IMPACT OF TRANSCATHETER VALVE SIZE ON THE ESTIMATION OF PARAVALVULAR LEAKAGE: AN FSI STUDY

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ABSTRACT
Transcatheter aortic valve implantation (TAVI) is a minimally invasive treatment for high-risk patients with aortic diseases. Despite its increasing use, uncertain influential factors require continuous investigation. TAVI “sizing” [1] (i.e. the selection of the prosthesis within a range of available sizes to ensure its best accommodation into the native aortic root) is an important aspect to be considered for the procedure success. This choice, along with the positioning strategy, strongly affects the onset of paravalvular leakage (PVL), a frequent TAVI complication with increased mortality [2]. From a modeling point of view, the Fluid-Structure Interaction (FSI) methodology represents the best numerical approach capable of reproducing the loading on the valve leaflets due to the fluid coupling [3]. The aim of this work is to study by means of FSI simulations how the choice of the transcatheter valve size affects the PVL after a TAVI procedure. A parametric anatomical-resembling model of the aortic root was realized with the morphing tool and subsequently meshed in ANSA pre-processor (BETA CAE Systems International AG). In particular, a patient with 26 mm of annulus diameter and a severe grade of stenosis was selected to virtually implant both 29 and 34 Medtronic Corevalve Evolut R size. The solid parts of the numerical model include the anisotropic hyperelastic aorta, the calcified native valve, the Nitinol frame of the prosthesis and its pericardium leaflets and skirt, while the fluid parts were created based on the anatomy of the aorta, which was totally immersed in the blood domain. The FSI simulations were then performed using the non-boundary fitted method implemented in LS-DYNA (LSTC). Results from the FSI analyses predicted different outcomes for the different implanted valve sizes in terms of the final configuration of the released device in the implantation site; furthermore, the aorta and calcification stresses, the pericardium leaflets kinematics, and the PVL estimations showed difference among the two different sizes. The calculation of velocity fields and flow rate curves with META post-processor (BETA CAE Systems International AG) allows the quantification of the most common clinical parameters used to assess the presence of PVL, such as the regurgitation volume and the effective regurgitation orifice area.