CONTRIBUTION OF ELASTIN TO THE CHANGE IN MECHANICAL PROPERTIES OF PULMONARY ARTERIAL TISSUES RESULTING FROM HYPERTENSION

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Background:

Pulmonary Hypertension

- Leads to vascular remodeling in the chronic situation. Resulting structural changes increase both the flow resistance of the distal arteries and the flow impedance of the proximal arteries.
- The increased afterload imposed on the heart leads to cardiac remodeling and eventual right ventricular failure.
- Stiffening of the proximal arteries increases the hydrodynamic load imposed on the heart, and exacerbates cardiac remodeling.

Artery Morphology

1. Typical structure of Elastic Arteries
   - Tunica Intima: Innermost layer consisting of a single layer of endothelial cells and a thin basement membrane.
   - Tunica Media: Elastic layer consisting of smooth muscle cells, elastic lamellae and collagen fibrils.
   - Tunica Adventitia: Heterically oriented collagen bundles provide strength and rigidity at high strain levels.

Methods:

Animal Model

- 3-Control, 5-Hypertensive Holstein calves (2-wks)
- Hypertension induced by hypoxia (2-wks, 3000’ equivalent air pressure)
- All studies were performed after approval by institutional animal care and use committees.

Measurement Locations and Dissection Geometry

Conclusions

- Physiologic pressures correspond to strains which reside entirely within the elastic dominant region of the stress-strain curve.
- Hypertension results in a thickening of the arteries and in a reduction in the area fraction of elastin. However, the ECF indicates that hypertensive arteries have an overall increase in the amount of elastin.
- There is a significant increase in the stiffness and modulus of both fresh arteries and arterial elastin tissue as a result of the disease.
- Our results show that the stiffness of elastin accounts for 49% of the stiffness of the arteries. However, it is likely that the modulus of the digested elastin samples is lower than the modulus of the tissue in its native state due to the removal of interstitial tissue during digestion.

Histology and Elastic Area Fraction Analysis

- Biopsy samples were fixed in 4% formaldehyde, embedded in paraffin, sectioned and stained with Verhoeff’s Van Gieson stain for elastic fibers.
- Photomicrographs: 100X magnification, sequential images were merged with Photoshop (Photomerge).
- Area fraction determined using Matlab image processing toolbox.
- Intensity Thresholding
- Morphological operations

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