Blood groups and Microbiology, A Comprehensive Study

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Abstract:

This research paper investigates the potential enzymatic conversion of blood groups facilitated by bacterial activity. Blood groups, characterized by the presence or absence of specific antigens on red blood cells, play a crucial role in transfusion medicine. The study explores the ability of certain bacteria to enzymatically modify blood group antigens and its implications for blood transfusion compatibility.

Introduction

The human blood group system is complex; 30 discrete blood groups are known, defined by 270 antigens plus 38 that have not been assigned to a particular group.

These blood group antigens are based either on oligosaccharide epitopes: (ABO, P, and Lewis antigens), or on specific amino acid sequences of proteins: (Rh, Kell, and Duffy antigens).

The majority of the antigens are integrated into the cell membrane, but some, like the Lewis system, are plasma antigens that are adsorbed onto the red cell surface.

The A, B, and H (O-type) carbohydrate antigens of the ABO blood group system are the most important clinically, with about 1 million antigens present on the surface of each RBC.

Blood transfusions are integral to modern healthcare, and ensuring compatibility between donor and recipient blood groups is paramount to prevent adverse reactions. This study aims to examine the enzymatic activities of selected bacteria in modifying blood group antigens, potentially opening new avenues for expanding the pool of compatible blood donors.

Literature Review:

A comprehensive review of existing literature discusses the known mechanisms of blood group determination and the role of enzymes in modifying surface antigens. Previous studies on bacterial enzymatic activities, particularly glycosyltransferases, provide a foundation for understanding potential interactions with blood group antigens.

Methods:

The study involves the isolation and identification of gut bacteria with known enzymatic capabilities. Cultures are grown under controlled conditions, and the enzymatic activities are assessed using specific substrates mimicking blood group antigens. The impact of enzymatic conversion on blood group compatibility is investigated through in vitro assays.

Results:

Preliminary results demonstrate the enzymatic modification of blood group antigens by gut normal flora bacterial strains. The study evaluates the efficiency and specificity of these enzymatic activities, shedding light on the potential for converting blood groups and expanding the pool of compatible donors.

Discussion:

The implications of enzymatic blood group conversion are discussed in the context of transfusion medicine. Considerations include the safety, feasibility, and ethical aspects of utilizing enzymatically converted blood for transfusions. The study addresses the limitations and challenges associated with this approach while highlighting its potential benefits.

Blood transfusion is an indispensable part of the health care system, saving many thousands of lives annually; careful matching of the host and donor ABO blood types is essential to avoid transfusion incompatibility events, which are fatal in 10% of all cases.

This applies to transfusion of whole blood, RBCs, or platelets as well as tissue or organ transplants, because ABO antigens are not only present on RBCs but also on most other tissues in the human body.

In emergency situations “universal” O-type blood (preferably O negative) is employed because, as explained below, it is compatible with A, B, AB, and of course O-type blood.

Minor incompatibilities due to other antigen mismatches are not typically life-threatening.

What if we don't have the universal blood type?

The incompatible transfusion can result in red blood cell (RBC) lysis, and lead to death.

In contrast, blood group O type RBCs can be transfused universally to patients of the same rhesus type.

Therefore, there is need for adequate supply of blood group O RBCs to meet the demands of blood transfusion.

A potential limitation of the strategy described here is the transient removal of blood group antigens at the phenotypic but not genetic level. It is therefore expected that antigenic glycans will be renewed within a relatively short time frame and may present an immunogenic challenge to the recipient. However, the host immunological response to such a challenge may not be a significant clinical problem in view of the documented phenomenon of graft accommodation in ABOi transplantation. This describes the acquired resistance of an organ to antibody- mediated rejection following transplantation after recurrence of high antibody titres.
The organs typically show normal histology and have glomerular filtration rates similar to those of ABOc kidneys.
It has been hypothesized that removal of incompatible blood group antigens at transplantation may prevent immediate hyperacute rejection and induce accommodation in the graft.

Conclusion:

This research provides valuable insights into the enzymatic conversion of blood groups by bacteria, presenting a novel perspective on transfusion medicine. While further research is needed to refine the methodology and assess the broader implications, this study lays the foundation for exploring alternative strategies to enhance blood transfusion compatibility.

In 2022, researchers Wang and colleagues at the Ajmera Transplant Center in Canada demonstrated a largely successful blood type conversion of type A organs into type O by using ex vivo lung perfusion (EVLP) and enzymes. Utilizing donor lungs unsuitable for transplantation, the team used EVLP to bring the organs to body temperature and improve organ quality.

Then, on three lungs, the team administered two glycosidase enzymes derived from *Flavonifractor plautii,* a type of bacteria found in the human gut microbiome. The enzymes, FpGalNAc deacetylase and FpGalactosaminidase, targeted the antigen A sugars, removing 99% and 90% of the antigens located on the red blood cells and aortae, respectively, without triggering acute lung toxicity.

After clearing most of the antigen from the blood in these lungs, the researchers transfused type O blood into both the treated lungs and the control group to simulate an incompatible transplant.

While the untreated lungs rejected the transfusion due to the anti-A antibodies in the type O blood attacking its own A antigens, the enzymatically transformed lungs tolerated the transfusion with minimal antibody binding and injury, effectively operating as type O organs.

In the future, I hope to begin clinical trials to further test the efficacy of organ ABO blood type conversion. If successful, the creation of more "universal donor" organs could significantly decrease the time spent on the waiting list and deaths among type O patients, but also patients overall.

While this method remains in its early stages, the innovations of derived enzymes and EVLP in organ transformation could lead to a more equitable and efficient organ transplantation process.

References

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Toward universal donor blood: Enzymatic conversion of A and B to O

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