PRELIMINARY STUDY IN CHARACTERIZING TISSUE GROWTH THROUGH RESIDUAL STRAIN

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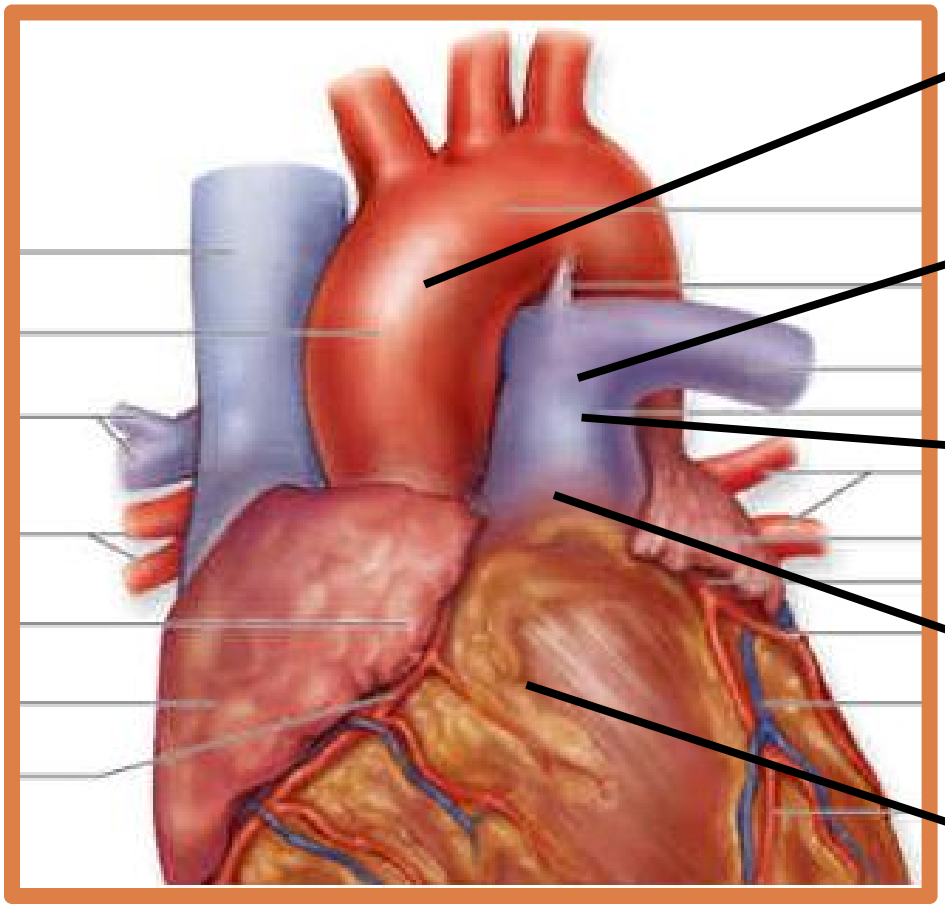
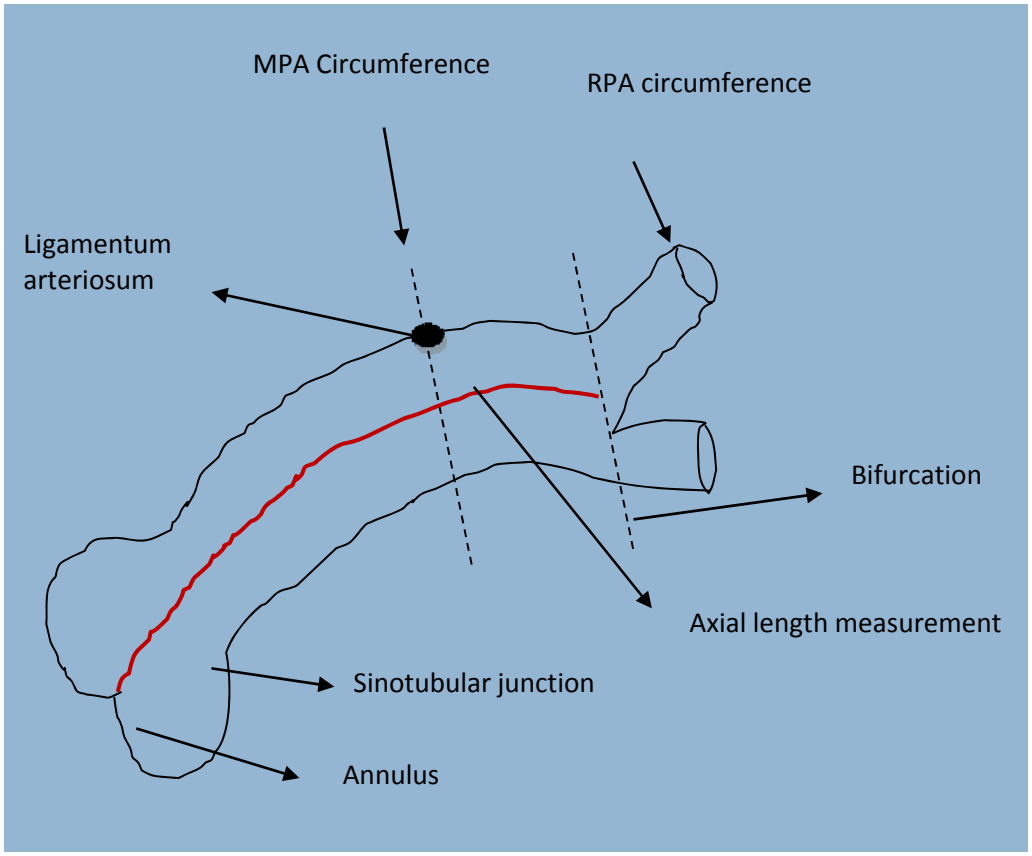
Introduction

- Tissue Engineering
  - Used to restore and maintain tissue/organ function
- The Application
  - Pediatric Right Ventricular Outflow Tract (RVOT) replacements
- The Problem
  - Body rejecting tissue, growth limitations
- The Need
  - Thorough study of native tissue behavior
- **AIM**
  - To characterize the pattern of residual strain in porcine pulmonary trunks (PT)

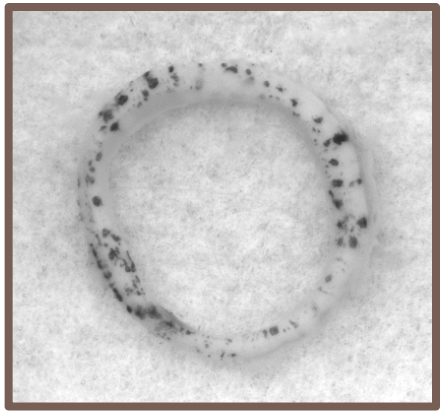
The Tissue


Aorta
Bifurcation Region
Pulmonary Trunk
Sinotubular Junction
Right Ventricle

Tissue Preparation

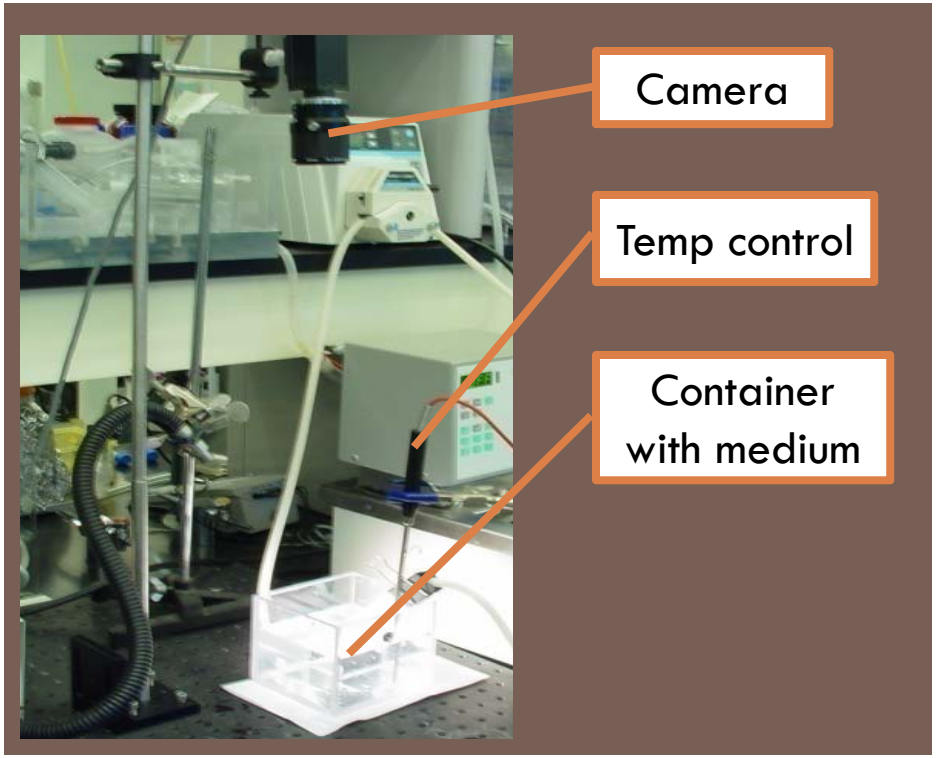


- Two rings cut
  - Sinotubular junction
  - Bifurcation
- Microdots applied

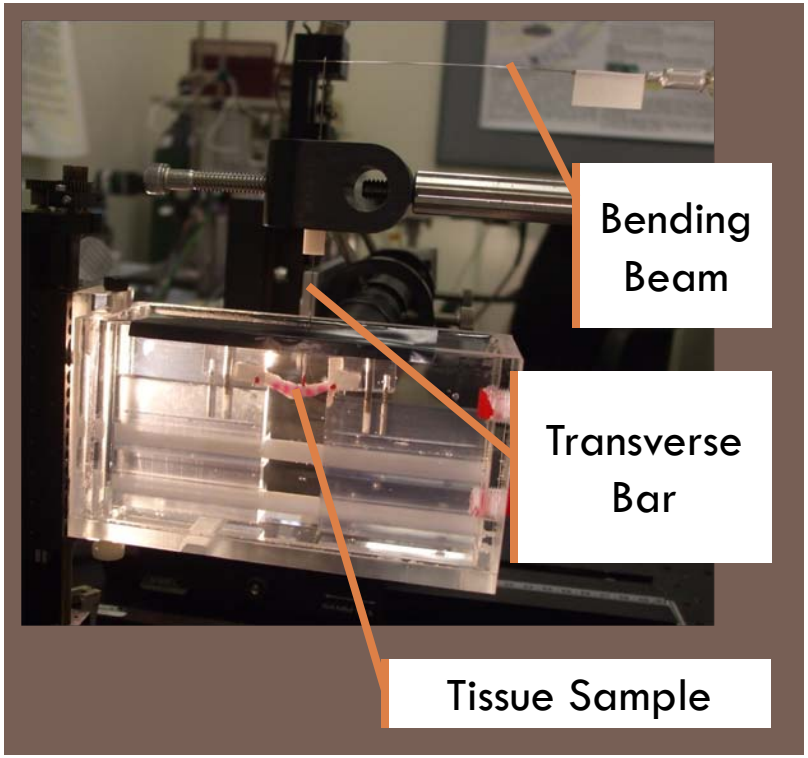


The Tests

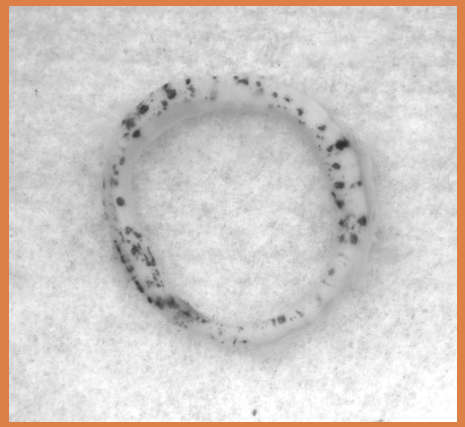
- **Opening Angle/Stretch:**
- Images taken before and after tissue is cut

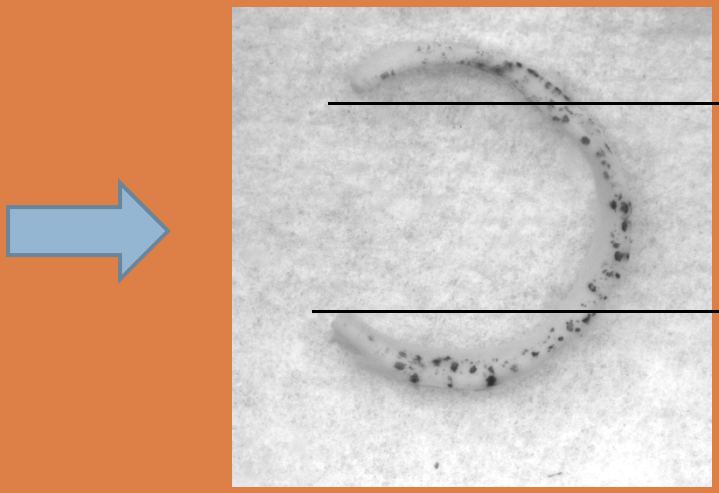


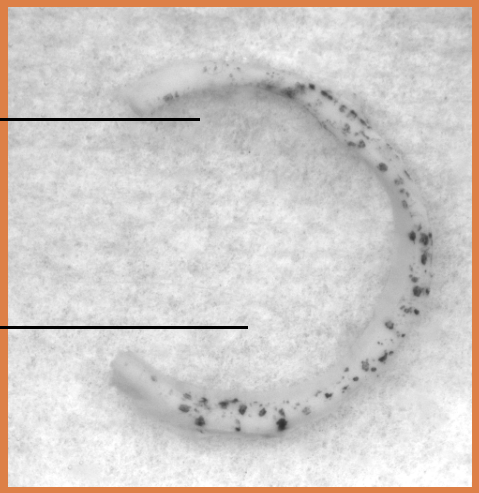
- **Flexural Test:**
- 3-point bending
  - AC and WC



Taking Images







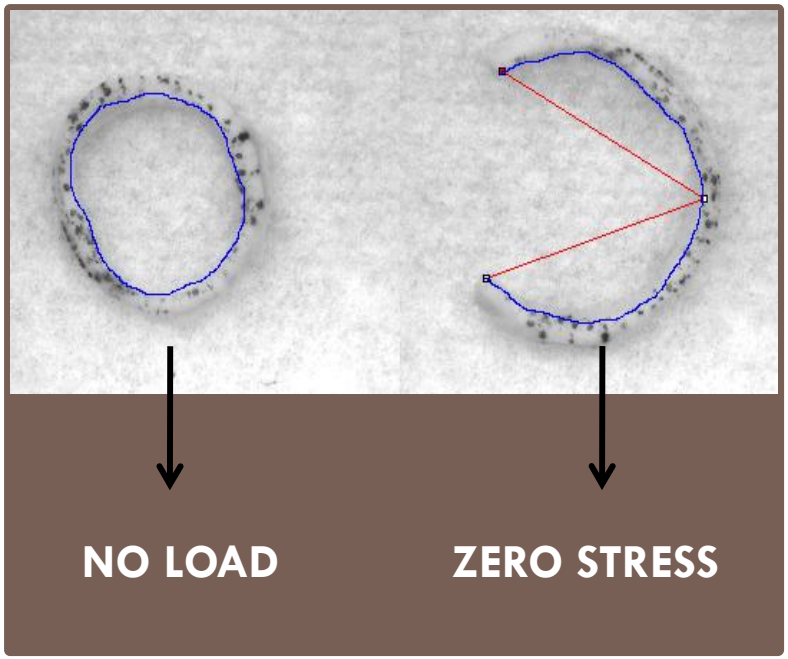
NO LOAD

1st Cut Image

Last Image

Calculations

- ImageJ used to calculate OA and circumferential lengths



- Circumferential Stretch

$$\lambda = \frac{l_{noload}}{L_{zerostress}}$$

- Residual Strain

$$E = \frac{1}{2}\left(\lambda^2 - 1\right)$$

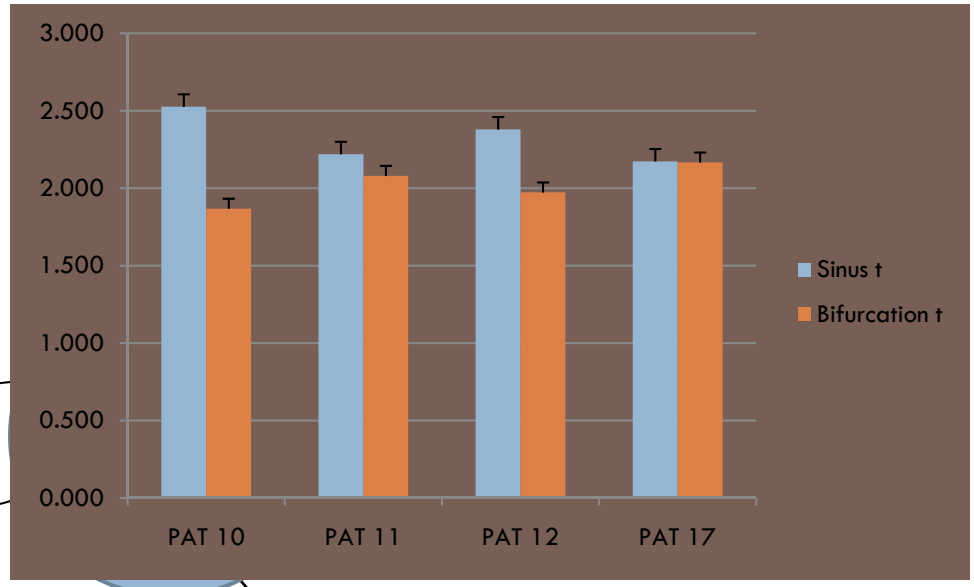
OA and Circumferential Stretch Results

	Sinus OA (in degrees)	Bifurcation OA (in degrees)
PAT 10	143.9617	62.0137
PAT 11	68.7627	0.8030
PAT 12	85.7947	12.9927
PAT 17	82.8827	49.2370
Average	**95.3504**	**31.2616**

	Sinus λ	Bifurcation λ	Sinus E	Bifurcation E	S:B E Ratio
PAT 10	0.9005	0.9808	-0.0945	-0.0190	**4.9780**
PAT 11	0.9775	0.9901	-0.0223	-0.0099	**2.2581**
PAT 12	0.9843	0.9921	-0.0156	-0.0078	**1.9889**
PAT 17	0.9559	0.9831	-0.0431	-0.0168	**2.5693**
Average	**0.9546**	**0.9865**			
SEM	**0.0190**	**0.0027**			
% Error	**1.9909**	**0.2754**			

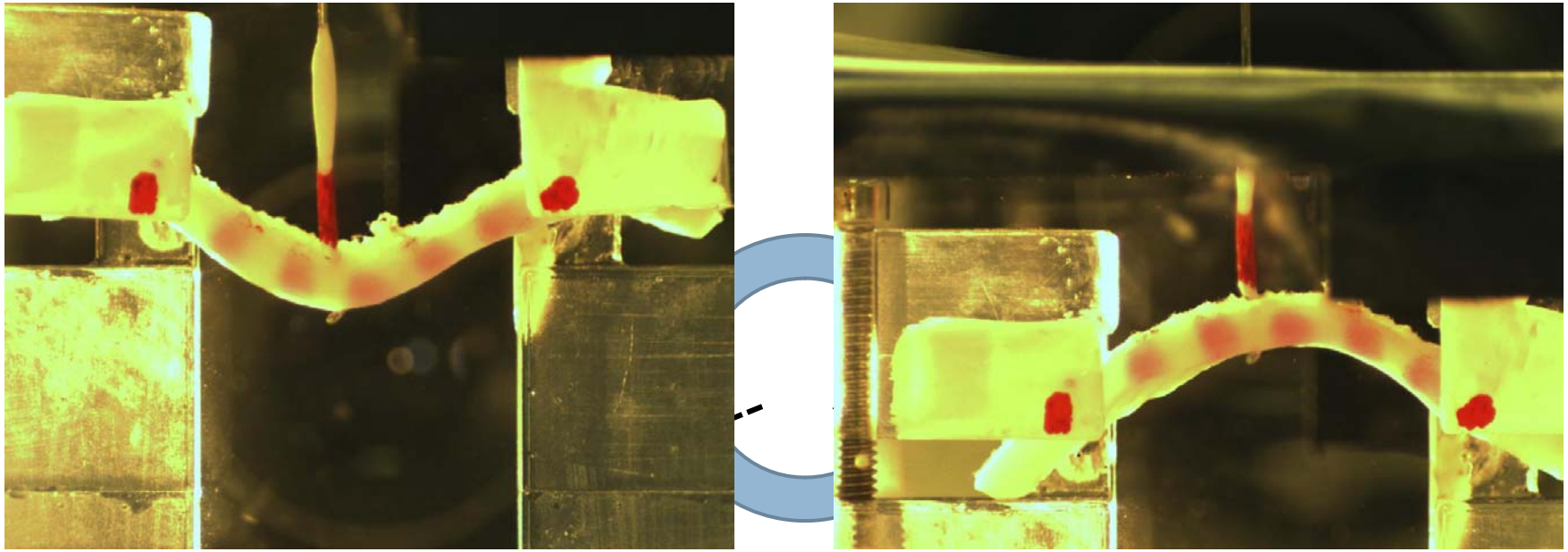
- Sinotubular junction has greater residual strain than Bifurcation region
- Correlation between OA and residual strain

Explaining the Results



	PAT 10	PAT 11	PAT 12	PAT 17	Average	SEM	%
Sinus t avg	2.526	2.220	2.380	2.173	2.325	0.080	3.458
Bifurcation t avg	1.868	2.080	1.973	2.166	2.022	0.065	3.202

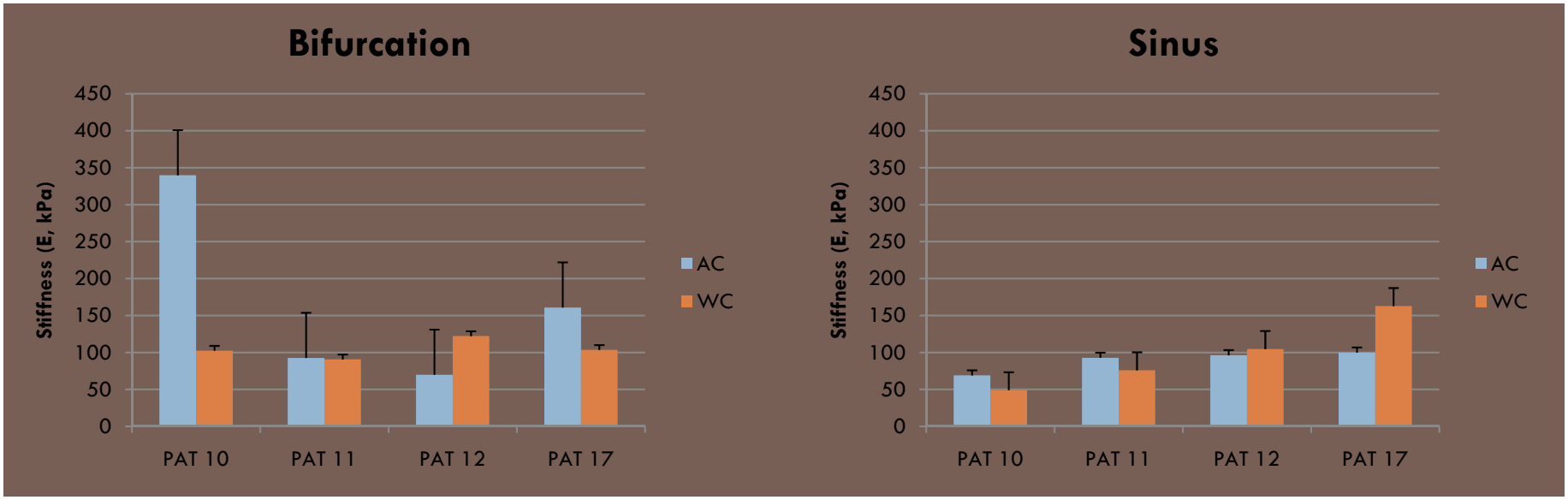
Flexural Tests



Against Curvature (AC)

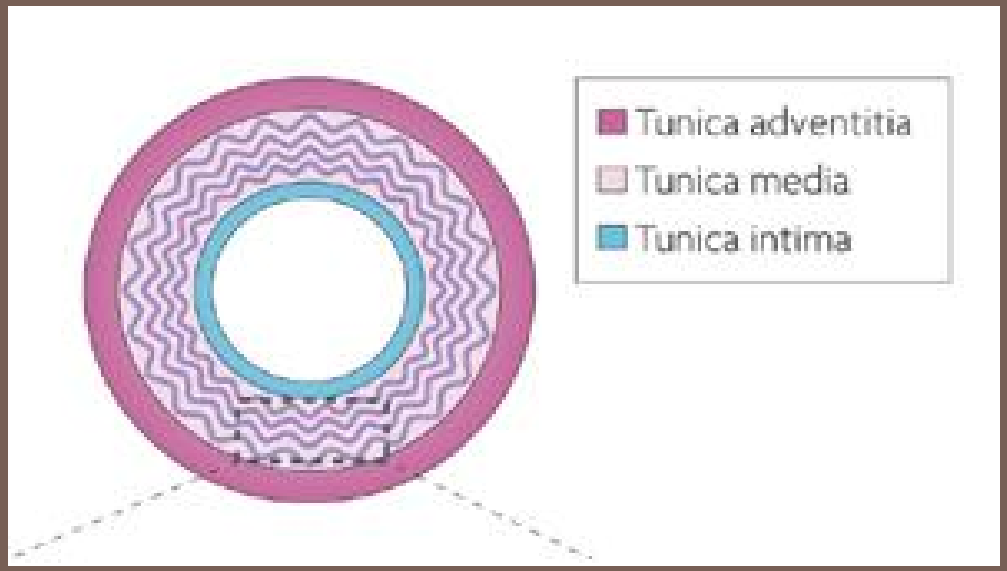
With Curvature (WC)

Flexure Test Results



- Comparing against curvature (AC) and with curvature (WC) stiffness for bifurcation and sinus end samples

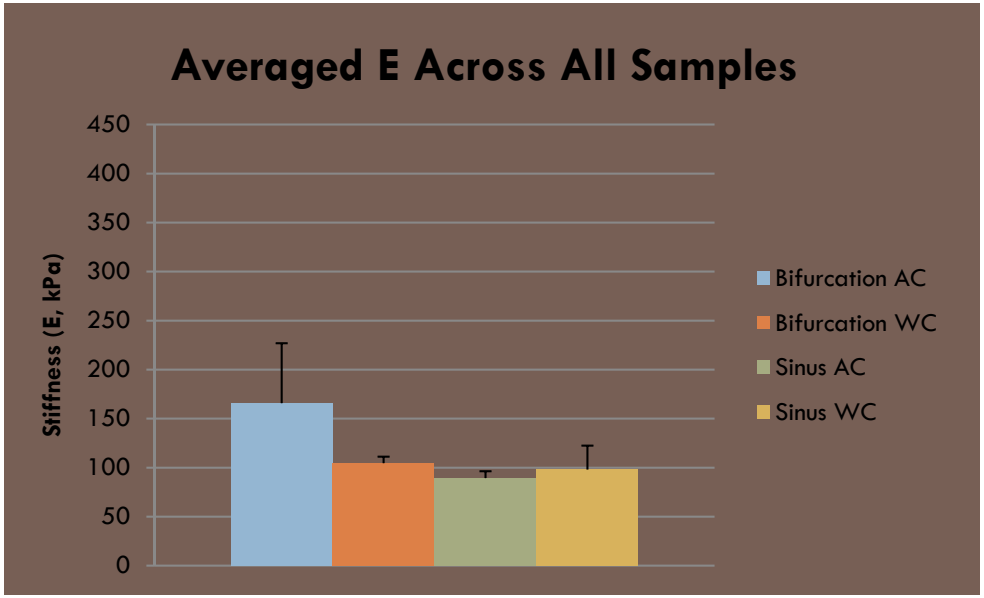
Possible Indication



- Similar stiffness values may indicate isotropic properties throughout tissue layers

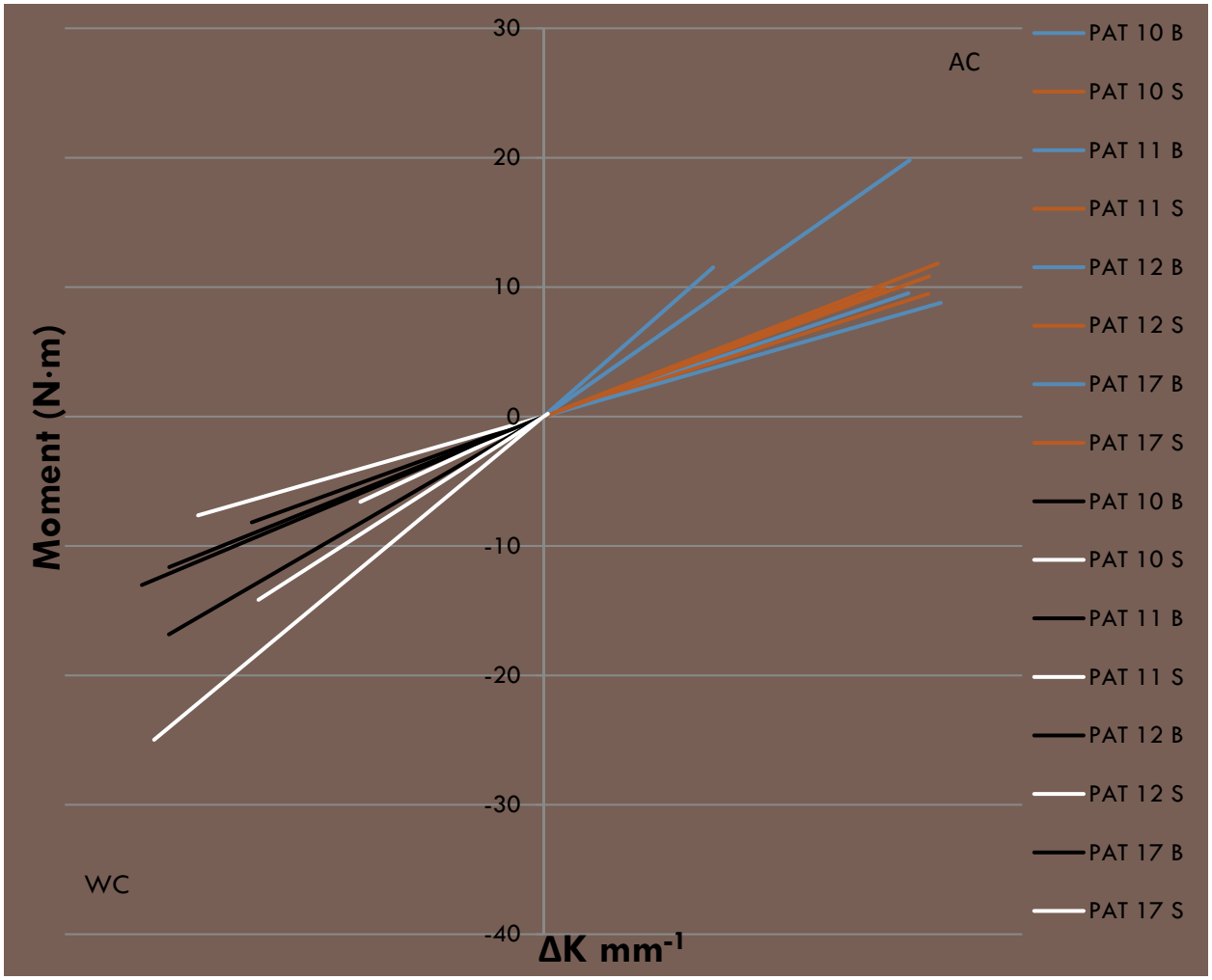
Image: http://www.nature.com/nrm/journal/v8/n11/images/nrm2262-f5.jpg

Flexure Test Results



- Comparing bifurcation, sinotubular junction, AC, and WC stiffness across all samples

Flexural Test Results



- Comparing Bifurcation and Sinus End Effective Stiffness
- $$E = \frac{M}{I\Delta K}$$
  - $$I = \frac{1}{12} wt^3$$

Conclusion and Future Research

- Preliminary data is promising and rough trends may be seen
- The significance of these trends is difficult to tell
- More samples need to be tested

- Expand test to see trend of residual strain over different aged samples
- Study residual stress

Acknowledgements

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