Original

ABO Phenotypes, Rhesus and Kell2 antigens of Blood donors attending University of Calabar Teaching Hospital

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Abstract

Background: Modern blood transfusion entails the transfusion of compatible blood units from a healthy donor to the recipient (patient). This study was aimed at evaluating rare and high- frequency blood antigens to aid planning in the study location.

Method: Descriptive cross-sectional study with systematic random sampling sample was employed in this study. The samples were analysed using commercially prepared reagents via serological technique (Standard tube agglutination method). The ABO was performed using anti-A, anti-B, and anti-AB reagent while Rh D was performed using anti D monoclonal reagent. KELL 2 (k) was performed using anti-kell reagent.

Result: Out of the 100 blood donors tested, 28 (28%) were KELL 2 (k+) positive while 100 (100%) were positive for Rh D antigen. ABO phenotype O constituted the majority (70%) of the studied subjects while A, B, and AB constituted 15%, 13%, and 2% respectively. The ABO cum Rhesus and blood group were in the order 0^{+}> A^{+}>, B^{+}>, AB^{+}.

Conclusion: KELL 2 antigen was relatively low among the studied subjects, while Rh D antigen was found to be a high-frequency antigen. Blood group O Rh D positive was found to be the most predominant blood group recorded among the studied participants.

Keywords: Rh D; Cellano; Kell 2, Kell antigen; ABO; blood group; Rh antigen

Introduction

Blood group is a term used in referring to blood group system made up of red blood cell antigens whose specificity is controlled by a sequence of genes that are allelic or linked very closely on the same chromosome.[1,2] These antigens have specific sites on different proteins, glycoproteins, or glycolipids that form part of the red blood cell membrane, which the immune system can interact with. As of June 2021, there were 43 recognised blood group systems containing 345 red cell antigens by the International Society of Blood Transfusion (ISBT) Working Party.[3,4] The antigens may occur as integral proteins where the polymorphism lies in the variation in amino acid sequence (e.g., Rh and Kell) or as glycoproteins or glycolipids (e.g ABO).[1]

Since its discovery over 100 years ago by Karl Landsteiner, the ABO blood group system has

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maintained prime importance in blood transfusion medicine, being the most immunogenic of all blood group antigens. Most common deaths due to mismatches caused by clinical errors often involve ABO incompatibility. The antigens of the ABO system are A and B. The ABO antigens are encoded by one genetic locus which has three alternative (allelic) forms – A, B, AB and O. Irrespective of the obvious clinical significance, the physiological function of ABO blood group antigens remains a mystery.[4]

The Rhesus blood group is the second-most significant blood group after ABO in transfusion medicine.[5] There are about 50 defined Rh antigens, out of which only five are important. The most important Rh antigens include D, C, c, E and e. Anti-D is the most important antibody in the Rhesus system, causing haemolytic transfusion reactions and haemolytic disease of the newborn.[6,7,8]

The Kell blood group is complex and consists of many antigens that are highly immunogenic. These antigens represent the third most immunogenic in transfusion medicine after ABO and Rhesus.[9] The Kell blood group consists of more than 30 antigens with the most important being K (KELL 1 or K+) and k (KELL 2 or k+) formerly "Cellano."[10] The antibodies to these antigens are immune and are not naturally occurring.[11,12] One of the critical challenges in blood transfusion medicine is the provision of compatible blood for patients who are negative for a high frequency blood group, who also have alloantibody against the antigen. High-frequency blood group antigens (k, Kp^b, Js^b, Lu^b, etc.) are present in ≥ 90% of the human population.[10,13] Consequently, patients lacking these antigens pose challenges in transfusion support as procurement of compatible blood is difficult in cases where the patient bears the alloantibodies. Fulfilment of such a request becomes herculean if a prior plan is not made.

This study was aimed at evaluating some rare and high frequency blood types to aid prior planning and ensure availability in case such requests are made within the study location.

Method

The study made use of descriptive cross-sectional design with systematic random sampling. One hundred prospective blood donors visiting the University of Calabar Teaching Hospital Donor Clinic were recruited for the study. The University of Calabar is a tertiary healthcare centre located in Calabar, Cross River State, Nigeria. Calabar lies in the geographical coordinates: 8°9'37.02E with an estimated population of 375,196 (2006 census). Calabar metropolis is a fusion of Calabar Municipality and Calabar South Local Government Areas.[14,15]

Ethical clearance was obtained from the Health Research Ethics Committee of the University of Calabar Teaching Hospital with the approval number UCTH/HREC/33/566. Informed consent was obtained from all participants before enrolment. Five millilitres (5 ml) of blood was collected via venipuncture from the participants into a plain container.

The blood samples were analysed using commercially prepared reagents by standard serological tube technique. The ABO grouping was performed using anti - A, anti – B and anti – AB. Rhesus D was performed using anti – D monoclonal reagent from Biotec, while kell 2 grouping was analysed using a specific monoclonal antibody (anti-kell) supplied by Lorne Laboratories Limited, Great Britain (UK). The validity of all negative samples were confirmed microscopically for agglutination.

Data was curated using Excel 2007 (Microsoft) and analyzed using SPSS version 25 (IBM Inc). The results were represented in frequencies and proportions (percentage).

Results

Figure 1 shows the distribution of the sampled subjects based on ethnicity. The majority of the subjects were of Efik (29%) and Ibibio (26%) decent. The rest were Igbo (8%), Ugep (7%), Obudu (6), Boki (5%), Akamkpa (4%), Ogoja (3%), Obubra (25), Ikom (2%), Yala (1%), and Yoruba (1%). Efik, Ugep, Obudu, Boki, Akamkpa, Ogoja, Obubra, Ikom, and Yala are all ethnicities in Cross River State where the study was performed. However, Ibibio is a tribe in neighbouring state Akwa Ibom, which was formally in Cross River State. The external ethnicities observed are the Igbos and Yorubas.

Table 1 shows the comparison of Rhesus D and KELL 2 (k+) antigens among the studied subjects and other studies in Nigeria and other parts of the world. RhD antigen prevalence of 100% was found among the studied subjects, while KELL 2 antigen prevalence of 28% was recorded.

Table 2 shows the ABO phenotype of the studied subjects and other studies in Nigeria and other parts of

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the world. Phenotype O constituted the majority (70%) of the subjects while A, B, and AB constituted 15%, 13% and 2%, respectively.

Table 3 shows the distribution of both ABO and RhD blood groups. Blood group O RhD positive constituted majority (70%) of the ABO/Rh blood group of the studied subjects. The order was $O^+ > A^+ > B^+ > AB^+$.

Table 1: Comparison of RhD and KELL 2 (k+) antigens among the studied subjects and other studies in Nigeria and other parts of the world.

Antigen		**Percentage (%)**								
Traditional	ISBT	Present study	Another Nig. study	S. Arabia[18]	India[19]	China[20]	CDV[21]	Oman[22]	Pakistan	Caucasians[25]
D	RH1	100.0	92.7[16]	80.0	93.4	98.9	92.9	89.3	89.1[23]	85.0
k	KELL 2	28.0	23.0[17]	100.0	100.0	100.0	98.1	99.4	98.9[24]	99.8

S.: Saudi; Nig.: Nigeria.

Table 2: Comparison of ABO phenotype of the studied subjects and other studies in Nigeria and other parts of the world

Studies	**ABO phenotypes**			
	O	**A**	**B**	**AB**
Present study	70.00	15.00	13.00	2.00
Other Nigerian studies				
Calabar, Nigeria[26]	70.78	17.71	11.08	0.43
Bayelsa, Nigeria[27]	65.30	19.03	13.57	2.10
Benin, Nigeria[28]	53.22	23.72	20.09	2.97
Sokoto, Nigeria[29]	51.91	20.78	23.50	3.18
Kano, Nigeria[30]	57.20	20.50	20.70	1.60
Abakaliki, Nigeria[31]	57.30	22.10	18.10	2.10
Other countries' studies				
Ghana[32]	50.00	24.30	20.70	5.00
Cameroon[33]	48.62	25.07	21.86	4.45
Burkina Fasso[34]	43.30	22.54	28.56	5.60
India[35]	32.07	25.13	33.77	9.03
Iraq[36]	36.90	39.90	15.80	7.40
Saudi Arabia[37]	56.80	33.40	6.00	3.80
Turkey[38]	30.80	43.80	16.20	9.20

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Table 3: Distribution of ABO phenotypes and RhD antigens in the studied population.

Blood group	Sex		Total (%)
	Male (%)	Female (%)	
A RhD positive	13 (18.31)	2 (6.90)	15 (15.0)
B RhD positive	10 (14.08)	2 (6.90)	2 (12.0)
AB RhD positive	1 (1.41)	1 (3.44)	2 (2.0)
O RhD positive	47 (66.20)	24 (82.76)	71 (71.0)
A RhD negative	0 (0.0)	0 (0.0)	0 (0.0)
B RhD negative	0 (0.0)	0 (0.0)	0 (0.0)
AB RhD negative	0 (0.0)	0 (0.0)	0 (0.0)
O RhD negative	0 (0.0)	0 (0.0)	0 (0.0)

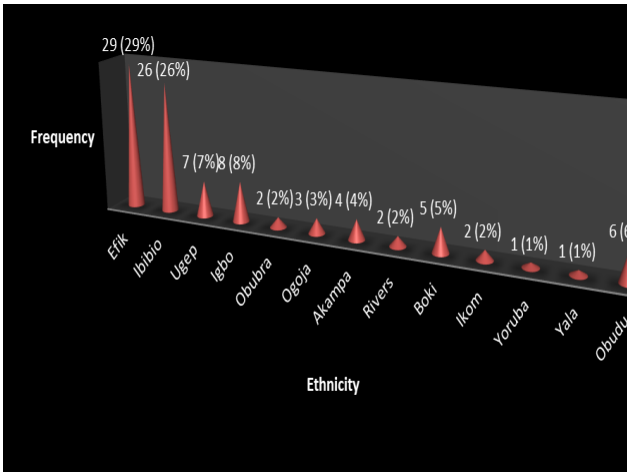

Figure 1: Distribution of blood donors based on ethnicity

Discussion

In the present study, we determined the frequency of antigens of Kell (k), Rhesus D and ABO among prospective blood donors.

A prevalence of kell (k) antigen of 28% was found. This value is similar to the 21.7% reported in another study in Kano, Northern Nigeria.[17] However, the value is lower than reports from Pakistan (98.9%),[24] Oman (99.4%),[22] Cote d' Ivoire (98.08%),[21] China (100%),[20] India (100.0%),[19] Saudi Arabia (100.0%),[18] and Caucasians (99.8%).[25] This means that while a good number of Nigerians in the study area develop anti-k, only a minute or nil population of Asians and Caucasians won't. The implication of this finding is mostly in travel medicine (particularly medical tourism). This implies that a Nigerian with anti – k on medical tourism who requires blood in the above Caucasian and Asian countries may find it difficult to procure such k-negative blood that is ABO and Rh compatible without prior planning. It has been documented that thousands of Nigerians travel every year to US, UK, India, China, Saudi Arabia, and among others for medical treatment.

It was found that a Rh D antigen prevalence of 100% in the studied population. This is similar to the 92.7% reported in previous research in Nigeria by Adewoyin and colleagues.[16] This is also similar to previous reports in Saudi Arabia (80.0%),[18] India (93.4%),[19] China (98.9%),[20] Cote d'Ivoire (92.93%),[21] Oman (89.3%),[22] Pakistan (89.1%)[23] and Caucasians (85.0%).[25] This portrays the Rh D antigen as a high frequency antigen (HFA) in the study location and the referenced Asian and Caucasian countries. The implication of this is the availability of suitable blood unit(s) in the event of occasional cases of blood transfusion involving persons lacking a high-frequency antigen. One of the challenges of transfusion medicine is providing compatible blood for patients lacking a high-frequency antigen.[10]

The ABO phenotype recorded in this study was in the following order: O (70%) > A (15%) > B (13%) and AB (2%), with the O phenotype being the predominant ABO phenotype. This trend is similar to the reports in Nigeria: Calabar,[26] Bayelsa,[27] Benin,[28] Sokoto,[29] Kano,[30] and Abakaliki.[31] Among studies outside Nigeria, similar trend was recorded in Ghana,[32] Cameroon,[33] Saudi Arabia.[37] However, studies in India[35] showed O > B > A > AB, while those of Iraq[36] and Turkey[38] showed A > O > B and > AB.

In view of both the ABO and Rh D blood groups, the blood groups were in the order $O^+ > A^+ > B^+ > AB^+$. This is similar to the report by Okoroiwu and colleagues.[39] On the other hand, Mubu and colleagues have reported $O^+ > B^+ > A^+ > AB^+ > O^- > A^- > B^- > AB$.[29]

The observed variation in blood group antigens across regions raises intriguing questions about the factors shaping this variation. A confluence of evolutionary, historical, and even environmental influences likely contributes to this phenomenon via natural selection, different environments and disease pressures can favour specific blood groups. For example, certain blood

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groups might offer increased resistance to malaria, prevalent in parts of Africa.[40,41,42,43] Over generations, such selective pressures can lead to higher frequencies of adaptive blood groups in particular regions.[44] More so, when a small, isolated population establishes itself in a new region, its initial gene pool significantly influences future generations. This can lead to unique blood group frequencies due to limited genetic diversity (Founder effect).[45] Also, random fluctuations in gene frequencies due to chance events (genetic drift) can also contribute to variations in blood group distribution, particularly in smaller populations.[46] Other means are migration, the epidemiology of infectious diseases and environmental factors.

The findings of this study should be interpreted in view of the limitations such as the relatively small sample size. However, the method of selection has ensured representation of the blood group antigens within the study location.

Conclusion

Knowledge of the prevalence of various blood group antigens in any population is essential in handling cases of alloimmunization. This becomes essential in the management of multiple transfused patients, such as sickle cell and cancer patients. Currently, Nigeria has the highest incidence of sickle cell disease globally.[47,48] The blood group information provided in this study will be useful in blood transfusion planning in the studied population.

Declarations

Ethical consideration: Ethical clearance was obtained from the Health Research Ethics Committee of the University of Calabar Teaching Hospital with the approval number UCTH/HREC/33/566.

Authors' contribution: JEE conceived the study, supervised it, performed the laboratory analysis, analyzed data. UIF conceived the study, performed laboratory analysis, analyzed data. EAA analyzed data, sourced for literature materials. HUO did literature search, analyzed data, performed statistical analysis and prepared the manuscript draft. All authors read and approved the final manuscript.

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