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Fluid Simulation of a Transcatheter Aortic Valve Deployment into a Patient-Specific Aortic Root

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Successful transcatheter aortic valve (TAV) deployment and function are heavily reliant on the implant-host tissue interaction. Many adverse events observed clinically in TAV procedures such as impairment of coronary artery flow, paravalvular leak, and access site injury could be attributed to improper TAV deployment and interaction with the aortic root. In this study, we performed a computational analysis of the TAV-aortic root interaction, particularly the hemodynamics before and after TAV deployment. Utilizing a recently developed computational TAV model, we simulated the deployment of this TAV into a 68 year old male patient. The geometry of the patient?s aortic valve and root were extracted from clinical CT images. From the simulation results, we obtained a peak transvalvular pressure drop of 78.45 and 25.27 mmHg before and after the TAV deployment, respectively. The mean systolic ejection transvalvular pressure reduced from 45.8 to 7.55 mmHg and effective orifice area (EOA) increased from 0.53 to 1.595 cm^2 following the TAV intervention. The altered flow pattern following TAV intervention resulted in a significant pressure drop in the vicinity of the sinuses of Valsalva, and a corresponding decrease in percentage of cardiac output reaching the coronary arteries from 5.14 to 4.07% from pre- to post-TAV deployment. In conclusion, the developed computational models allow for a quantitative analysis of the hemodynamics before and after TAV intervention, and thus could be an enabling tool for patient screening and TAV design improvement.

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