ECA 2025 Conference

The 4th International Electronic Conference on Antibiotics

21–23 May 2025 | Online

MDPI

Corrugated Biopolymeric Grafts: A Multifunctional Approach to Vascular Reconstruction and Haemodynamic Optimization

Hadiya Malik [1,2], Waqar Ahmed [1,3], Mishaal Khawar [1], Rabia Slamat [1], Nabeera Malik [4], Manala Khalid [1], Komal Tariq [1]

1 Department of Biomedical Engineering, Riphah International University, 55150 Lahore, Pakistan
2 Biomedical Engineering Centre, University of Engineering and Technology, Lahore, Kala Shah Kaku (K.S.K.) Campus, Pakistan
3 Department of Mechanical Engineering, University of Engineering and Technology Lahore, Pakistan
4 Quaid-e-Azam Medical College, Bahawalpur, Pakistan

INTRODUCTION & AIM

Vascular grafts are pivotal in treating cardiovascular diseases, yet conventional synthetic materials (ePTFE/Dacron) face challenges like thrombosis and mechanical mismatch. Corrugated biopolymeric grafts emerge as a promising alternative,offering enhanced mechanical stability, biocompatibility, and hemodynamic optimization through tailored surface geometries.

This study employs computational modeling (COMSOL) to evaluate the mechanical strength and hemodynamic behavior of smooth versus corrugated grafts, addressing their clinical trade-offs—balancing reduced thrombosis risk in smooth grafts against the superior integration and compliance of corrugated designs—to guide next-generation vascular graft innovation.

METHOD

01 Model Design
- Geometry construction
- Material Assignment

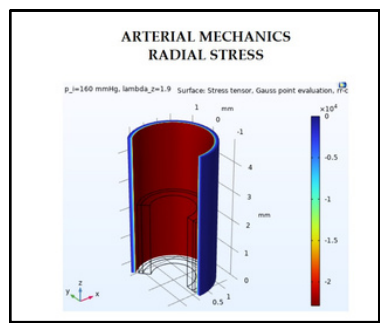
02 Physics Setup
- Stress Strain Analysis
- Thermal Effects
- Fluid structure interaction

03 Simulation Execution
- Dynamic testing
- Parametric testing

RESULTS & DISCUSSION

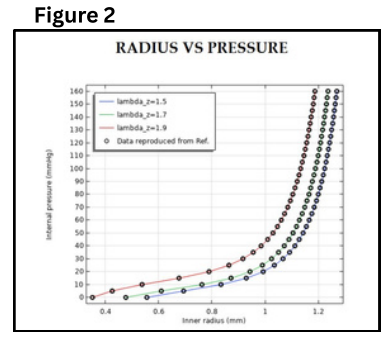
These findings suggest that the corrugated design, while potentially offering better tissue integration as mentioned in the introduction of the project report, exhibits a different stress profile and fluid dynamics compared to smooth grafts.

Figure 1



Stress concentration observed in figure 1 could have implications for the long-term mechanical integrity of the graft.

Figure 2



Radius-Pressure relationship in figure 2 demonstrates the compliance characteristics of the graft under varying axial stretch, for mimicking the natural artery.

Figure 3

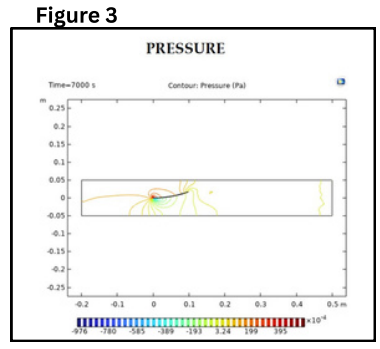


Figure 4

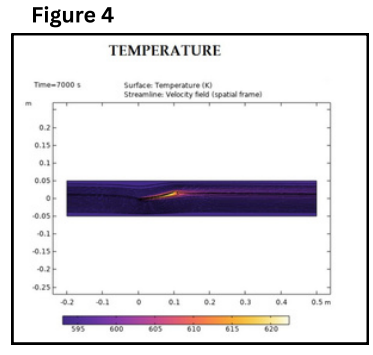
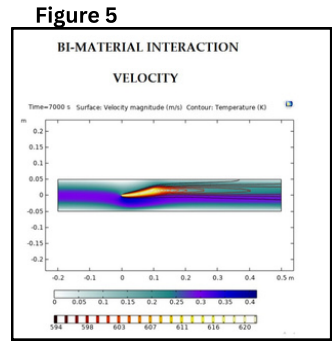


Figure 5



Temperature, Pressure, and Velocity profiles in figures 3-5 provide insights into the microenvironment of the graft, which can influence cellular behavior and graft performance.

CONCLUSION

The computational modeling provides valuable data for understanding the mechanical and hemodynamic characteristics of smooth and corrugated vascular grafts. The results underscore the trade-offs between the two designs, suggesting that the optimal graft choice may depend on the specific clinical application and the desired balance between mechanical stability, biocompatibility, and hemodynamic performance.

FUTURE WORK

Future research will combine advanced computational modeling of biofilm formation with in vivo validation of infection resistance. This will pave the way for improved long-term graft outcomes.