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The prevalence of Anti-A1 in donors with A2 and A2B blood groups in Bushehr Blood Transfusion Organization from 2017 to 2023: Cross-Sectional Study

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Abstract

Introduction: The presence of anti-A1 antibodies in individuals with A2 and A2B blood types can have clinical significance, particularly in transfusion medicine, organ transplantation, and genetic studies, as these antibodies may lead to hemolytic reactions. Therefore, assessing the prevalence of anti-A1 antibodies is essential to ensure patient safety. This study aimed to determine the frequency of A2 and A2B blood types with anti-A1 antibodies among blood donors in Bushehr Province.

Materials and Methods: The cell typing and reverse (back) typing results of all donors referred to the Blood Transfusion Institute in Bushehr Province between 2017 and 2023 were examined to identify any discrepancies between forward and reverse blood grouping. Donors with cell type A or AB and reverse type O were included in the evaluation. The collected data were then analyzed using statistical software. The study determined the frequency of A2 and A2B blood groups with anti-A1 antibodies among donors in Bushehr Province during the specified period.

Results: Between 2017 and 2023, a total of 160,435 individuals donated blood in Bushehr Province, comprising 7,497 females and 152,938 males. Among these donors, blood group analysis identified five male individuals with the A2B blood type.

Conclusion: Although the prevalence of anti-A1 antibodies in individuals with A2 and A2B blood types is rare, it remains clinically significant due to the potential for serological reactivity during transfusion. Accurate identification of these subgroups is essential for precise ABO blood grouping. ABO discrepancies occur when forward and reverse typing results do not align. For the safety of patients, it is crucial that such discrepancies are thoroughly investigated and resolved before confirming the blood group and issuing compatible blood products.

Keywords: ABO blood group, anti-A1. A2, A2B

1. Introduction

The International Society for Blood Transfusion (ISBT) recognizes 346 blood group antigens. Of these, 308 are classified into 36 blood group systems, while 38 remain unassigned. Among these systems, the ABO system also known as the histo-blood group system plays a central role in transfusion medicine due to its clinical significance and immunological importance [1].

The ABO blood group system, first discovered by Karl Landsteiner, is of paramount importance in various fields, including blood transfusion, genetics, inheritance patterns, and disease susceptibility. ABO antigens are expressed on the surface of multiple cell types, such as red blood cells (RBCs), platelets (PLTs), lymphocytes, and endothelial cells (ECs). Additionally, these antigens are present in soluble form in various secretions, including saliva, tears, and milk [2]. Since their discovery, ABO antigens have served as a fundamental criterion for determining compatibility in blood transfusion. Due to the presence of naturally occurring IgM antibodies against ABO antigens, this blood group system plays a critical role not only in transfusion practices but also in stem cell transplantation and solid organ transplantation [3].

The ABO blood group system is categorized into four primary groups: A, B, AB, and O. In addition to these, two less common subgroups exist: A2 and A2B. Among these, the A2B subtype is the rarest, representing only about 1% of the global population. Furthermore, approximately one-third of individuals with the A2B blood group naturally produce anti-A antibodies [4].

The production of ABO antibodies begins at birth, although the antibody titer is typically too low to be detected in early life. The levels of these antibodies can vary based on factors such as gender, age, and environmental influences. In individuals with blood group O, anti-A antibodies are generally present at higher titers than anti-B antibodies. Incompatible blood transfusions can lead to severe clinical consequences, emphasizing the importance of proper blood typing and compatibility testing. Blood group A accounts for 44.6% of all ABO blood groups. A3, AX, Aend, AY, and Ael are rare subgroups of A. A1 and A2 are the primary subgroups of blood group A, which differ both qualitatively and quantitatively. The qualitative difference between A1 and A2 lies in their chemical structures. A1 and A2 antigens have distinct carbohydrate compositions. Dolichos biflorus is a useful tool for differentiating A1 and A2 antigens in red blood cells, as it reacts with the A1 antigen in A1 and A1B blood groups. Subtypes of blood group A can lead to discrepancies in ABO blood grouping and rare hemolytic transfusion reactions. A2 and A2B are rare subgroups of blood group A. Approximately 0.4% of A2 individuals and 25% of A2B individuals produce anti-A1 antibodies. The A1 antigen is expressed on the red blood cells of about 80% of individuals with blood group "A." The naturally occurring IgM alloantibody, Anti-A1, can occasionally be found in 1 to 8% of A2 individuals and 22% to 35% of A2B individuals. The optimal reaction of these natural alloantibodies occurs at room temperature or lower, and they generally have no clinical significance [5]. The reaction is based on Dolichos biflorus lectin, which agglutinates A1 red blood cells but does not agglutinate A2 and A2B red blood cells [6]. Anti-A1 agglutinates A1 red blood cells but does not agglutinate A2 and A2B red blood cells. These antibodies are of the IgM type and are potent hemolysins. This can cause discrepancies in blood group determination during cell and back typing. Individuals with blood group A2 who have anti-A1 antibodies in their serum will exhibit the A blood group phenotype, which corresponds to their actual blood group. However, during back typing, they may show reactivity with A1 red blood cells in addition to B red blood cells, potentially leading to discrepancies. These antibodies also affect the cross-match test. The red blood cell packs typically intended for injection in these individuals mainly come from the A1 blood group. As a result, the presence of the A1 antibody causes a positive result in the cross-match test. In individuals with the A2 blood group, the anti-A1 antibody usually acts as a cold agglutinin, interacting with A1 red blood cells only at 4°C or room temperature. While this interaction typically does not cause significant issues in blood transfusions, it can influence test and experiment outcomes. In some cases, the antibody may have a higher titer, enabling it to react with RBCs over a broader temperature range, including at 37°C. In such instances, this can lead to serious complications during blood transfusion [6]. If an individual requires a blood transfusion, only A2 or A2B blood types are suitable, while A1 blood should be avoided. It is crucial to detect anti-A1 antibodies in the serum of individuals with A2 and A2B blood types, as these antibodies have a broad thermal reactivity range and can cause reactions at 37°C. Identifying A2 and A2B individuals with anti-A1 antibodies is essential, as it can explain discrepancies in blood typing results obtained through cell type and back type methods. This identification helps correct and prevent distorted test outcomes in blood banks, ultimately reducing the risk of hemolytic transfusion reactions. Given the significance of anti-A1 in ABO differences, it plays a key role in causing hemolytic reactions during blood transfusions and can lead to clinical complications in hematopoietic stem cell transplants and organ transplantation [5]. In this project, we aim to investigate the prevalence of anti-A1 antibodies in A2 and A2B individuals among blood donors. The Blood Transfusion Organization of Bushehr Province is committed to enhancing performance and accuracy in the field of medicine.

2. Materials and Methods

This was a cross-sectional study conducted at the Blood Transfusion Organization in Bushehr Province.

Blood samples were collected from all blood donors in Bushehr province who donated between 2017 and 2023 at the Bushehr Institute of Transfusion Medicine. The cell type and back type of each individual were analyzed to determine their ABO blood group and identify any discrepancies. Special attention was given to individuals whose cell type indicated blood group A or AB, while their reverse type suggested blood group O; these cases were investigated further.

Commercially available antisera (Cinnagen ABO grouping kit) were used to determine the ABO blood group (cell type and back type) and Rh status of all samples using the tube method. Anti-A1 lectin was employed for further testing on blood groups with a positive A antigen, specifically group A and AB. Anti-A1 lectin testing was used to classify donors with blood groups A and AB into A1, A2, A1B, and A2B. Additionally, serum grouping with A1 red cells was conducted, and A2 and A2B donors were tested for the presence of anti-A1 antibodies.

3. Results

The total number of donors in Bushehr province from 2017 to 2023 was 160,435, of which 7,497 were female and 152,938 were male. The age range of donors was between 17 and 60 years [Table 1]. Upon examining the blood groups of the donors, five male donors with an A2B blood group were identified; however, blood type A2 was absent in the group. The ages of these donors ranged from 45 to 51 years

Table 1. Total number of donors in Bushehr province

Total number of blood grouping tests	*160435*
Male	152938
Female	7497
Age range	17-60 y
A2B blood group	5

4. Discussion

It should be noted that, to date, no studies conducted in Bushehr province have reported the prevalence of A2 and A2B blood groups. This is the first study to report the frequencies of A2 and A2B in this region. The results of the current study indicate that A2 and A2B are rare phenotypes. According to the literature, the prevalence of anti-A1 among A2 and A2B individuals ranges from 1–8% and 22–35%, respectively [6-7]. Chaudhari et al. (2008) reported a case of IgG Anti-A1. Similarly, two other studies have documented hemolytic transfusion reactions caused by anti-A1. The development of anti-A1 antibodies following allogeneic stem cell transplantation and organ transplantation has also been reported. From a transfusion perspective, individuals with A2 and A2B blood types should ideally be transfused with blood of the same type. However, due to the rarity of A2B, special attention should be given when an identical blood type is unavailable and the patient requires a transfusion of packed red cells. In such cases, group O packed red cells may be transfused as the next compatible option. A major limitation of this study is the small sample size, which may explain the absence of anti-A1 antibodies in the A2 individuals examined.

In a study conducted by Najafzadeh et al., the prevalence of Anti-A1 was found to be 1–8% in A1 individuals and 22–35% in A2B individuals [6].

In another study conducted in the Japanese population, the prevalence of Anti-A1 was reported to be 1.8% in A2 individuals and 3.75% in A2B individuals[8].

5. Conclusion

In conclusion, the prevalence of anti-A1 in A2 and A2B individuals is rare. It is crucial to rule out any potential issues related to its thermal reactivity. Any discrepancies in these individuals should be addressed before blood transfusion. To the best of our knowledge, the significance of identifying A2 and A2B subgroups, along with anti-A1 antibodies, among blood donors in Bushehr province has never been explored. The findings of this study highlight the importance of investigating subgroups such as A1, A2, and anti-A1 in blood group analysis, which, despite their rarity, can be crucial for accurate ABO grouping.

Ethical Considerations

Compliance with ethical guidelines

Student Research Committee of Bushehr University of Medical Sciences, No# IR.BPUMS.REC.1402.300

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Author's contributions

Mohadeseh Rostamipoor and Narges Obeidi performed the experimental work and wrote the manuscript

Conflict of interest

There is no conflict of interest in the manuscript.

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