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ABO, RH phenotypes and kell blood groups frequencies in an Egyptian population

Abstract

Objective: Blood safety is a core objective in transfusion medicine, this can be enhanced by avoiding alloimmunization with clinically important antibodies. The frequencies of ABO, Rh antigens (D,C,E,c,e), and KEL1 antigen in Egypt were not addressed before. This study was performed to provide information about the frequencies of ABO and Kell blood groups and Rh antigens, phenotypes, and the expected genotypes among an Egyptian population and comparing them with other races.

Subjects and methods: Samples from 216 blood donors and recipients were serologically tested for ABO, Rh (D, C, E, c, and e) and KEL1 antigens using gel column agglutination card method. Rh Phenotypes' frequencies were expressed as percentages, and expected genotypes were calculated.

Results: The percentage frequencies of A, O, B and AB groups were 39.4%, 25.9%, 24.1%, and 10.6% respectively. The Rh D negative incidence was 14.4%. The most frequently occurring antigen was found to be e (100%), followed by c (91.2%), then D (85.6%), C (70.4%), and finally E (41.7%). DCCee was the most prevalent phenotype (32.9%). ddccee was the most common phenotype amongst RhD negative individuals. The frequency of KEL1 antigen was 23.6%. The distribution of the blood group antigens among different races showed great variability except for e Antigen which is almost similar in all populations.

Conclusion: This study provides the first step to create a donor data bank and to prepare red cell panels to provide compatible blood to multi-transfused patients.

Keywords: Rh phenotypes, ABO blood group, kell, egyptian population, red cell antigens

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Introduction

Red cell transfusion is a procedure that has a critical nature and can lead to life threatening complications such as acute hemolytic transfusion reactions (AHTR), delayed hemolytic transfusion reactions (DHTR), and hemolytic disease of the newborn (HDN), along with laboratory findings such as delayed serologic transfusion reactions and a positive direct antiglobulin test (DAT). These complications are due to alloimmunization risk from exposure to foreign antigens on donor or fetus red cells leading to formation of unexpected alloantibodies.[1,2]

A blood group is classified based on the presence or absence of inherited antigenic substances on the outer surface of the red blood cells; some of these antigens are also present on the surface of other cell types of different tissues. These antigens may be proteins, carbohydrates, glycoproteins, or glycolipids, depending on the blood group system.[3] According to The International Society of Blood Transfusion (ISBT), the recognized blood group antigens are 346, of which 308 are clustered within 36 blood group systems, the 38 other serologically defined antigens have not been assigned to a blood group system yet.[4] Each blood group system represents either a single gene or a cluster of closely linked homologous genes. Most blood group antigens are glycoproteins and their specificity is determined either by oligosaccharide (e.g. ABO) or amino acid sequence (e.g. MN, Kell, Duffy, Kidd).[5]

The ABO system (ISBT 001) is the first and most clinically important system with recognized oligosaccharide antigens (A, B, AB and A1). Each individual has plasma antibodies (isohemagglutinins) that are directed against blood group antigens that their RBCs lack. These isohemagglutinins are formed early in life. ABO antigens are expressed on RBCs, platelets, and endothelial cells and are present in body fluids.[3]

The Rhesus blood group system (ISBT 004) is the most complex and polymorphic blood group system; comprising 54 antigens numbered RH1 to RH61 with seven obsolete numbers. There are 18 phenotypes can be distinguished by using anti-D,C,c,E, and e. In addition, there are eight possible haplotype arrangements of Rh genes on short arm of chromosome 1 i.e. Dce, DCe, DcE, DCE, dec, dCe, dcE and dCE and results in 36 possible genotypes.[3] The KEL (Kell) system (ISBT 006) is currently known to contain 36 antigens. The K antigen is strongly immunogenic. Anti-K has been reported as the cause of hemolytic transfusion reactions, both immediate and delayed, and hemolytic disease of the newborn.[4] There is wide variation in the frequencies of ABO, Rh and Kell antigens throughout the world and there is no published data from Egypt about this issue. The aim of this study was to detect the frequencies of ABO, Rh and Kell blood group antigens among blood recipients from the inpatients and blood donors coming to Suez Canal University Hospital blood bank, Ismailia, and to compare it with that of other ethnic groups.

Subjects and methods

This observational cross-sectional study was conducted at Suez Canal University Hospital blood bank, Ismailia, Egypt. Two milliliters whole blood samples were taken into ethylenediaminetetraacetic acid (EDTA) tubes from blood donors, and inpatients who were admitted

to different wards of Suez Canal University Hospital. Ethical approval was obtained from the Ethics Committee of Faculty of Medicine, Suez Canal University and a written consent was provided for each participant. All age groups and both gender were included. The study population included 216 individuals who were subjected to a brief interview by which data was collected including: name, age, sex and past transfusion history (and its cause, if any).

Forward and reverse ABO and Rh D blood grouping were performed by the gel column agglutination card method using the DiaMed system (ABO-Rh/Reverse Grouping, ID-Card, Switzerland). For Rh extended phenotyping, detection of the major antigens of Rh apart from Antigen D and Kell systems (Antigens C, c, E, e and K), specific monoclonal antisera were used and the test was performed by Gel technique (DiaClon Rh- Subgroups + K, ID-Card, Switzerland). Controls were set in each card to ensure the validity of the results.

The possible genotypes were determined as follows: (1) If D is positive, the number of possible genotypes was one less than the number of positive reactions (except if all 5 antigens are positive, in this case, there are 6 possible genotypes). (2) If D was negative, the number of possible genotypes was two less than the number of positive reactions (except if there are only 2 positive reactions, in this case there is 1 possible genotype).

One haplotype was inherited from each parent (for instance, DCe/ce was one genotype having both the DCe and the ce haplotypes).

The ABO, Rh antigens, and phenotypes, and Kell blood groups frequencies were calculated by summing the number of subjects who tested positive for the particular antigen/phenotype and dividing by the total number of the studied population. The results were expressed as percentages.

Results

A total of 216 subjects; 174 (80.5%) were recipients, while 42 (19.5%) were blood donors. Mean age± standard deviation (SD) of the recipients and donors were 32±16.1 and 31.3±8.9 years respectively. Out of 216 samples, males were 114 (52.8%) while female were 102 (47.2 %). Out of 174 recipients, 117 (67.2%) were multi-transfused, while 57 (32.8%) were transfused for the first time. Causes of transfusion were thalassemia (19%), accidents (13.8%), chronic liver diseases (13.8%), surgery (9.8%), cesarean section (8.6%), chronic renal failure (8%), neoplastic diseases (7.5%) vaginal delivery (6.9%), severe anemia (6.9%), hemorrhage (4%) and dilatation and curettage (1.7%).

Table 1 and Table 2 show the frequencies of ABO blood groups and the five major Rh antigens in the studied population. Blood group A was predominant (39.4%), followed by O (25.9%), B (24.1%) and AB blood group which had the lowest percentage (10.6%).

The Rh D negative incidence was 14.4%. Out of 18 possible Rh phenotype combinations (9 belongs to Rh D positive and 9 D negative), the results of the studied population did not reveal any case of phenotypes DCCEe, DccEE, DCCEE, DCcEE, ddCCEe, ddccEE, ddCcEE or ddCCEE. The most common Rh positive phenotype in study was DCcee, while in Rh D negative samples it was ddccee. In order of descending frequency, the most common phenotypes were DCcee (32.9%), DCcEe (25.9%), DccEe (9.7%), Dccee (9.3%), DCCee (7.9%) and ddccee (6%). The less common phenotypes were ddccEe (4.6%), ddCcee (1.9%), ddCcEe (1.4%) and the least frequent was ddCCee (0.5%) (Figure 1). Table 3 shows the expected Rh genotypes' frequencies. DCe/ce, DCe/Dce and Dce/Ce genotypes were the most prevalent (32.9%), while Ce/Ce genotype was the least frequent (0.5%). The frequency of presence of K antigen among the studied population was 23.6%.

Table 1 Frequency of ABO blood groups in the studied population

ABO groups	Total population (n=216)
	Frequency (Percent)
A	85 (39.4)
AB	23 (10.6)
B	52 (24.1)
O	56 (25.9)

Table 2 Frequency of Rh antigens in the studied population

Rh antigen	ISBT nomenclature	Number (Percent)
D	RH1	185 (85.6)
C	RH2	152 (70.4)
E	RH3	90 (41.7)
c	RH4	197 (91.2)
e	RH5	216 (100)

Table 3 Distribution of the studied population according to the expected Rh genotypes

Rh phenotypes Fisher[6]	Total (n=216)	
	Expected genotypes Fisher[7]	Number (%)
DCcee	DCe/ce (R_1 r) DCe/Dce (R_1 R_0) Dce/Ce (R_0 r') DCe/DcE (R_1 R_2) DCe/cE (R_1 r '')	71 (32.9)
DCcEe	DCE/Dce (R_z R_0) DCE/ce (R_z r) DcE/Ce (R_2 r ') DcE/Dce (R_2 R_0)	56 (25.9)
DccEe	DcE/ce (R_2 r) Dce/cE (R_0 r'')	21 (9.7)
Dccee	Dce/Dce (R_0R_0) Dce/ce (R_0 r)	20 (9.3)
DCCee	DCe/DCe (R_1 R_1) DCe/Ce (R_1 r ')	17 (7.9)
ddccee	ce/ce (r r)	13 (6.0)
ddccEe	cE/ce (r'' r)	10 (4.6)
ddCcee	Ce/ce (r ' r)	4 (1.9)
ddCcEe	cE/Ce (r'' r ') CE/ce (ry r)	3 (1.4)
ddCCee	Ce/Ce (r ' r ')	1(0.5)

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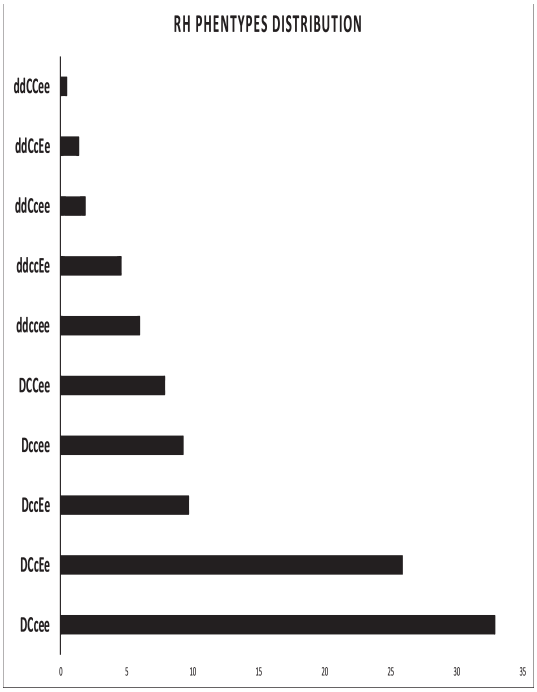

Figure 1 Rh phenotypes distribution in the studied population.

Discussion

The current study comprised 216 subjects who were selected randomly from both blood donors and recipients. The age of patients and donors ranged from 2 years to 80 years. Males to females' ratio was 1.1: 1.

The frequencies of blood groups A, O, B and AB were 39.4%, 25.9%, 24.1% and 10.6%. The current study results agreed with a study conducted in Jordon in having group A to be the most common group (38.4%) followed by O (36.6%) then B (18%) and the least common was AB (7%).[8] While there was difference found, when compared to the results of both a Palestinian study, that showed that O was the predominant blood group (38.1%), followed by A group being (33.1%), B (21.3%) and the AB blood group being (7.5%),[9] and Saudi Arabia study that reported having O as the most common (52%) followed by A (24%), B (17%) and the least common AB (4%).[10] Another disagreement was with an Indian study, which tested 9.280 donors and found Group B (37.3%) to be the most common, followed by groups O (31.8%), A (21.8%) and AB (9.1%).[11]

In this study the Rh D negative incidence was 14.4%. Similar studies on the Caucasian populations, revealed that the proportion of Rh D-negative people was 15-17%. It was 15% in the white population and 8% in the blacks.[12] In a study carried out in Karbla (Iraq), Rh D Negative was 17.7%.[13] Geographically higher incidence of Rh D positive was reported in Japanese (99.7%) while it was 94.3% in India,[11] and lower in European population (83%).[14]

In the current study, Rh phenotyping (D, C, E, c and e) revealed that the frequencies of D, C, E, c and e were 85.6%, 70.4%, 41.7%, 91.2% and 100% respectively. Several studies addressed the same issue and revealed data showing Rh phenotypes around the world. In European countries, the frequencies of Rh major antigens were 85%, 68%, 29%, 80% and 98% for D, C, E, c, and e respectively.[15] While in Africa, a Nigerian study observed the most frequently occurring antigen among 400 subjects was c (99.8%), followed by e (98.7%), D (95 %), E (20.5%) and finally C (17.7%).[16] In a 661 cohort from UAE, it was reported that the most frequently occurring antigen was e (97.3%) followed by D (91.1%), C (73.2%), c (71%) and E (21%).[17] A Palestinian study reported the percentage of Rh antigens among 232 students; D, C, E, c and e was 92%, 69%, 38%, 81% and 97%, respectively.[9] In a study conducted on 1.240 regular donors from north India and found that amongst Rh antigens, e was the most common (98.3%) followed by D (84.7%), C (84.8%), c (52.8%) and E (17.9%).[18]

In English blood donors, C and c antigens showed frequencies of 68% and 81%, respectively. While, in black Africans, the frequency of c was much higher 99%, and the frequency of C was much lower (17%). Whereas the same study showed that in Eastern Asia the opposite was the case, C is higher 94% and c is lower 43%. Regarding E antigen, it represents 29%, 23%, 36% of English, black Africans and Eastern Asia studied populations respectively. The e antigen frequency was 98%, 99%, and 96% of the respective populations.[19]

From what mentioned above it is clear that in all populations, e is significantly more common than E[19] agreeing in this with the current study. While some regions and countries differ regarding the frequencies of C and c phenotypes. As C was lower in both the Nigerian study and in the Black African,[16,19] which it was not the case in the current study.

Kell incompatibility has a significant consequence on transfusion medicine and cause haemolytic disease in babies born to Kell sensitized mothers leading to serious sequel and hence, it is suggested that extended blood typing including Kell antigen to be carried out for multi-transfused patients to avoid acute or delayed types of haemolytic transfusion reactions, and difficulty in finding compatible blood units, and risk of HDN.[20]

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The current study found that the frequency of positive K antigen was 23.6% agreeing with a study in Saudi Arabia showing a frequency of 20%.[21] And not matching other studies showing a wide varying distribution of Kell blood grouping in different parts of the world. In a Sudanese study, the proportion of Kell antigen positivity was 5.6%,[22] approximately 9% of the Caucasian population had (KEL1) positive, 4% in North India, 2 % in blacks and is very rare in East Asia.[15,19] The most common phenotype for Kell blood group was K-k+ (98%) among a cohort of Indian donors.[11]

Rh phenotypes distribution differs in various populations. In this study, according to (Fisher-Race nomenclature) the DCcee was the most common phenotype (32.9%). Similar findings were in Caucasians (32%), it represents 35.1% and 32.9% in North and South India respectively. It was a lower in Saudi Arabia (28.1%), and in blacks (26%), and much lower in Chinese (8.7%). While in Rh D negative, the current study revealed that ddccee was the most common with a percent of 6%, similar to what was found in South India (6%), 7% in blacks, and only 1% in Chinese population and much lower than those found in Caucasians (15%), and in Saudi Arabia (10.3%). Dccee is the most frequent Rh phenotype in East Africans, Somalis, and the general Black population 81.9%, 64.1%, and 42% respectively. For Chinese, the most common Rh phenotypes are DCCee (47%) and DCcEe (30%). For North Indian, DCCee is the most common (42.6%).[1] In 38,836 Albanian blood donors, D positive phenotype was (89%). The Ccee phenotype is the most prevalent (32.4%) followed by CCee (25.78%), CcEe (16.02%), and not a single case of CCEE was found.[23] Difference and similarity of the frequency of different antigens are mostly due to genetic factors.

Rh genotype is used in haemolytic disease of newborn (HDN) and predicting HDN by testing the father's Rh genotype. This help to predict likelihood of HDN due to RhD antigen when mother has anti-D. The most common Rh genotype of the father will indicate whether the baby has 0%, 50% or 100% probability of being RhD positive. When undertaking RhD typing of patients and selecting blood donors, consideration must be given to the qualitative and quantitative variations in the expression of RhD antigen.[14] In the current study, DCe/ce, DCe/Dce and Dce/Ce genotypes were the most prevalent (32.9%), while Ce/Ce genotype was the least frequent (0.5%). Similarly, in whites, it was DCe/ce (39.4%) the most frequent genotype, while in blacks it was Dce/ce (45.8%).[15] A study from Saudi Arabia reported the commonest genotype was DCe/DcE and the least common was Ce/ce.[24]

Conclusion

The distribution of the blood group antigens among different races showed different results. The prevalence of non-ABO blood group antigens in any particular population is valuable in managing cases of alloimmunization in multi-transfused patients. Knowledge of the frequencies of the different blood groups in Egypt is very important for Blood Banks and transfusion service policies and also important for clinical studies (for example disease association), as well as for population studies. Data about the frequency of red blood cell-antigen phenotypes in a population can help establishment of a donor data bank for the preparation of native cell panels and for providing antigen-negative compatible blood to multi-transfused patients who may have developed alloantibodies and in HDN.

According to the Egyptian regulations, pregnant women have to perform ABO and Rh when they are registered in the pregnancy follow up program in the primary health care units yet Kell status is not included. So, we suggest that every Egyptian pregnant woman should be notified about Rh D and Kell status and a prior screening for anti Kell antibodies of the Kell negative pregnant women is crucial if a newborn manifests hemolytic disease and it is important to use Kell negative blood for exchange transfusion in such cass.

This study was conducted to provide information about the frequencies of Rh major antigens and phenotypes, ABO and Kell blood groups among a sample of an Egyptian population, a serological study to our knowledge, was not addressed in earlier published data.

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None.

Conflict of interest

The authors declare that they have no financial or nonfinancial conflicts of interest related to the subject matter or materials discussed in the manuscript.

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