Perspective
Volume 20:05, 2024

Journal of Surgery

ISSN: 1584-9341

Open Access

Impact of Immobilized Antithrombin III on the Thromboresistant Properties of Polycarbonate Urethane

Pierre Moreau*

Department of Medicine, University of Szeged, 6720 Szeged, Hungary

Introduction

The use of biomaterials in medical devices has revolutionized healthcare by improving the functionality, safety and longevity of implants, prosthetics and surgical devices. Among the various biomaterials in use, Poly Carbonate Urethane (PCU) stands out due to its excellent mechanical properties, biocompatibility and flexibility. These characteristics make PCU an ideal candidate for applications such as vascular grafts, heart valves and other cardiovascular devices. However, despite its promising properties, PCU surfaces can still present challenges when in contact with blood, particularly in terms of thrombogenicity meaning the potential to induce clot formation. Blood thrombosis in medical devices can lead to serious complications, including device failure, embolism and stroke, making the reduction of thrombotic risk a major area of focus in biomaterials research [1].

One promising approach to enhancing the thromboresistant properties of materials like PCU is the immobilization of Anti Thrombin III (ATIII), a naturally occurring plasma protein that plays a crucial role in the regulation of blood clotting. ATIII inhibits thrombin and other clotting factors, thereby reducing the risk of blood clot formation. By immobilizing ATIII onto the surface of PCU, researchers aim to create a material that can resist thrombosis while maintaining the desirable mechanical properties of PCU. The interaction between ATIII and PCU surfaces can provide a novel strategy for designing biomaterials with improved hemocompatibility, potentially making them more suitable for long-term use in contact with blood. This study seeks to explore the impact of immobilizing ATIII on the thromboresistant properties of polycarbonate urethane. It will evaluate how this modification influences the material's ability to resist thrombosis, the mechanisms behind ATIII's interaction with PCU and the potential clinical implications of using such modified materials in medical devices [2].

Description

Polycarbonate urethane is a thermoplastic elastomer composed of a hard polycarbonate segment and a soft urethane segment. It is well-known for its mechanical strength, flexibility and biocompatibility, which makes it a versatile choice for a wide range of medical devices. In particular, PCU is often used in devices that come into direct contact with blood, such as artificial heart valves, vascular grafts and blood-contacting catheters. The material's excellent durability, low friction and ability to be processed into various shapes are key reasons for its widespread use. However, one significant limitation of PCU in medical applications is its thrombogenicity. When blood contacts an artificial surface, it triggers a cascade of events leading to the activation of platelets and coagulation factors. This can lead to the formation of blood clots, which can result in complications such as thrombosis, embolism and device malfunction. Therefore, there is a critical need to modify the surface properties of PCU to reduce its thrombotic potential while maintaining its excellent mechanical characteristics [3].

Antithrombin III is a naturally occurring glycoprotein found in human plasma that plays a pivotal role in regulating the coagulation cascade. ATIII inhibits the activity of thrombin and other serine proteases in the clotting pathway, such as Factor Xa. By binding to these enzymes, ATIII accelerates their inactivation, thus preventing excessive clot formation. The natural anticoagulant properties of ATIII are well-documented and its therapeutic use, particularly in patients with clotting disorders or undergoing surgeries, has been shown to reduce the risk of thrombosis. Immobilizing ATIII onto the surface of biomaterials provides an opportunity to directly apply its anticoagulant properties to medical devices. Unlike systemic administration of ATIII, which may be associated with side effects or complications, immobilized ATIII remains localized to the surface of the device, providing a targeted and sustainable anticoagulant effect. Moreover, immobilization techniques allow for the controlled release and sustained activity of ATIII over time, making it an attractive strategy for improving the thromboresistant properties of materials such as PCU [4].

To effectively immobilize ATIII onto the surface of polycarbonate urethane, several surface modification techniques can be employed. One common method is covalent bonding, where chemical reactions are used to form stable bonds between ATIII molecules and functional groups on the PCU surface. This approach can be achieved through surface activation processes such as plasma treatment, Ultra Violet (UV) radiation, or the use of coupling agents like glutaraldehyde. These treatments introduce functional groups like amines or carboxyls onto the PCU surface, providing reactive sites for the covalent attachment of ATIII. Other techniques include physical adsorption, in which ATIII molecules adhere to the surface of PCU through non-covalent interactions such as van der Waals forces, hydrogen bonding, or electrostatic attraction. While this method is simpler and less resource-intensive than covalent bonding, it may result in a less stable attachment of ATIII, which could reduce the effectiveness of the thromboresistant properties over time. More advanced strategies involve the use of nanomaterials or polymer coatings to enhance the immobilization of ATIII, further improving its effectiveness and longevity. The success of these techniques depends not only on the chemistry involved but also on the retention of the functional activity of ATIII after immobilization [5].

Conclusion

In conclusion, the immobilization of antithrombin III on polycarbonate urethane surfaces offers a promising strategy for enhancing the thromboresistant properties of medical devices, particularly those used in cardiovascular applications. The combination of ATIII's natural anticoagulant activity with the desirable mechanical properties of PCU holds great potential for reducing the risk of thrombosis and improving the long-term performance of blood-contacting devices. The research on ATIII-immobilized PCU highlights the importance of surface modification techniques in improving the hemocompatibility of biomaterials. Although challenges remain, such as optimizing the stability and functionality of immobilized ATIII and ensuring consistent anticoagulant performance over time, the current findings suggest that these modified materials could significantly improve patient outcomes in various medical fields.

Future research should focus on refining the immobilization techniques to enhance the stability and release kinetics of ATIII, as well as expanding in

***Address for Correspondence:** Pierre Moreau, Department of Medicine, University of Szeged, 6720 Szeged, Hungary; E-mail: moreaupierre@gmail.com*

Received: 02 September, 2024, Manuscript No. jos-24-154448; **Editor Assigned:** 04 September,2024, PreQC No. P- 154448; **Reviewed:** 18 September, 2024, QC No. Q- 154448; **Revised:** 23 September, 2024, Manuscript No. R- 154448; **Published:** 30 September, 2024, DOI: 10.37421/1584-9341.2024.20.172

vivo studies to better understand the long-term biocompatibility and clinical effectiveness of ATIII-immobilized PCU. Moreover, the development of more advanced materials, such as hybrid biomaterials that combine ATIII with other bioactive molecules or coatings, could further enhance the thromboresistant properties of PCU and other biomaterials. Ultimately, the incorporation of ATIII into medical devices represents a significant step forward in the pursuit of safer and more effective biomaterials for use in direct blood contact. With continued advancements in materials science and biotechnology, it is likely that we will see broader clinical applications of these innovative biomaterials, leading to improved therapeutic outcomes for patients and a reduction in the risks associated with thrombosis in medical devices.

Acknowledgement

None.

Conflict of Interest

None.

References

1. Reed andrew M., Jon Potter and Michael Szycher. "A solution grade biostable polyurethane elastomer: ChronoFlex® AR." *J Biomater Appl* 8 (1994): 210-236.
2. Otto, Michael. "Staphylococcus epidermidis the'accidental'pathogen." *Nat Rev Microbiol* 7(2009): 555-567.
3. Wendel, Hans P., Nils Hauser, François Briquet and Gerhard Ziemer. "Hemocompatibility of medical connectors with biopassive or bioactive surface coatings." *J Biomater Appl* 171 (2002): 5-17.
4. Eckman, Peter M. and Ranjit John. "Bleeding and thrombosis in patients with continuous-flow ventricular assist devices." *Circulation* 125 (2012): 3038-3047.
5. Butruk-Raszeja, Beata, Maciej Trzaskowski and Tomasz Ciach. "Cell membrane-mimicking coating for blood-contacting polyurethanes *J Biomater Appl* 29 (2015): 801-812.

How to cite this article: Moreau, Pierre. "Impact of Immobilized Antithrombin III on the Thromboresistant Properties of Polycarbonate Urethane." *J Surg* 20 (2024): 172.