Assessment of Thrombotic Risk following Transcatheter Mitral Valve Replacement

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Aims: Device-induced thrombosis has a prevalence of 12.7% in Transcatheter Mitral Valve Replacement (TMVR) and is associated with increased risks of stroke and transient ischemic attacks. Currently, standard practice for managing thrombus formation following TMVR is the prescription of anticoagulants pre post-procedure. However, anticoagulants can increase the risk of major bleeding, and there is a lack of consensus as to the duration of treatment following implantation. This study aims to quantify biomarkers of thrombus formation to improve personalisation of anticoagulation therapy.

Methods: Blood flow simulations were performed based on imaging data from a patient who received TMVR to treat chronic mitral regurgitation. The left ventricle (LV) was manually segmented from Computed Tomography scans and LV wall motion tracked using in-house software to provide patient-specific boundary conditions. A CAD model of a commercial bioprosthesis comprising of inner and outer stents was embedded in the LV model. Two cardiac cycles were simulated using the software STAR-CCM+ (Siemens PLC). Prothrombotic biomarkers of blood stasis such as blood particle accumulation and blood residence time within the LV were measured via Lagrangian particle tracking to identify potential areas of thrombus formation.

Results: Within one cycle 21% of the inflow was ejected, with particles accumulating between the inner and outer stents, and between the outer stent and the endocardium wall. Blood residence time in these areas was 2.4s and 2.3s, respectively, indicating these particles were not ejected in the second cycle.

Conclusion: Patient-specific and device-specific computer models may be used to identify areas of high thrombotic risk for patients considered for TMVR. Blood particle analysis enables the identification of areas of blood stasis adjacent to transcatheter mitral valves that may translate to increased risk of thrombus formation.

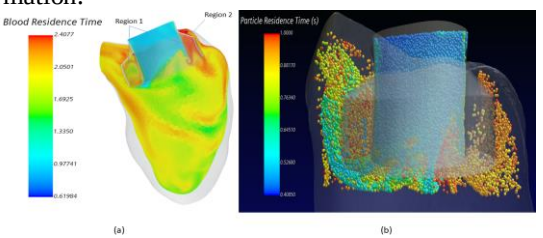

Figure 1- (a) Isocontours of blood residence time in a longitudinal slice through the length of the left ventricle. (b) Visualisation of lagrangian particles at the beginning of the diastole, showing the accumulation of blood that was not ejected