Geometrically-Tunable Blood Shunt for Heart Reconstructive Surgeries

DREXEL UNIVERSITY School of Biomedical Engineering, Science and Health Systems

Carly Bachner, Slava Beliaev, Malkah Sheldon, Marie Trang, Joshua Yang

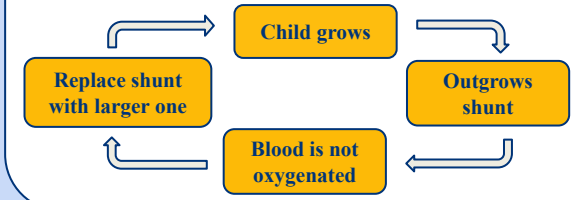
Christopher Rodell, Ph.D., Associate Professor

Team 11

Need

Fatal single ventricle birth defects occur 1,000 to 2,000 annually

- Existing shunts do not accommodate growth



Objective: Develop a method to create a 3D tubular hydrogel in a shunt with an uniform inner lumen

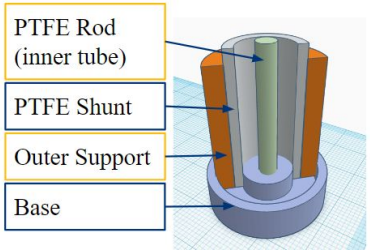
Requirements

- **R1:** Hydrogel is fully adhered to shunt (***Failure > 60% strain***)
- **R2:** Uniform concentric lumen diameter (***3.5 mm ± 5%***)

Solution

A **molding apparatus** to allow hydrogel to form and adhere in PTFE shunt and create a concentric inner lumen

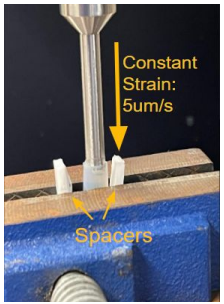
- Shunt support
- Dowel
- Uniform liquid gel loading

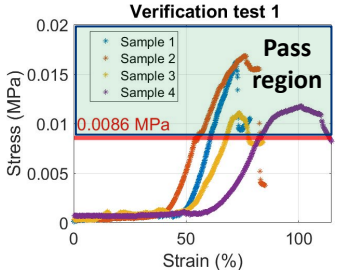


Results

Pushout Test (VT1)

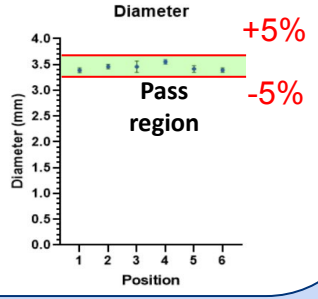
- **No gel delaminations from shunts (n=4)**
- **Push-out test PASSED**





ImageJ Analysis (VT2)

- **No lumen out of 5% tolerance (n = 15)**
- **ImageJ Analysis PASSED**



Impact & Future Revisions

- Translated hydrogel from 5mm washers to 3cm tubings (500% increase)
- Reduce neonatal open-heart surgeries which have 24% fatality rate
- Stiffer inner dowel to form centered inner lumen
- Implement a design to help remove shunt tubing from outer support
- Higher quality 3D printer, to ensure correct tolerances and mitigate leakages