The Development of Heart Disease Models for Better Patient Understanding

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Abstract

MOTIVATION: This research topic allows for deeper understanding in the topic of cardiovascular health. The specific disease researched in this lab is Hypertrophic Cardiomyopathy. Knowledge on this disease allows for early detection, better treatment, improved outcomes, and a deeper understanding in cardiovascular pathology.

OBJECTIVE:
The goals of this lab are to:

1. Develop a strong understanding of **how the heart functions and the mechanisms of key heart diseases**, including hypertrophic cardiomyopathy and cardiac fibrosis.
2. **Create physical models of the left ventricle** with carious wall thicknesses to help patients visualize and understand how structural changes affect heart function during conditions involving left ventricular remodeling.

Background

- Heart Disease is the #1 cause of death worldwide, yet patients often struggle to understand how it physically affects their bodies. One form, Hypertrophic Cardiomyopathy, causes the walls of the left ventricle (the heart's main pumping chamber) to thicken abnormally.
- Thickening can cause a variety of symptoms such as blocked blood flow from the heart, chest pain, shortness of breath, fainting, and increased sudden cardiac death.
- Most patients see 2D images, or read pamphlets about their condition but they don't physically grasp what's happening in their own heart.
- This gap in understanding can lead to fear, confusion, aand poor treatment adherence.
- Current Solutions to this issue include 2D medical diagrams, MRI's, ultrasounds, and verbal explanation from doctors. However all of these methods can be difficult for patients to interpret without prior training in the field.

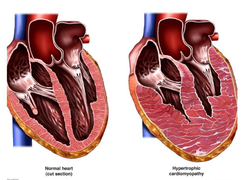
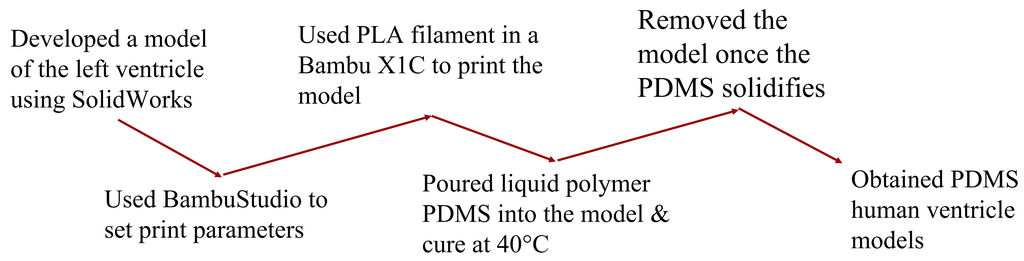


Figure 1. *Hypertrophic Cardiomyopathy (from NIH NHLBI)*

Experimental Methods

In order to create the model of the left ventricle, we needed to **gain a deeper understanding on the functions of the heart and how certain diseases impact the pumping function..** Research included diving into Hypertrophic Cardiomyopathy, Cardiac Fibrosis, stress/strain relationships, and elastic modulus. This background information was crucial in our understanding of the topic.

Experimental Process



Results

3D DESIGNING/ SKETCHES

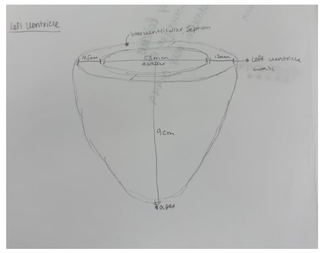


Figure 1. *Hand drawn sketch of 3D left Ventricle Mold*

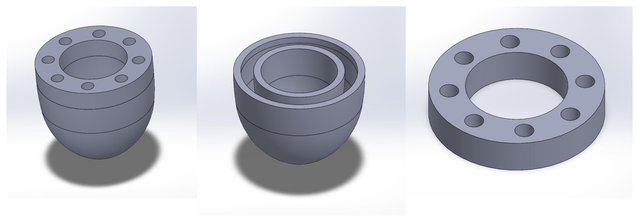


Figure 2. *Solidworks 3D Design*

3D PRINTING/ PDMS POLYMER

Figure 3. *Bambu X1C 3D printer*

Figure 4. *3D Printed Mold with PDMS inside*

Figure 5. *Completed Polymer Ventricle Model*

Conclusion and Future Steps

CONCLUSION: This research project focused on the development of physical and visual models to represent **how heart diseases affect the structure and function of the left ventricle.** Through studying the anatomy of the heart and conditions like HCM, we gained a deeper understanding of how thickening of the ventricular wall can reduce chamber volume, obstruct blood flow, and impact overall cardiac efficiency.

FUTURE STEPS: To continue on with this research, **additional heart disease models can be developed to aid in patient understanding.** Some people struggle with understanding their heart conditions and creating something that is universally understandable can help them comprehend the condition.

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