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Multi-physics 3D computational study of leaflet thrombus formation following surgical and transcatheter aortic valve replacement KOOHYAR VAHIDKHAH, MOSTAFA ABBASI, MOHAMMED BARAKAT, University of Denver, DANNY DVIR, University of Washington, ALI AZADANI, University of Denver — An increasingly recognized complication following surgical/transcatheter aortic valve replacement is thrombosis or blood clot formation on replacement valve leaflets. A predisposing factor in thrombus formation on biomaterial surfaces of a bioprosthetic heart valve is blood stasis. Longer residence time of blood provides an opportunity for platelets and agonists to accumulate to critical concentrations that leads to platelet activation and then thrombosis. In this study, we have developed a fluid-solid interaction (FSI) modeling approach, to quantify blood stasis on the leaflets of bioprosthetic aortic valves with different design operating in a patient-specific geometry. We have validated our FSI model against experimental measurements of valve opening/closing as well as in-vitro particle image velocimetry. We have also embedded in our method a model for transport of platelets and agonists (ADP, TxA2, and thrombin) and their interactions that result in platelets activation and adhesion to biomaterial bioprosthetic surfaces. We have provided quantitative evidence for the correlation between long residence of blood on bioprosthetic aortic valve leaflets and formation of high thrombogenicity risk regions on the leaflets that are characterized by accumulation of activated platelet.

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