The effect of surface roughness on activation of the coagulation system and platelet adhesion in rotary blood pumps

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The surface roughness of left ventricular assist devices (LVADs) is important for the biocompatibility of blood pumps. However, little is known about the effect of surface roughness on the antithrombogenicity of the device. The present study investigated the effect of surface roughness on the activation of the coagulation system and platelet adhesion in an impeller-type blood pump. Three identical Baylor Gyro 710 centrifugal blood pumps (Baylor College of Medicine, Houston, TX, USA) were manufactured with impeller surface roughness of 0.05, 0.2, and 0.4 microm, respectively, as determined by a stylus profilometer and by scanning electron microscopy. Whole blood was anticoagulated (1-IU heparin/mL, ACT 250 s) and circulated for 60 min in an artificial circulatory system, simulating LVAD perfusion (5-L/min flow against 100 mm Hg). Enzyme-linked immunosorbent assays were developed to quantify fibrinogen- and von Willebrand factor (vWf) adsorption as well as platelet adhesion directly on the impellers of the pumps. Levels of prothrombin fragment F1.2 and thrombin-antithrombin (TAT) complex were measured in order to quantify activation of coagulation. Compared with the 0.05-microm surface, platelet adhesion was 40 and 76% higher on the 0.2- and 0.4-microm surface, respectively (P < 0.01). The evaluation of adsorbed fibrinogen and vWf showed significant higher protein antigen levels on the rougher surfaces (P < 0.01). Furthermore, nonpulsatile perfusion activated the coagulation system. By contrast, the surface roughness had no significant influence on plasma prothrombin F1.2 fragment- and TAT concentrations. Antithrombogenicity was significantly reduced in pumps with inferior metal-finishing quality.

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