In silico models of post-dilatation in TAVI patients

Letizia Maria Perri, Benedetta Grossi, Francesco Migliavacca, Gianluigi Condorelli, Giulio Stefanini, Giulia Luraghi
Politecnico di Milano, Department of Chemistry, Materials and Chemical Engineering

Abstract:
Balloon post-dilatation in Transcatheter Aortic Valve Implantation (TAVI) aims to reduce paravalvular leakage (PVL). This study develops a computational model to simulate post-dilatation in patient-specific anatomies, predicting complications and improving clinical outcomes. A post-dilatation balloon model is reconstructed, and simulations of deflation, crimping, and inflation are conducted. The balloon is then integrated into patient-specific anatomical models based on preoperative CT images. Two patients undergoing balloon post-dilatation with implanted self-expandable valves are analyzed using finite-element simulations. Model validation is performed through qualitative and quantitative comparisons with postoperative clinical data, including angiographies and CT images. Additionally, fluid dynamics simulations are conducted to evaluate and predict the PVL with and without post-dilatation. A qualitative match is observed between simulated and in vivo stent configurations. Among all
post-dilation simulations, the maximum and minimum orifice area percentage differences between the simulated and segmented stents are 2.33 Â± 1.32% and 1.14 Â± 0.92%, respectively. Eccentricity errors are 1.7301% (max) and 0.1112% (min). Compared to simulations without post-dilatation, orifice area and eccentricity improvements reach 70% and 75%, respectively. Preliminary fluid dynamics results indicate enhanced PVL prediction and evaluation. The findings confirm that post-dilatation significantly impacts stent configuration, reducing errors in key parameters. Including this phase in simulations enhances computational modeling of TAVI, providing a valuable tool for clinical decision-making and predicting post-implantation complications.