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A novel method for the quantification of platelet adhesion on biochemically-modified poly(vinyl alcohol) vascular grafts

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Keywords

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Abstract

The clinical standard for small diameter vessel treatment, currently, is the use of autologous vessels. However, due to limited availability and pre-surgical complications, many patients are ineligible for this treatment. In addition, synthetic vascular grafts have been shown to exhibit limited long-term patency at diameters less than 6 mm, creating a large unmet clinical need. By biochemically modifying the surface of small diameter poly(vinyl alcohol) (PVA) grafts, anti-thrombotic properties can be achieved. Previously, thrombogenicity has been investigated through an ex vivo, non-human primate, shunt model. However, this model only characterizes platelet attachment over the length of the entire graft, losing the ability for dynamic physical properties of the thrombus along the graft to be understood. This work introduces a novel method to quantify thrombus formation along the cross-sectional area of biochemically-modified PVA grafts.

MicroCT imaging was utilized to analyze thrombus formation within biochemically modified PVA vascular grafts. Using Amira, the physical properties of the grafts were segmented and labeled for all cross sectional voxels. The surface area and volume were then computed, and 3D renderings of the segmented features were generated for the biochemically-modified PVA grafts. Thrombus formation was then quantified for each cross-sectional area per slice over the entire length of the graft.

Through the methods established, the analysis of physical quantification of platelet adhesion was enhanced compared to previous methods and validated with direct measurement of the graft dimensions. The ability to quantify thrombus formation through microCT images along the cross-sectional area of each graft shows a novel method compared to the prior work using the ex vivo shunt model. Physical characteristics of the thrombus for each surface modification was compared for thrombus content and uniformity along the length.

The method developed using microCT images reflects and enhances shunt data through the physical evaluation of thrombus formation.