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Original Research Article

Distribution of Rh, Kell and Duffy Blood Group Antigens and Their Phenotypic Characteristics in Blood Donors of Barpeta District of Assam: A Hospital Based Study from North East India

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Abstract

Background: Determination of the blood group antigens and the different phenotypes is limited to the ABO and Rh blood group antigens only as antigens of these system can cause most of the transfusion reactions. This is the first study to evaluate the frequency of Rh, Kell and Duffy antigens and their phenotypes in voluntary blood donors of Barpeta district of Assam, North East India.

Materials and Method: A total of 520 samples from voluntary blood donors attending the Blood Centre, Fakhruddin Ali Ahmed Medical College and Hospital, Barpeta, Assam, India, were typed for the presence of antigens of Rh, Kell and Duffy blood group system by tube agglutination method. The different phenotypic frequencies were evaluated and results were expressed in percentage.

Results: The D antigen frequency was highest with 95.96% followed by e (92.69%), C (87.88%), c (41.35%) and E (21.54%). The most common Rh phenotype is DCCee. Most common antigen in Kell blood group system was k (100%) and its most common phenotype was K-k+ (98.46%). K antigen was positive in 2.69%. In Duffy blood group system, Fya is positive in 80.77% and Fyb is positive in 57.50%. The most common Duffy phenotype is Fy(a+b+) (46%).

Conclusion: This study will not only help in having a database of antigens and their phenotypic frequencies but also in providing antigen negative compatible blood units in alloimmunized patients, thalassemia patients requiring repeated blood transfusions, which will be helpful to prevent blood transfusion reaction and thereby ensure safe blood transfusion.

Keywords: Antigen, Blood Group System, Phenotype, Frequency, Assam, North East India.

Introduction

The main aim of the Blood Centre is to provide safe and compatible blood and blood components to the patients in need. [1] To achieve this, we not only need the ABO and Rh blood group of the patient and the donor to be matched, but also the phenotype of the other blood group antigens is also essential to prevent transfusion reaction. A local database of the donor phenotypes in this regard would be helpful in attaining safe blood transfusion. The International society of blood transfusion has identified a total of 345 RBC antigens, which are clustered in 43 blood group systems, nine (ABO, Rh, Kell, Duffy, Kidd, MNS, P, Lewis and Lutheran) are considered to be major blood group systems. [2-3]

The blood group phenotypes of the other RBC antigens are present in different frequencies in different population and ethnic groups around the globe. The frequency distribution among the African, Caucasian, Chinese, Japanese, and Indian population and also the varying frequencies among the different regional and ethnic groups of population of the Indian sub-continent is documented in different studies.

Thus, a database of the other RBC antigen phenotype will help us to prevent the transfusion of the corresponding antigen positive blood units in which alloantibodies have already developed in the recipients due to previous sensitization and thus will help us to prevent the development of blood transfusion reaction.

In this part of the country, the prevalence of hemoglobinopathies and thalassemia is common. A database of the antigen phenotype of the various blood group system in local donor population will be of great benefit as it will be helpful to provide antigen negative blood to patients like thalassemia and leukemia who require regular multiple blood transfusion. So we have selected Rh, Kell and Duffy blood group antigen and their phenotypic characteristics to be done in blood donors of Barpeta District of Assam.

The Rh antibody was so named on the basis of antibody production by guinea pig and rabbit when transfused with rhesus monkey RBCs [4]. Rh is one of the most common cause of HDFN, erythroblastosis fetalis, and a significant cause of hemolytic transfusion reaction4.There are three Rh antigens : D(d), C(c) and E(e). The frequency of the D antigen varies between populations throughout the world. In China, for example, almost 99.99% of the population are D+, whilst in the Basque region of Spain as many as 25% of the population are estimated to be D-. In the United Kingdom, approximately 85% of the population are D+ and 15% D [5].

The Kell blood group system consists of 32 high-prevalence and low-prevalence antigens. Anti K was identified in 1946 in the serum of Mrs. Kelleher. The antibody reacted with the RBCs of her newborn infant, her older daughter, her husband and about 7% of the random population [6]. Excluding ABO, K is rated second only to D in immunogenicity. Most anti-K appear to be induced by pregnancy and multiple transfusion.

The Duffy blood group system was named for Mr. Duffy, a multiple transfused hemophiliac who in 1950 was found to have the first described example of anti-Fya. One year later, the antibody defining its antithetical antigen, Fyb, was found in the serum of a woman who had had three pregnancies.

In 1955, Sanger and colleagues [7] reported that the majority of African Americans tested were Fy (a-b-). The gene responsible for this null phenotype was called Fy. FyFy appeared to be a common genotype in blacks, especially in Africa; the gene is exceedingly rare in whites.

In 1975, it was observed that Fy (a-b-) RBCs resist infection in vitro by the monkey malaria organism Plasmodium knowlesi. It was later shown that Fy (a-b-) RBCs also resist infection by P. vivax (one of the organisms causing malaria in human). [7] This discovery provides an explanation for the predominance of the Fy (a-b-) phenotype in persons originating from West Africa.

Antibodies to other antigens in the Duffy blood group system, Fy3, Fy5, are rarely encountered. RBCs that are Fy(a-b-) are also Fy: -3, -5. Fy5 is also not present on Rh RBCs, regardless of the Fy^a or Fy^b status of those RBCs. The Duffy blood group system is designated by the symbol Fy or 008 by the ISBT.

Aim and Objectives

To evaluate the phenotypic characteristic of Rh, Kell and Duffy blood group system in the blood donors attending the Blood Centre of Fakhruddin Medical College and Hospital.

Materials and Methods

This is a prospective hospital based observational study conducted at Blood Centre and Multi-Disciplinary Research Unit, Fakhruddin Ali Ahmed Medical College and Hospital(FAAMC&H) Barpeta, Assam from May, 2018 to April, 2019 after obtaining approval from the Institutional Ethical Committee. This study was conducted to evaluate the phenotypic characteristic of Rh, Kell and Duffy blood group system in the blood donors attending the Blood Centre of FAAMC&H. A total of 520 voluntary donors were enrolled in the study. Donor selection were done as per Drugs and Cosmetic Act, 1940 and rules 1945. All the participant were enrolled after obtaining informed consent.

2 mL of blood sample was collected in EDTA tube from each donor. A total of 520 samples were typed for the presence of antigens of Rh (D, C, c, E, e), Kell (K,k), and Duffy (Fya, Fyb) blood group system by conventional -tube agglutination method. Agglutination denotes positive reaction and signifies presence of the corresponding antigen. Anti-D negative cases were evaluated again for the presence of weak-D phenotype by indirect antiglobulin test according to standard operating procedure using a blended IgG and IgM anti-D antisera.

Rh typing was done by conventional tube agglutination method using antisera from two different companies (Tulip Diagnostics Pvt. Ltd., Verna, Goa, India; containing monoclonal IgM antibody and Span Diagnostic Pvt. Ltd., Surat, India; containing both monoclonal IgM and IgG). The other antigens of Rh-System were tested by conventional tube agglutination method using the specific monoclonal antisera manufactured by Diamed, GmbH, Switzerland and imported by Bio-Rad Laboratories, (India) Pvt. Ltd. The Kell and Duffy blood group antigens were also tested using the reagents manufactured by Diamed GmbH, Switzerland.

Results

A total of 520 donors were typed for presence of antigens of Rh, Kell, Duffy blood group system. Rh D antigen was found to be present in 499 donors (95.96%). 4.04% donors were negative for Rh D antigen (Table 1).

Table 1: Frequency of Rh D antigen in blood donors

Rh D positive (%)	Rh D negative (%)
499 (95.96)	21 (4.04)

Table 2 shows the antigen frequency of the different antigens of the Rh blood group system. In the present study, the ‘D’ antigen has the highest frequency of 95.96%, followed by ‘e’ antigen with 92.69%. C, c and E antigen have a frequency of 87.88%, 41.35% and 21.54% respectively.

Table 2: Comparison of frequencies of Rh-antigen in our present study with other studies in different populations in India and other parts of the world.

Studies	Antigens				
	D (%)	C (%)	c (%)	E (%)	e (%)
Present study	95.96	87.88	41.35	21.54	92.69
Makroo et al. [8]	93.6	87.0	58.0	20.0	98.0
Thakral et al. [9]	93.3	84.76	52.82	17.9	98.3
Kahar and Patel [10]	84.34	81.74	56.52	21.74	100
Pahuja et al. [11]	95.9	89.6	57.7	17.29	95.6
Sarkar et al. [12]	92.25	87.55	51.06	26.55	98.42
Caucasian [13]	85.0	68.0	80.0	29.0	98.0
Black [13]	92.0	27.0	98.0	22.0	98.0
Asian [13]	99.0	93.0	47.0	39.0	96.0
Japanese [14]	99.5	87.84	56.99	50.69	90.95

Table 3 shows different distribution of Rh-phenotype. The most common phenotype in Rh system is DCCee (50.96%), followed by DCcee and DCcEe with 17.69% and 13.08% respectively. The most common phenotype in Rh-negative sample was dccee (3.65%).

Table 3: Comparison of different Rh phenotypes with different ethnic groups and other Indian studies

Rh-Phenotypes	Present study (n)	Present study (%)	Makroo et. al.[8]	Pahuja et al.[11]	Caucasian [13]	Black[13]	Asian[13]
DCCee	265	50.96	42.6	42.2	18.5	2.0	51.8
DCcee	92	17.69	32.2	34.5	34.9	21.0	8.5
DCcEe	68	13.08	14.5	11.0	13.3	4.0	30.0
DccEe	21	4.04	0.1	2.6	11.8	18.6	2.5
DCcEE	4	0.77	1.1	1.5	0.1	Rare	0.4
DCCEe	18	3.46	0.5	0.2	0.2	Rare	1.4
Dccee	25	4.81	1.3	1.1	2.1	45.8	0.003
DCCEE	4	0.77	---	0.2	0.01	Rare	Rare
DccEE	2	0.38	0.8	2.7	2.3	0.2	4.4
Dccee	19	3.65	4.6	---	15.1	6.8	0.1
dCcee	2	0.38	0.3	0.1	0.8	Rare	0.1

In the Kell blood group system, 2.69% donors were typed as K-antigen positive. However, all the donors were 100% k-antigen positive (Table-4). The dominant phenotype in the Kell blood group system was found to be K-k+ (98.46%). The remaining 1.54% were of K+k+ phenotype (Table-5).

Table 4: Distribution of Kell blood group antigen

Studies	Antigen	
	K (%)	k (%)
Present study	2.69	100
Caucasian[13]	9	99.8
Black[13]	2	100
Asian[13]	Rare	---

Table 5: Comparison of phenotype of Kell blood group system with different ethnic group and other Indian studies

Studies	Kell phenotype		
	K+k+	K-k+	K+k-
Present study (n)	8	512	0
Present study (%)	1.54	98.46	0
Makroo et al. [8]	3.5	96.5	Rare
Pahuja et al. [11]	1.9	98.1	---
Thakral et al. [9]	5.68	94.32	---
Kahar and Patel [10]	6.09	93.91	---
Agarwal et al. [15]	1.97	98.03	---
Nanu and Thapliyal [16]	4.04	95.96	---
Caucasian [13]	8.8	91.0	0.2
Black [13]	2.0	98.0	Rare
Chinese [8]	---	100	---

80.77% donors were typed as Fya antigen positive and 57.50% donors were reported as Fyb antigen positive (Table-6). The most common phenotype in Duffy blood group system was Fy(a+b+) (46%) followed by Fy(a+b-) (35.2%) (Table-7).

Table 6: Distribution of Duffy blood group antigen

Studies	Antigen	
	Fy^a (%)	Fy^b (%)
Present study	80.77	57.50
Caucasian [13]	66	83
Black [13]	10	23
Asian [13]	99	18.5
Chinese[13]	---	9.2

Table 7: Comparison of phenotype of Duffy blood group system with different ethnic groups and other Indian studies

Studies	Duffy phenotype			
	Fy(a+b+)	Fy(a+b-)	Fy(a-b+)	Fy(a-b-)
Present study (n)	239	183	63	35
Present study (%)	46.0	35.2	12.1	6.7
Makroo et al. [8]	45.3	42.1	12.3	6.7
Thakral et al. [9]	42.9	43.85	13.25	---
Kahar and Patel [10]	9.57	37.39	4.35	48.69
Agarwal et al. [15]	48.03	36.22	15.36	0.39
Nanu and Thapliyal [16]	42.57	40.80	16.19	0.44
Caucasian [13]	49.0	17.0	34.0	Very rare
Black [13]	1.0	9.0	22.0	68.0
Chinese [13]	8.9	90.8	0.3	---
Japanese [13]	17.6	81.5	0.9	---
Thai [13]	28.0	69.0	3.0	---

Discussion

The data regarding the presence of different antigens of the various blood group system help us to perform safe blood transfusion. [17] When clinically significant antibodies are detected in patient's serum, then the corresponding antigen negative donor blood is selected

for transfusion to prevent transfusion reaction. [18]

Different studies have reported different frequencies of Rh D antigen in different population of the world. In our study, Rh D antigen was found to be present in 95.96% of donors.

Regarding the presence of different Rh-antigens, the current study is compared with similar studies from other parts of the country. The Rh antigens namely D, C, c, E and e were found in similar frequency with studies done by Makroo et al [8], Thakral et. Al [9], Pahuja et. Al [11], and Sarkar et al. [12] The antigen frequencies were also compared with Caucasian, Black, Asian, and Japanese population. [13,14] In Caucasian and Black population, e-antigen has the highest frequency (98%). [13]

The most common Rh phenotype in the present study is DCCee (50.96%) followed by DCcee (17.70%). Similar findings were found in other studies done in other parts of the country. [8,11] But the findings are different in studies done among the Caucasian and Black population where the highest frequency is found in DCcee (34.9%) and Dccee (45.8%) respectively. [13] In studies done among the Asian population highest frequency is found in DCCee (51.8%) followed by DCcEe (30%). [13]

Kell blood group has 4 different phenotypes but the vast majority show K-k+ phenotype (98.46%) and a small percentage comprises of K+k+ (1.54%). While the other two phenotypes, K+k- and K-k- are very rare. [8-11,15,16,19,20, 21] Similar observations were also reported in other studies in India and World (Table-5).

The Duffy phenotype Fy(a+b+) (46%) was found to be the highest frequency closely followed by Fy(a+b-) (35.2%). This finding is comparable to other studies done in India. [8,9,15,16] While one study done by Kahar and Patel has completely different finding with Fy(a-b-) (48.69%) having the highest frequency. [10] Study done on Caucasian population has different findings with Fy(a+b+) (49%) having the highest frequency followed by Fy(a-b+) (34%). [13] Black and Chinese population has the highest frequency of Fy(a-b-) (68%) and Fy(a+b-) (90.8%) respectively. [13] Japanese population has the highest frequency of Fy(a+b-) (81.5%) followed by Fy(a+b+) (17.6%). [13] Similar observations were also observed in Thai population which has the highest frequency of Fy(a+b-) (69%) followed by Fy(a+b+) (28%). [13]

Conclusion

As we are aware of differences in phenotypic distribution of different blood group antigens in different parts of India which sometimes may result in mismatched blood transfusion reaction due to alloimmunization and can also sometime be life threatening mostly in patient receiving multiple transfusion like in thalassemia patient, which is prevalent in this part of the State. So, our study database regarding the knowledge of phenotype in a blood donor population may be helpful in blood transfusion service in this region of North East India in reducing the rate of alloimmunization by making available of antigen-matched blood and thereby preventing transfusion reaction in multi-transfused cases to great extent and ensuring safe blood transfusion.

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