Nicholas' Contributions - Gore Capstone – Iliac Bifurcation Aneurysm Model

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Abstract

The objective of project : create an in-vitro model of a Common Iliac Artery Aneurysm (CIAA) model and a replicable manufacturing process for this model . I was an imperative part of this team .

The CIAA Team was able to do this as well as we did because of collaboration . My largest contributions were:

- Material Characterization
- CAD Model Redesign
- Wax Key Technician for Manufacturing
- Treasurer Duties

Material Characterization – Rheometer Testing

Current methods of *in-vitro* modeling is typically glass or silicone models. The CIAA Team wanted to develop a manufacturing process for a material that could potentially mimic the properties of human vascular tissue. The following tests can be compared to human vascular tissue data. [1]

Polyurethane samples from BJB Enterprises with varying amounts of a thinning agent called SC-22 (BJB Enterprise) were characterized with a Discovery HR-2 Rheometer (TA Instruments – **Fig 1,** for Tests 1-4). These Tests were adopted and replicated from [1] for these polyurethane samples.

- **Test 1** [1] : A compression test was preformed in order to acquire Elastic Modulus (**Fig 2**)
- **Test 2** [1] : Shear Modulus was acquired using the same fittings as Test 1 (**Fig 2**)
- **Test 3** [1] : *A 5mm indenter tip was used in order to record hardness data* (**Fig 3**)

Fig 1 [1] : Hybrid rheometer

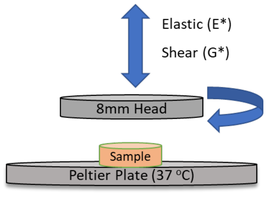


Fig 2 [1] : Setup for Test 1 and Test 2

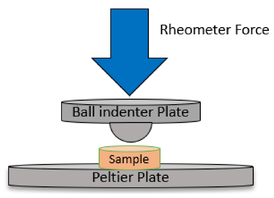


Fig 3 [1] : Setup for Test 3

- **Test 4** [1] : *An innovative Lubricity test was also replicated from [1]. This test can be compared to human data using the same test in order to further characterize the material against an endothelial medium.* ***Fig 4*** *shows the lubricity test that was preformed.*

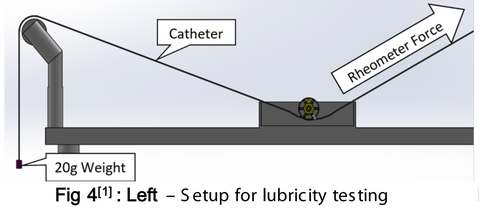
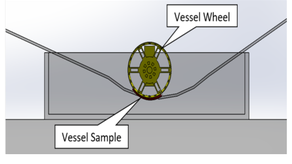


Fig 4 [1] : **Left** – Setup for lubricity testing



Right – Close up of sample wheel

Material Characterization – Graphs

The material Characterization was preformed, and the resulting graphs are presented below.

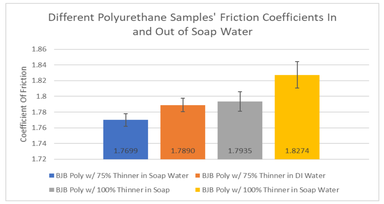


Fig 5: Soap will lower the lubricity but adding thinner will raise it.

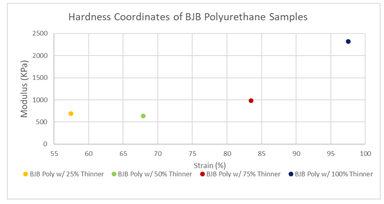


Fig 6: The percent compression was increasing linearly however the modulus was changing exponentially. A second hardness test was preformed to acquire the Shore A

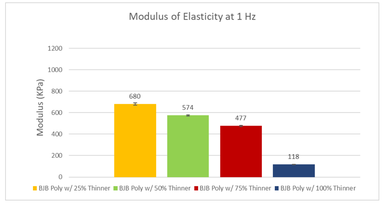


Fig 7: There seemed to be a linear response to the thinning agent until the 100% .

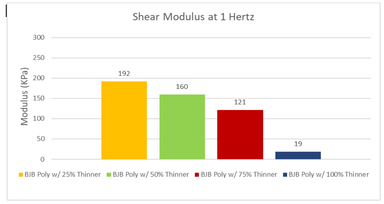


Fig 8: The trend is the same as the elastic test. The materials respond as if they are homogenous. As expected for this material.

CAD Model Redesign

The CAD geometries were discovered by myself and Noah. The Final CAD model was my responsibility. The first iteration of the CAD model had some minor issues that were mostly discovered after the first prototype was made (**Fig 10**). **Fig 9** shows the CAD model that this model was based fro

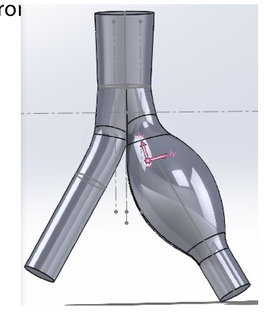


Fig 9: Initial CAD Design

Fig 10: Our First In-Vitro Model

Both CAD Models have accurate anatomical data according to research; however, the point at which the vasculature bifurcates comes to a sharp point. This looks anatomically correct in comparison to cadaver pictures, but the fluid dynamics could be disrupted by the small sharp point on the inside of the model, and this created a stress concentration and tearing issue.

Results – Continued

In order to resolve these issues the design was iterated, and the bifurcation was smoothed in order to allow for less turbulent hemodynamics and to resolve the tearing issue. The second design is sho

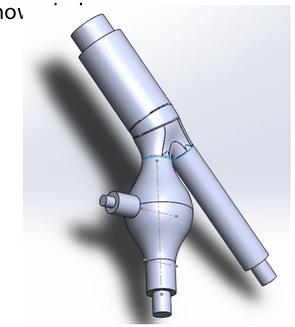


Fig 9: Final CAD Design

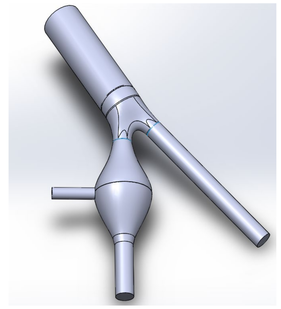


Fig 10: Final Design for the Wax Key

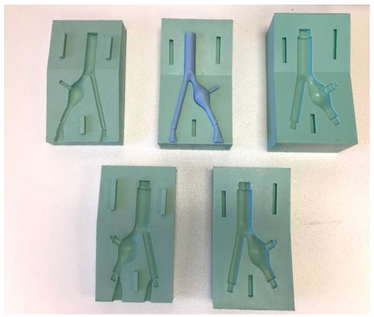


Fig 9: Silicone Molds from Final Design

Fig 10: Final Model Cast from Silicone Molds

Treasurer Duties

To best accomplish the duties as treasurer, I had to ensure that I was familiar with every aspect of the project at every point. This allowed me tou gauge the needs of the team and purchase needed items in a timely manner. I also networked and created relationships between myself and other departments. This gave our team the best advantage when unforeseen circumstances arose. I was able to accomplish all tasks listed, more than that, and budgeted to such a degree that the team was able to afford polos for a professional appearance for our presentations.

References

[1] Norris N, Settanni C, Merrit W, Smith I, Becker T. *In Vitro* Vascular Model Material Characterization. Journal of Nuro Introventional Surgery Issue 11

Acknowledgments

W.L. Gore and Associates
Dr. Becker

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