Development of MicroCT Techniques for Quantifying Thrombus Formation in Cardiovascular Biomaterials

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Thrombi formed under blood flow are complex structures of blood coagulation factors, cellular components, and fibrin fibers. In the case of non-tissue vascular grafts, thrombi invade the graft lumen over time. A well-established measurement of biomaterial-induced thrombosis uses an ex vivo arteriovenous shunt with measurements of radiolabeled platelet and fibrin attachment to the material. However, the physical parameters of the thrombus are unknown, so we sought to develop a complementary method using microCT and advanced image analysis to improve the efficiency and accuracy of composition measurement. Two common cardiovascular biomaterials, collagen-coated and regular polytetrafluoroethylene (ePTFE) and polyvinyl alcohol (PVA), were tested in a non-human primate model arteriovenous shunt. By using microCT scanning and the Amira® software, methods were successfully developed to quantify thrombus characteristics on biomaterials with various properties. Microfil® or Lugol's positively or negatively marks the lumen, which, coupled with physical measurements, allows for quantification of luminal and thrombus volumes. The correlation of the measurements obtained using the digital methods with physical dimensions and platelet and fibrin accumulation indicates model accuracy and its utility in the quantification of thrombus formation on cardiovascular biomaterials.