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Prevalence of weak "D" among voluntary blood donors in a tertiary care hospital in Chennai

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Abstract

Introduction: Rh system is a complex blood group system having 49 different antigens. Out of all these, D antigen is the most significant and highly immunogenic, next to the ABO blood group system. D antigen has more than 30 distinct epitopes. About 3% to 25% of the human population lacks Rh D antigen depending upon the ethnic group. Mutations in the RHD gene may result in amino acid alterations in the D protein structural regions and the resulting phenotype is known as the D variant. Weak D reacts variably with anti D sera and poses a problem in blood banking. The purpose of D typing is to provide D negative units to negative recipients and avoid inadvertent D positive transfusions.

Aim: To determine the prevalence of weak D antigen among voluntary blood donors in a tertiary care hospital in Chennai.

Materials and Methods: The study was conducted in the Department of Transfusion Medicine, Govt. Kilpauk Medical College and Hospital, Chennai from January 2020 to December 2021, a total of 10671 voluntary blood donors were tested for routine ABO grouping and Rh-D typing by tube agglutination method and those who tested negative for Rh-D antigen were further tested to weak D antigen using blend of IgM and IgG monoclonal anti-D immunoglobulin in the Indirect antiglobulin test (IAT).

Results: A total of 10671 voluntary blood donors were studied. Among these 10143(95.1%) were Rh positive and 528(4.9%) were Rh negative. Out of these 521 samples tested to be Rh negative and 7 donors (0.07% of total donors and 1.3 % of Rh-negative donors) turned out to be weak D positive.

Conclusion: The prevalence of Rh-D negative in our study population is 4.9% and that of weak D is 1.3% out of total Rh-D negatives and 0.07% out of total blood donors. As Rh-D antigen is highly immunogenic and can produce alloimmunization if transfused to Rh-D negative subjects, it is important to detect and label weak-D RBC units as D-positive among donor population to ensure blood transfusion safety by optimizing the management of D-negative RBC units. It is always mandatory to confirm Rh-D negative typing among donor population.

Keywords: Blood Donors, Rh-D positive, Rh-D negative, Weak D, alloimmunization.

Introduction

Rh (Rhesus) blood group antigens were first discovered by Levine and Stetson in 1939, who described in a patient having an antibody that agglutinated with 85% of ABO compatible donors. This was a second major landmark discovery in immunohematology after ABO blood groups by Landsteiner in 1990.[1]

The Rh blood group system is one of the most polymorphic and immunogenic blood group systems in humans. The expression of Rh blood group antigen is complex, among that Rh-D antigen is the most important antigen because of its high immunogenicity.[2] The RHD and RHCE genes are located on chromosome 1 (p34–36). The RHD gene is highly polymorphic and contains more than 460 alleles. The D antigen encoded by the RHD gene has extracellular, transmembrane and intracellular regions.[3] Rh positive individuals have both genes, whereas most Rh-negative individuals have only the RHCE gene.[4] Mutations in the RHD gene may result in amino acid alterations in the D protein structural regions and the resulting phenotype is known as the D variant. Eighty five percent of the Caucasian population is Rh-D positive while in India incidence of Rh positivity is 95%.[3] The incidence of Rh negativity worldwide varies around 3-25%. Weaker variants of D, formerly known as Du, are defined as quantitative variations with reduced expression D antigen per red cell but have all the epitopes. Weak D is weakly immunogenic, which is characterized by weaker than expected reactivity with anti-D typing reagents and requires detection by Indirect antiglobulin test. The Incidence of weak D antigen ranges from 0.2-1%.[5,6] The incidence of weak D varies in different populations and in different geographic locales. It is easy to detect D antigen in most of the cases. Sometimes, variable expression of D antigen leads to presence of D variants. Weak D reacts variably with anti D sera and poses a problem in blood banking.[2] The purpose of D typing is to provide D negative units to negative recipients and avoid inadvertent D positive transfusions.[7]

The main concern about weak D phenotype arises due to the risk of alloimmunization among the recipients and subsequent exposure to such red blood cells can lead to fatal haemolytic reaction or haemolytic disease of newborn in a sensitized pregnant female.[2] As D antigen is highly immunogenic, individuals with weak D phenotype are typed depending upon whether the person is donor or the recipient; the recipients with weak D are considered D negative and must be transfused with D negative blood and the donors are considered as D positive. Mothers with weak D fetus must receive Rh immunoprophylaxis as passage of weak D red cells from fetus to mother may result in sensitization.[8] The aim of the study is to determine the prevalence of weak D antigen among voluntary blood donors in a tertiary care hospital in Chennai.

Materials and methods

The study was conducted in the Department of Transfusion Medicine, Govt. Kilpauk Medical College and Hospital, Chennai from January 2020 to December 2021, a total of 10671 voluntary blood donors were tested for routine ABO grouping and Rh-D typing by tube agglutination method and those who tested negative for Rh-D antigen were further tested to weak D antigen. For Rh-D typing two different anti-D reagents, D1-IgM monoclonal anti-D immunoglobulin and D2 -blend of IgM and IgG monoclonal anti-D immunoglobulin were used. All the blood samples which were negative for agglutination by immediate spin method for Rh-D were further tested for weak-D using blend of IgM and IgG

monoclonal anti-D immunoglobulin in the Indirect antiglobulin test (IAT).

Results

A total of 10671 voluntary blood donors were studied. Among these 10143(95.1%) were Rh positive and 528(4.9%) were Rh negative shown in figure1. All Rh-negative samples were subjected to weak D testing. Out of these 521 samples tested to be Rh negative, all were male donors and 7 male donors (0.07% of total donors and 1.3 % of Rh-negative donors) shown in figure2&3 turned out to be weak D positive.

Figure 1: Distribution of Rh-D antigen.

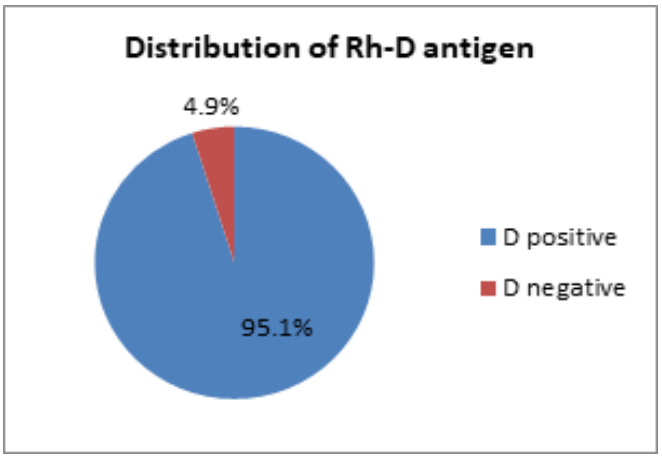


Figure 2: Prevalence of weak D Phenotype among Total Donors.

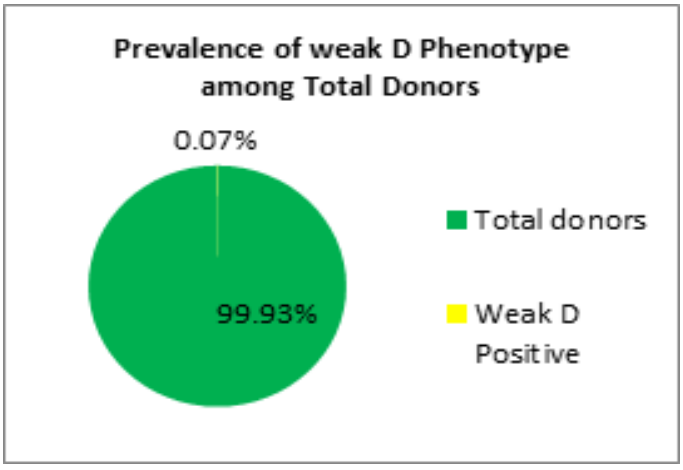
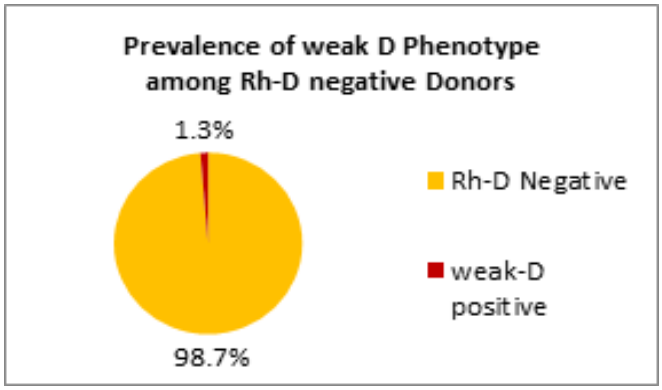


Figure 3: Prevalence of weak D Phenotype among Rh negative Donors.



Discussion

The prevalence of Rh-D negative in our study population is 4.9% and that of weak D is 1.3% out of total Rh-D negatives and 0.07% out of total blood donors. In weak D positive individuals, B (1.5%) & O (1.5) phenotype were found to be most common followed by A (1.1%).

The prevalence of weak D antigen varies worldwide in different geographical areas. In Caucasians it varies from 0.2-1% among Rh-D negative population,[9] the incidence in Europe is 0.23-0.5% and 3% in USA among Rh-D negative population.[10] In Indian studies the incidence of weak D in Rh-D negative population is in the range of 0.01–7.6% which could be due to geographic variations.[2]

Our study data is in concordance with a study done by Anshu Gupta et al[2], in which the prevalence of weak D is 0.25% in donor population and 7.6% in Rh-D negative population.

Weak D testing is difficult to differentiate between partial D and weak D, molecular analysis of RHD and RHCE genes can identify the majority of D variants in our population.[2]Several studies have proved that weak D is immunogenic and can produce alloimmunization if transfused to Rh-D negative recipients and may lead to Haemolytic transfusion reaction in subsequent transfusions. Mothers with weak D fetus must receive

immunoprophylaxis as passage of Weak D red cells from fetus to mother may cause sensitization.[11]

According to NACO and DGHS guidelines in transfusion practice it is mandatory to detect weak D antigen for the donor and the recipient can safely be considered as Rh-D negative even if weak D is positive.

Conclusion

The prevalence of Rh-D negative in our study population is 4.9% and that of weak D is 1.3% out of total Rh-D negatives and 0.07% out of total blood donors.

As Rh-D antigen is highly immunogenic and can produce alloimmunization if transfused to Rh-D negative subjects, it is important to detect and label weak-D RBC units as D-positive among donor population to ensure blood transfusion safety by optimizing the management of D-negative RBC units. However, testing for weak expression of D antigen by Indirect antiglobulin testing (IAT) is not required for transfusion recipients, who would then receive D-negative units without untoward effects. Even though the molecular tests are confirmatory in detecting Rh-D variants, in country like India, weak D testing in IAT phase is essential and cost-effective for Rh-D typing of donors.

Acknowledgement

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