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IMPACT OF TEMPORAL VARIATION IN INLET WAVEFORM ON HEMODYNAMIC PREDICTION IN THE DESCENDING AORTA

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1. Introduction

Ascending Thoracic Aortic Aneurysm (ATAA) poses life-threatening risks such as aortic dissection, especially for Marfan Syndrome (MFS) patients [1]. The David procedure reduces Type A aortic dissection risk in MFS, but Acute Type B Aortic Dissection (ATBAD) risk remains 20% after proximal repair at 20 years from the original surgery [1]. Pre- and post-repair hemodynamic variations may provide insights into this elevated incidence of ATBAD. Computational fluid dynamics (CFD) can assess these changes, but concerns persist about the choice of inlet boundary condition (BC) in the absence of patient-specific inlet data as interindividual variability in flow waveform may affect accuracy [2]. In this study, we explore the sensitivity of hemodynamic parameters' alteration in the descending aorta to the temporal variation of inlet BC.

2. Materials and Methods

Pre-op and post-op CT scans were obtained from a 54-year-old male diagnosed with MFS who underwent the David procedure at Toronto General Hospital. CFD simulations were then employed to analyse the 90th percentile of time-averaged wall shear stress (TAWSS) before and after the surgery considering two generic inlet waveforms with different temporal variations. Segmental analysis was conducted within each 5 mm segment of the descending aorta.

3. Results

Both inlet scenarios effectively depicted TAWSS spatial characteristics, highlighting low and high TAWSS regions. However, they differed in magnitudes, with the first scenario showing 1.36- and 1.32-times higher magnitudes than the second scenario for pre-op/post-op ratios, respectively. Across all segments, the maximum difference in circumferentially averaged values between scenarios was 0.23 Pa. Furthermore, the pre-op/post-op median ratio for the entire descending aorta was 0.96 for the first scenario and 0.92 for the second scenario (Fig. 1).

4. Discussion and Conclusions

Temporal changes in the inlet waveform mainly affect magnitude of TAWSS, with minimal impact on the characteristics and averaged TAWSS values in the descending aorta. In cases of unavailable patient-specific inlet data, and when magnitude is not the focus, using a generic waveform scaled by cardiac output is acceptable for assessing hemodynamic variations in the descending aorta.

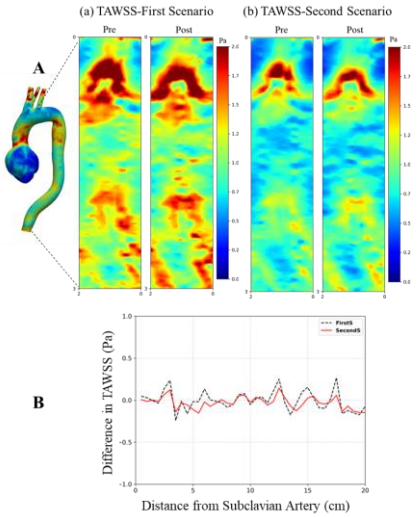

Figure 1. (A) TAWSS map and (B) circumferentially averaged TAWSS in the descending aorta for both inlet scenarios.

References

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2. Tajeddini, Farshad, et al. Journal of Fluids Engineering 145.6 (2023): 061106.

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