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Immobilized Antithrombin III on the Thromboresistance of Polycarbonate Urethane

Vladimir Sokolov*

Department of Cardiothoracic Surgery, Maastricht University Medical Centre, 6229 HX Maastricht, The Netherlands

Introduction

The development of biomaterials with improved thromboresistance is a critical area of research in the field of medical devices, particularly for applications involving blood-contacting materials. Polycar Bonate Urethane (PCU) is a widely used polymer in the medical industry due to its excellent mechanical properties, biocompatibility and flexibility. However, one of its major limitations is its susceptibility to blood clot formation (thrombosis) when it comes into contact with circulating blood. Thrombosis not only complicates the performance of medical devices such as catheters, blood vessels and heart valves but also increases the risk of serious complications, including embolism and device failure [1].

One promising strategy to enhance the thromboresistance of PCU involves the immobilization of natural anticoagulants on the surface of the polymer. Anti Thrombin Iii (ATIII) is a naturally occurring glycoprotein that plays a crucial role in regulating blood coagulation by inactivating thrombin and other clotting factors. Immobilizing ATIII on the surface of PCU could potentially improve the material's ability to resist clot formation. This article aims to explore the effect of immobilized Antithrombin III on the thromboresistance of Polycarbonate Urethane, focusing on the mechanisms involved, the methodologies used for immobilization and the resultant performance improvements. By investigating the impact of ATIII immobilization on the thromboresistance of PCU, this research seeks to contribute to the development of more effective, long-lasting and safer biomaterials for blood-contacting medical devices [2].

Description

Poly Carbonate Urethane (PCU) is a versatile biomaterial known for its mechanical durability, flexibility and biocompatibility. These characteristics make it an attractive choice for a wide range of medical applications, including vascular grafts, catheters and prosthetic heart valves. However, one of the challenges with PCU is its interaction with blood, which can lead to thrombus formation on its surface when exposed to circulating blood. Thrombosis poses significant risks in clinical settings, often leading to device failure and complications in patients. Therefore, enhancing the thromboresistance of PCU is a major focus of ongoing biomaterials research. Thrombosis is the process by which a blood clot (thrombus) forms within the vascular system, often in response to injury or surface contact. This process is initiated by the activation of the coagulation cascade, which leads to the formation of fibrin clots. In the context of biomaterials, the introduction of foreign materials into the bloodstream can trigger clot formation as the body recognizes the material as potentially harmful. Understanding the mechanisms behind thrombosis is critical for designing materials that resist clot formation, thus improving the safety and functionality of medical devices [3].

***Address for Correspondence:** Vladimir Sokolov, Department of Cardiothoracic Surgery, Maastricht University Medical Centre, 6229 HX Maastricht, The Netherlands; E-mail: vladimirsokolov@yahoo.com*

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The process of immobilizing ATIII onto the surface of PCU typically involves chemical or physical methods that allow the protein to remain active while adhering to the surface of the polymer. Various immobilization techniques, such as covalent bonding, electrostatic interaction and layer-by-layer deposition, can be employed to ensure that ATIII is effectively anchored to the surface of PCU. The method of immobilization can significantly influence the performance of the material, affecting the density of ATIII on the surface, its activity and its stability over time [4].

To evaluate the effectiveness of ATIII-immobilized PCU, a series of in vitro and in vivo tests are typically performed. These include platelet adhesion assays, fibrinogen adsorption tests, thrombus formation assays and animal models to assess the long-term effects of ATIII on thromboresistance. Surface characterization techniques such as Scanning Electron Microscopy (SEM), X-ray Photoelectron Spectroscopy (XPS) and contact angle measurement can also provide insights into the surface properties and the efficiency of ATIII immobilization [5].

Conclusion

The immobilization of Antithrombin III on the surface of Polycarbonate Urethane represents a promising approach to enhance the thromboresistance of blood-contacting medical devices. Through its potent anticoagulant properties, ATIII can effectively inhibit the coagulation cascade and reduce thrombus formation, thereby improving the safety and longevity of devices made from PCU. The success of this strategy depends on several factors, including the method of immobilization, the density and stability of the ATIII layer and the specific application requirements. Future research should focus on optimizing the immobilization techniques to enhance the bioactivity and durability of ATIII, as well as exploring the long-term effects of ATIII-modified PCU in clinical settings. Additionally, investigations into the cost-effectiveness and scalability of this approach will be essential for widespread adoption in the medical industry.

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Conflict of Interest

None.

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