CALIFORNIA SCIENCE & ENGINEERING FAIR
2018 PROJECT SUMMARY

Name(s)

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Project Number

38091

Project Title

A Comparative Study of the Tensile Strength and Elastic Modulus of Mammalian Ventricular Tissue

Abstract

Objectives/Goals

The objective of this project was to determine the tensile strength and elastic modulus of mammalian ventricles in order to compare these values between hearts of different mammals as well as between biologically-preserved and natural hearts. Based on the Frank-Starling Law of the Heart, calculating the elastic modulus should assist in predicting the stroke volume, cardiac output, and efficiency of the heart.

Methods/Materials

3 biologically-preserved heart specimens from cows, pigs, and sheep and 3 fresh cow hearts were obtained from commercial sources. Each heart was dissected to obtain the dorsal and ventral sides of each right and left ventricle. These specimens underwent a gravity tensile test, in which they were suspended in the air using wire and a stepladder. A pail was attached to the base of each specimen, and coins were added to the pail until the specimen fractured. Using the kilograms held, cross-sectional area, and the gravity acceleration constant, engineering stress-strain could be calculated and plotted into Microsoft Excel. This allowed for the determination of the tensile strength and elastic modulus of each specimen.

Results

Researched Body Mass of Each Mammal: Sheep (55.5 kg), Pig (192 kg), Cow (465 kg)

Averaged Results for All Mammalian Ventricular Specimens:

Kilograms Held: Sheep Heart (5.85 kg), Pig Heart (12.61 kg), Fresh Cow Heart (15.76 kg), Preserved Cow Heart (25.85 kg)

Tensile Strength: Pig Heart (79,699.22 Pa), Fresh Cow Heart (83,984.76 Pa), Sheep Heart (111,514.41 Pa), Preserved Cow Heart (114,278.17 Pa)

Elastic Modulus: Sheep Heart (1,360,251.74 Pa), Fresh Cow Heart (3,414,779.54 Pa), Pig Heart (3,874,009.29 Pa), Preserved Cow Heart (5,510,009.27 Pa)

Conclusions/Discussion

A correlation was discovered between body mass and elastic modulus, which supports the idea that mammals with larger body mass need a greater stroke volume and cardiac output to fit their needs. This correlation could not be extended to tensile strength, which could be explained through the comparative anatomy of the mammals. Additionally, biological preservatives did increase the potential efficiency of the heart but would be impractical to test in living organisms due to invasive chemicals. Ultimately, researching the biomechanical properties of the heart will assist cardiologists in engineering biomimetic heart transplants and scaffolds that may be able to replace or support defective heart tissue.

Summary Statement

The tensile strength & elastic modulus of various mammalian ventricles were calculated experimentally in order to draw comparisons between these values and determine a relative stroke volume/cardiac output for each heart.

Help Received

My parents purchased the materials; however, I designed and performed all of the dissection and experimentation by myself.