LIPIDS ADSORPTION IN BIOMATERIALS: THE CASE OF POLYMERIC VASCULAR PROSTHESES

D. Mantovani, PhD, FBSE
Laboratory for Biomaterials and Bioengineering
Canada Research Chair for the Innovation in Surgery, PLT-1745
Laval University, Quebec City, Canada
P: 1 (418) 656-2131 # 6270 – F: 1 (418) 656-5343 – Diego.Mantovani@gmn.ulaval.ca

ABSTRACT: Biomaterials have saved the patients' life and improved their quality for millions on the globe. Since 1970, vascular prostheses made of Teflon or Dacron have been largely implanted worldwide in vascular surgery to save limbs in patients suffering from progressive atherosclerotic diseases. Unhappily, the absence of endothelium coverage on the surface of synthetic vascular prostheses may lead to their high thrombogenicity and to the implant failure. Still today, sixty-five percent of ePTFE vascular prostheses have to be replaced within 10 years of their implantation following the development of major clinical complications. Lipid uptake is a factor which is considered to inhibit the infiltration process required for a complete healing of the prosthesis. The purpose of the present study is to propose a valid solution to the problem of lipid uptake by the validation and the comprehension of the fundament of the problem and its implications.

The hypothesis of the phenomenon of lipid uptake on the implanted prostheses was validated by the analysis of the surfaces of more than three hundred explanted prostheses by infrared spectroscopy which has shown the presence of fatty acids on all the surfaces. The comprehension of the basis of the phenomenon was articulated in two directions. Firstly, similarities between lipid uptake in synthetic prostheses and the phenomenon of atherosclerosis in natural arteries were investigated. Secondly, an experimental model of the phenomenon was used to study the relationships between the transmural concentration and pressure gradients and the transport of lipids across the wall of the prosthesis. A mechanical test was developed to evaluate the lubricant effect of the lipid uptake on the circumferential rigidity of the prosthetic wall. Finally, a specific radio-frequency plasma surface modification system was developed to introduce functional sites by which biologically active molecules with specific properties can be anchored, with ionic or covalent bonds, on the internal surface of the prostheses.

In conclusion, this work will present the implications of the lipid adsorption and uptake on ePTFE arterial prostheses. The microporous and hydrophobic structure of the wall, and the presence of the reinforcing wrap on the external surface, act as a catalyst to the undesirable lipid uptake and inhibitor to the essential tissue infiltration, respectively. Finally, surface treatments can be envisaged as a valid alternative for the modification of the blood/prosthesis interface for the future development of vascular prostheses. In this presentation, with a personal perspective, the implication of molecule adsorption on the fate of biomaterials when implanted in humans as well as possible solutions will be presented and discussed.

KEYWORDS: lipid uptake, Teflon, biomaterials.