## Introduction

More than 5 million Americans are diagnosed with valvular heart disease each year [1]. These diseases frequently correlate with a change in the mechanical properties and microstructure of the heart valve (HV). Three-dimensional computational modeling has recently been employed to gain better insight into how disease-induced stress overloads affect the underlying structure and tissue mechanics of the HV during cardiac function [2]. To properly utilize these diseased models for comparative purposes, accurate material data describing the mechanical response of the native healthy HV is essential. We have previously characterized the mechanical properties and microstructure of the central region of the mitral and tricuspid valve leaflets. The goal of this study is to systematically investigate the spatial variation in both mechanical properties and microstructure of the atrioventricular HV tissues.

## Methods

This study examines the strongly anisotropic mitral anterior leaflet (MVAL) and tricuspid anterior leaflet (TVAL) as representative of the spatial variance in mechanical responses. To quantify this variation, we dissected both MVAL and TVAL and sectioned each leaflet into 6 square specimens (**Fig. 1a, b**). We test each tissue specimen with our biaxial mechanical tester (CellScale, Canada) to characterize its anisotropic material response under various physiological loads. We are also utilizing a polarized spatial frequency domain imaging (pSFDI) system to examine the variance in content and alignment of birefringent collagen fibers in each of these two selected leaflets.

## Results

Preliminary results from a non-statistically-significant sample size suggested increased radial stiffness in the MVAL closer to the heart septum (**Fig. 1c, d**). Similarly, TVAL results showed increased extensibility in both radial and circumferential orientations further from the leaflet attachment at the tricuspid annulus.

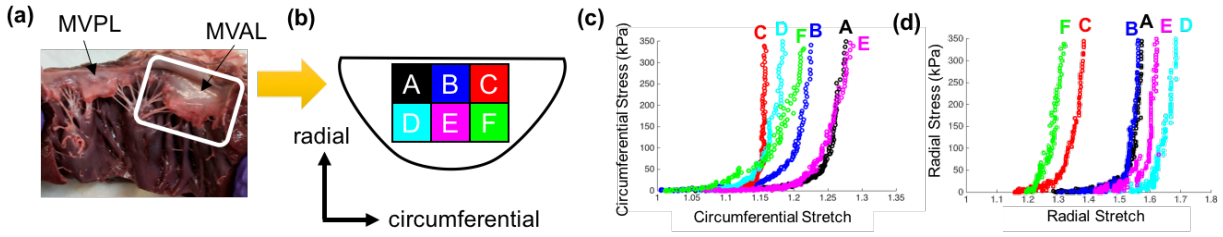


**Fig. 1**. **(a)** a dissected view of the porcine mitral valve with anterior (MVAL) and posterior (MVPL) leaflets labelled. **(b)** schematic of the sectioning of the MVAL into 6 regions for investigation of the spatial variance of leaflet mechanical properties. 1st Piola-Kirchhoff stress versus stretch response of the representative MVAL under equibiaxial tensions, showing spatially-varied anisotropic mechanical behavior in both **(c)** circumferential and **(d)** radial directions.

## Discussion

Both MVAL and TVAL displayed regional variance in mechanical response. These observed regional differences will allow improved computational models through utilization of spatially heterogeneous material models. In addition, we expect that the relation of collagen microstructure to mechanical properties will be instrumental in the creation of multiscale, high-fidelity HV models, as well as in the optimization of bioreactor loading protocols for tissue engineering of HVs. These future improvements to computational modeling and tissue engineering will allow the advancement of HV disease diagnosis, treatment, and healthcare.


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## References


1. Stoodley, L., et al., (2017). J. for Nurse Practitioners, 13(4) pe195
2. Lee, C.H., et al., (2014). J.B., 47(9), p2055-2063