Location Matters: Offset in Location of Tissue Engineered Vascular Grafts Affects Wall Shear Stress in Porcine Models

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Background

- Congenital heart defects affect 40,000 children annually
- We have developed biodegradable patient specific tissue engineered vascular grafts (TEVG), designed for precise locations, to improve congenital vascular repair and optimize hemodynamic performance
- Computational fluid dynamics (CFD) is used to design optimal conduits by predicting hemodynamic performance in terms of wall shear stress (WSS), energy loss, helicity, & vorticity
- High WSS may lead to high-risk plaques and thus, atherosclerosis and myocardial infarction

Objective

To investigate whether the location of the implanted TEVG affects the hemodynamic performance of the blood vessel

Methods

Creation of TEVG for Nine Porcine Subjects

Results

- Patient specific TEVG were displaced by approximately 1 to 8 mm during implantation surgery when compared to their intended locations used in CFD simulations
- Greater offset between intended and observed position led to higher WSS in post-operative vasculature (P = 0.0001), but no correlations were observed with energy loss, helicity, and vorticity (P = 0.1695, P = 0.2649, and P = 0.5321, respectively)
- Grafts implanted closer to their surgically simulated locations showed improvements in WSS hemodynamic performance

Conclusion

- This is the first study assessing accuracy of surgical planning using patient specific TEVG
- Higher WSS was observed if TEVG were implanted far from their intended location used in surgical simulations
- Underscores precision-guided implantation of TEVG to optimize hemodynamics in cardiac surgery
- Future Work: Develop a precision guided surgical implantation tool to increase the reproducibility of preoperative surgical planning