SURFACE MODIFICATION OF CARDIOVASCULAR DEVICES TO REDUCE THE RISK OF THROMBUS FORMATION

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Introduction

Blood contacting cardiovascular devices are successfully employed to treat heart failure. Hemocompatibility-related issues due to unphysiological flow and exogenous material still occur and anticoagulant treatment is necessary [1], [2]. In this study, innovative surface manufacturing presenting definable micropatterned geometries, that may reduce adhesion of platelets compared to a fully polished surfaces, are investigated.

Methods

4 geometries: reverse cones, riblets, grids and spheres have been designed based on 3 criteria: i) hydrophobicity fluid repulsion ii) reduction of accessible area for platelets adhesion iii) improving of the action of the blood flow in washing away platelets from the surface. Micropatterned surfaces are printed via 2 photon polymerization printer (2PP, UpNano GmbH) and replicated via nanoimprinting lithography (NIL, Profactor GmbH). Then, the surfaces are employed in 2 tests corresponding to rationale described: i) wettability measurements via water contact angle (WCA); ii) platelets adhesion tests in static conditions measured via Scanning Electron Microscoppe (SEM).

Results

Geometries are printed in 4 dimensions: Extra-Small (1-3µm), Small (3-9 µm), Medium (6–18 µm), Large (12-36 µm), and wettability test are performed and compared to a flat surface. Large and Medium size of all structures showed a higher hydrophobicity (WCA 120-130°) with respect Extra-Small and Small structures (WCA 100-110°) especially Large riblets showed a superhydrophobic behavior (WCA>150°). All the WCA values resulted at least hydrophobic contrary to the flat surface (WCA 69°).
Secondly, surfaces are incubated with human platelets in a low shear condition (static experiments). Results for Small Cones, Riblets, Grids are showed in Figure 1.

Discussion

We have shown that our micropatterned surface are highly hydrophobic with respect the flat surface as commonly employed in cardiovascular devices. This feature may play an important role in the platelet adhesion reduction since, at the conditions we set, the fluid (blood) is repelled. This result agrees with the results obtained in the static conditions experiments.
As a next step microfluidic experiments to evaluate the platelet adhesion under shear conditions are currently being established.

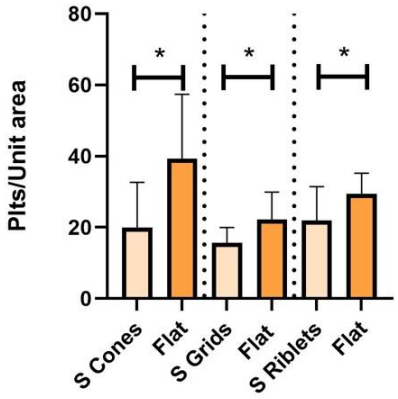

*Figure 1: Number of platelets adhering on unit area on Small Cones, Small Grids, and Small riblets compared with flat surfaces. For each microstructured surfaces tested, a flat surface sided is tested. N=6, *p<0.05.*

References

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