Platelet response to PEG-modified surface with different molecular architecture

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Introduction: Cellular and tissue responses to biomaterials are crucially important for all medical devices. Implantation of biomaterials evokes the hierarchical biological response; protein adsorptions, blood coagulation, complement activation, acute and chronic inflammation, angiogenesis, granulation and fibrous encapsulation. The biological responses to biomaterials can be controlled by designing suitable interface property which is determined by the cooperative functions their chemical, physical and biological properties. The interface property of biomaterials has been investigated mainly focusing on their chemical, physical and physiological properties such as electrostatic charge, wettability and microstructures, they have not been evaluated against biomaterials with different molecular architecture yet. In this report, platelet adhesion and activation in response to the contact with the poly (ethylene glycol) (PEG)-modified interface with different molecular architectures, graft with a free terminal, loop, and polymer brush.

Methods: Different architectures were designed by use of self-assembled monolayer (SAM) on gold surface. PEG (Mw; 3000 g/mol) was immobilized onto gold substrate in graft architecture with one free terminal (PEG-graft), and in loop shape whose both ends bind to substrate (PEG-loop) [1] (Figure 1). Unreacted Au surface was covered with tri(ethylene glycol) dodecanethiol (TEGDT). Platelet reactions to these surfaces were evaluated by using human whole blood or platelet-rich plasma (PRP). Adhesive platelets were counted LDH assay in the case of PRP and observed their morphology by immunostaining with FITC PAC-1 antibody and rhodamine phalloidin. In addition, platelet activation was determined by FACS with FITC PAC-1 antibody.

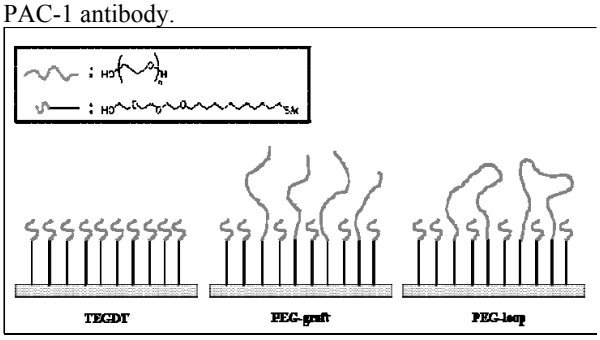

Figure 1. Illustration of PEG-modified surfaces with different molecular architecture.

Results: Platelets responses to PEG-graft and PEG-loop were extremely different (Figure 2). Platelet adhesion was strongly inhibited by PEG-graft in comparison with TEGDT, and adherent platelets on PEG-graft were spherical. On the other hand, many platelets adhered onto PEG-loop and they were spreading with the pseudopod formation.

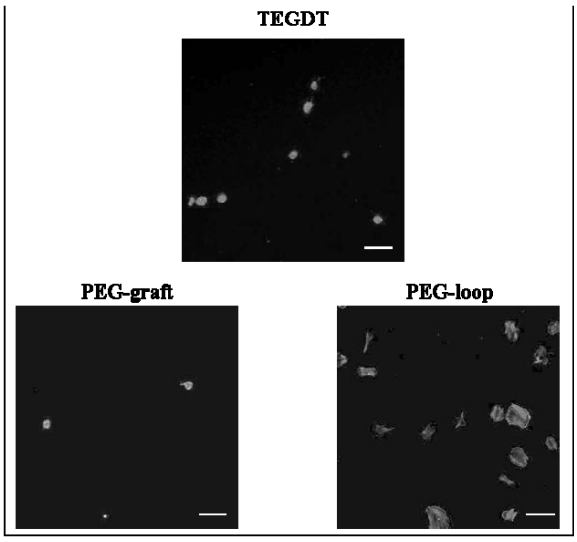

Figure 2. Adherent platelets onto different surfaces stained by rodamine phalloidin.

Immunostaining of adherent platelets with PAC-1 antibody indicated that most of them on each surface are activated. The number of adherent platelets on each surface was corresponding to the adhesive area of platelets. These results show that PEG-loop promoted platelets activation more than PEG-graft. Furthermore, FACS analysis showed that the activation level of the non adherent (floating) platelets were also very different in response to the PEG architecture.

Conclusions: Platelet response to PEG-modified surface with different architectures, PEG-graft and PEG-loop, have been evaluated and was found that the history of contacting with the surfaces of a same chemical property but different surface architectures greatly affected on the GPIIb/IIIa activation.

References:

1. D.H. Yang. Polymer J. 2009: 41: 952-953.