearly perfect linear response over the entire bending curve, the decellularized valve leaflets demonstrated a nonlinear response in both with curvature (WC) and against curvature (AC) direction. The decellularization also caused a large decrease in flexural rigidity (e.g. Effective flexural stiffness of WC – Native: 156.0±24.6 kPa, SDS: 23.5±5.8 kPa, Trypsin: 15.6 ± 4.8 kPa, Triton-X: 19.4±8.9 kPa). Collagen fiber architecture mapping by SALS showed that decellularization treatments resulted in overall disruption of collagen network. Polarized light imaging also revealed that the macroscopically well-organized collagen crimp structure was disrupted by all decellularization protocols. In conclusion, changes of biaxial mechanical properties and nonlinear response of flexural properties of decellularized valve leaflets were likely associated with the ECM disruptions.