



Haemoglobin Electrophoretic Patterns, ABO and Rhesus D Blood Groups Distribution among Antenatal Women in Sokoto, Nigeria

Udomah FP¹, Isaac IZ², Aliyu N², Erhabor O^{2*}, Ahmed MH¹, Yakubu A³, Hassan M³ and John RT³

¹Department of Haematology and Blood Transfusion Science, University of Calabar Teaching Hospital, Nigeria

²Department of Haematology and Blood Transfusion Science, Faculty of Medical Laboratory Science, Usmanu Danfodiyo University, Nigeria

³Department of Obstetrics and Gynecology, Usmanu Danfodiyo University Teaching Hospital, Nigeria

*Corresponding author: Erhabor Osaro, Department of Haematology and Blood Transfusion Science, Faculty of Medical Laboratory Science, Usmanu Danfodiyo University, Sokoto, Sokoto state, Nigeria, E-mail: n_osaro@yahoo.com

Abstract

Background: This study was carried out to determine the haemoglobin electrophoretic patterns and distribution of ABO and Rhesus D blood group among antenatal women attending Usmanu Danfodiyo University Teaching Hospital (UDUTH), Sokoto.

Method: Three hundred consecutively-recruited and consenting pregnant women aged 18 – 45 years (mean age 27.62 ± 3.6 years) constituted the subjects for this study. Standard method involving cellulose acetate electrophoresis was carried out using Tris EDTA borate at alkaline pH of 8.6. Hemoglobin S was confirmed using sickling test involving sodium metabisulphite. Standard tile method using potent antisera was used for the determination of ABO and Rhesus D blood group.

Results: Among the 300 pregnant women studied, 221 (73.7%) were HbAA, 67 (22.3%) were HbAS, 11 (3.7%) were HbAC and 1 (0.3 %) was HbSC ($p=0.01$). HbAA was more prevalent among group O subjects followed by A, B and AB. HbAS was more prevalent among group A followed by B, O and AB. HbAC was more prevalent among group A and O followed by B and AB. The prevalence of HbSC was concentrated among blood group O subjects. There was no homozygous S and C haemoglobinopathies. The ABO blood group distribution indicated that blood group O was the predominant blood group followed by group A, B and AB ($p=0.01$). The ABO distribution among the subjects followed the pattern O>A>B>AB. A significant number of subjects were Rhesus D positive (94%) compared to 6% who were Rhesus D negative ($p=0.001$).

Conclusion: This study indicates that haemoglobinopathies is prevalent among pregnant women in Sokoto, North Western Nigeria. The results from this study also show that blood group O is the predominant ABO blood. Evidenced based data obtained from this study will facilitate optimum stocking of blood and blood products in blood banks in the area and the management of Haemolytic Transfusion Reaction and Haemolytic Disease of the Foetus and Newborn.

Keywords

Haemoglobin, Electrophoresis, Blood group, Pregnant women, Sokoto

Introduction

All human red blood cells contain a pigmented metalloprotein called haemoglobin which is of different types. Hemoglobin is the oxygen carrying pigment of the red blood cells. Defects in its genes can produce abnormal haemoglobin which leads to conditions known as haemoglobinopathies. Haemoglobin electrophoretic patterns include the normal haemoglobin which is the most prevalent and is referred to as hemoglobin A (HbA) and other abnormal ones also exist, like hemoglobin S (HbS), which is a variant form of the normal haemoglobin. The variation is in the β -globin chain gene, causing a change in the properties of haemoglobin which results in sickling of red blood cells. Another variant is haemoglobin C (HbC), which also occurs as a result of a variation in the β -globin chain gene. This variant presents with mild chronic hemolytic anemia (in homozygous HbCC and in double heterozygous SC).

Sickling disorders include the heterozygous state for haemoglobin S or the sickle cell trait (AS), the homozygous state for HbS or sickle cell anemia (SS), and the compound heterozygous state for HbS together with other haemoglobin (C, D, E) or other structural variants [1]. The prevalence of sickle cell anaemia (HbSS) among the Black population in the United States is reported to be 9% [2] and 30% – 40% generally for Africans [3]. These hemoglobin variants cause moderate to severe haemolytic anemia leading to high degree of morbidity and mortality [4,5]. Sickle-cell disease (SCD) or sickle-cell anaemia (SCA) is an autosomal recessive genetic blood disorder characterized by red cells that assume an abnormal, rigid, sickle shape. Sickle cell disease causes polymerization of haemoglobin resulting in vaso-occlusive, a plastic, sequestration and haemolytic crisis. It is caused by a single point mutation in the β -globin chain of the haemoglobin molecule and result from a substitution of the hydrophilic amino acid glutamic acid by the hydrophobic amino acid valine at the sixth position¹. The carrier frequency ranges between 10% and 40% across equatorial Africa, decreasing to 1–2% on the North African coast and <1% in South Africa [6]. The highest frequency of sickle cell disease is found

Citation: Udomah FP, Isaac IZ, Aliyu N, Erhabor O, Ahmed MH, et al. (2015) Haemoglobin Electrophoretic Patterns, ABO and Rhesus D Blood Groups Distribution among Antenatal Women in Sokoto, Nigeria. *Obstet Gynecol Cases Rev* 2:034

Received: March 14, 2014; **Accepted:** April 20, 2015; **Published:** April 23, 2015

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in tropical regions, particularly sub-Saharan Africa, India and the Middle-East [2]. Migration of substantial populations from these high prevalence areas to low prevalence countries in Europe and America has resulted in a dramatic increase of sickle cell disease in some European countries and the United States. In the US, the prevalence is approximately 1 in 5,000, affecting predominantly Americans of Sub-Saharan African descent [3]. In mainland France, 1/2,415 birth is affected with SCD [7]. In other areas like United Kingdom, 1 baby in every 2,000 is born with SCD; approximately 17% of the population in the Eastern province of Saudi Arabia carry the gene and about 1.2% have sickle cell disease [8,9].

Communities in Africa constitute a major part of the population that is vulnerable to many erythrocytic hereditary and haematological disorders such as haemoglobinopathies. The frequencies of abnormal haemoglobin variants vary from one population to another. There is paucity of data on haemoglobin electrophoretic patterns, ABO and Rhesus D phenotype distribution among pregnant women in Sokoto, North Western Nigeria. The aim of the study was to determine the haemoglobin electrophoretic patterns and distribution of ABO and RhD phenotypes among pregnant women attending antenatal women in Usmanu Danfodiyo University Teaching Hospital (UDUTH), Sokoto.

Materials and Methods

Study subjects

Three hundred consecutively recruited pregnant women attending antenatal clinic in Sokoto, North Western Nigeria constituted the subjects for this study. The age range and mean age of these subjects was 18- 45years and 27.62 ± 3.6 years respectively. Ethical approval was obtained from the hospital ethical committee and verbal informed consent was obtained from all the subjects before sample collection.

Study design

This aim of this prospective case study was to determine the distribution of some haemoglobinopathies, ABO and Rhesus D blood group among pregnant women in Sokoto, North Western Nigeria.

Inclusion criteria

All adult (≥ 18 years), consenting and non- transfused (last 4 months) pregnant women visiting the antenatal clinic of Usmanu Danfodiyo University Hospital were consecutively recruited as subjects for this study.

Procedure

Threemilliliters of blood was collected from each subject into EDTA anticoagulated tube for the analysis of haemoglobin electrophoresis, ABO and Rhesus D blood groups. The Electrophoretic pattern was determined using cellulose acetate electrophoresis involving Tris-EDTA-Borate buffer at alkaline pH 8.6. The conventional tile method using potent antisera (Lorne Laboratories, UK) was employed for the determination of ABO and Rhesus D blood group. In all subjects suspected of having a sickle cell syndrome, the presence of haemoglobin S was confirmed using sickling test involving sodium metabisulphite. Sodium metabisulphite reduces the oxygen tension inducing the typical sickle-shape of red blood cells. This is because other abnormal hemoglobin fraction separate at the same position as Hb S (Hb D and G).

Statistical analysis

Statistical analyses were conducted using SPSS (version 11; SPSS Inc., Chicago, IL) software. Data were expressed as mean \pm standard deviation. Descriptive analyses of percentages of categorical variables were reported. A p-value of ≤ 0.05 denoted a statistically significant difference in all statistical comparisons.

Results

The overall frequency of the various haemoglobin electrophoretic

Table 1: Haemoglobin electrophoretic patterns among the study subjects

Haemoglobin electrophoretic pattern	n	(%)	p-value
HbAA	221	73.3	0.01
HbAS	67	22.3	
HbAC	11	3.7	
HbSC	1	0.3	
Total	300	100	

Table 2: Haemoglobin electrophoretic pattern among the four ABO blood groups in the antenatal women

ABO blood group	HbAA n(%)	HbAS n(%)	HbAC n (%)	HbSC n(%)	Total n(%)
A	62(20.7)	21(7.0)	4(1.3)	0(0)	87(29.0)
B	54(18.7)	20(6.7)	2(0.7)	0(0)	76(25.3)
AB	10(3.3)	8(2.7)	1(0.3)	0(0)	19(6.3)
O	95(31.7)	18(6.0)	4(1.3)	1(0.3)	118(39.3)
Total	221(73.7)	67(22.3)	11(3.7)	1(0.3)	300(100)

Table 3: ABO blood group distribution among the pregnant women

ABO blood group	n	(%)	p-value
A	87	29.0	0.01
B	76	25.3	
AB	19	6.3	
O	118	39.3	
Total	300	100	

Table 4: Rhesus (D) blood group distribution among the study subjects

Rhesus (D) group	Frequency	Percentage (%)	p-value
Negative	18	6.0	0.001
Positive	282	94.0	

patterns indicated that 73.7% (221) of the screened pregnant women were HbAA, 22.3% (67) were HbAS, 3.7% (11) were HbAC and 0.3% (1) was HbSC ($p=0.01$) (Table 1).

HbAA was more prevalent among group O subjects followed by A, B and AB. HbAS was more prevalent among group A followed by B, O and AB. HbAC was more prevalent among group A and O followed by B and AB. The prevalence of HbSC was concentrated among blood group O subjects. There was no homozygous S and C haemoglobinopathies (Table 2).

Blood group O was the predominant blood group followed by group A, B and AB ($p=0.01$). The ABO distribution among the subjects followed the pattern $O>A>B>AB$ (Table 3).

A significant number of subjects were Rhesus D positive compared to Rhesus D negative ($p=0.001$) (Table 4).

Discussion

This study was designed to evaluate the frequency of the various haemoglobin electrophoretic patterns, ABO and Rhesus blood group distribution among antenatal women in UDUTH, Sokoto. We observed haemoglobin electrophoretic pattern; HbAA, HbAS, HbAC, HbSC among 73.3%, 22.3%, 3.7% and 0.3% respectively of our cohort of pregnant women.

The proportion of HbAS found in this study (22.3%) is slightly lower than the 29.4% observed in the Southern part of Nigeria [10] among students in the Niger Delta area. Our observed frequency of HbAS is consistent with of the 20 – 30% frequency of HbAS observed by other researchers in other parts of Nigerian [11,12]. Our finding is also consistent with frequency of 20% – 40% observed in previous report in other parts of Africa [13-15]. The frequency of HbAS was reported as follows; 8% – 16% for Black Americans, 8% – 10% for white Americans, 6% – 15% for Europeans, 7% – 8% for Middle Easterns [13]. HbAS is thought to offer some protective role against *Plasmodium falciparum* malaria and conclusive evidence of this exists with Haemoglobin S. However, the mechanism(s) of the protection exerted remain(s) debatable for both haemoglobin variants HbC and HbS. Recently, an abnormal display of PfEMP1 was observed

in an HbAC and HbCC infected erythrocytes that showed reduced cytoadhesion and impaired rosetting *in vitro* [16].

The normal haemoglobin (HbAA) frequency among Nigerians ranges from 55-75% [17,18]. Our finding of HbAA frequency of 73.3% is consistent with frequency of 74% and 97% observed in lowland and highland areas of Nigeria respectively [11,12].

In this present study, we observed a zero percent prevalence of HbCC and HbSS. A similar work done earlier on the general population in this same area, observed a 4.75% HbSS [19]. Our finding is consistent with the report of some researchers who reported the absence of HbSS among pregnant women in Abakaliki, Nigeria [20]. Similar finding was also reported in malaria endemic areas of Kenyan [18]. The low per capital income in our study area coupled with the high cost of the management of sickle cell disease patients may be responsible for the low life expectancy among sickle cell disease patients thus limiting the number that survive to marriageable and reproductive age. The decline in prevalence of HbSS in this study and other studies in Nigeria population [21,22], compared to those reported earlier [23,24], implies that the sickling gene pool is gradually shrinking in the area thus lowering the occurrence of haemoglobin S- related haemoglobinopathies in the area. Another possible factor may be due to the increased awareness about sickle cell anaemia, the inclusion of haemoglobin electrophoresis testing as a pre-marital test and the offering of pre-marital counseling by the major religious groups in Nigeria.

In this study we observed 0.3% frequency of haemoglobinopathy HbSC. Our finding although lower is consistent with previous report [19] among residents in Sokoto which reported HbSC among 0.75% of subjects studied.

In this study, we observed that the distribution of the ABO blood groups followed the pattern O>A>B>AB. Our finding is consistent with previous reports in other parts of Nigeria [25-32] which observed a preponderance of phenotype A over B. ABO distribution studies among Mauritanian population in a previous report were of the order of O>A>B [33]. Our finding is at variance with some reports in Nigeria [22,34,35] and among Guinean population in which the prevalence of B was greater than A [36]. In the same vein, a previous study conducted to determine the frequency of ABO and Rhesus D blood groups among a cohort of subjects in Swat, Pakistan indicated that group B was the predominant blood group [37]. The ABO blood group distribution among residents of Bangal, India follow a pattern (O>B>A>AB) [38]. Similarly, ABO blood group distribution study carried out in the Poonch district in Azad Jammu and Kashmir showed the same trend of prevalence similar to that observed in the general Indian subcontinent (B> or = O>A > AB) [39].

In this study we observed that group O was the most predominant ABO blood group among our cohort of pregnant women in Sokoto North Western Nigeria. Our finding is consistent with previous reports [10,29,40] in different parts of Nigeria which showed that blood group O is the most predominant ABO blood group. There is however an exception to this rule. Previous report [41] among the Gwari tribe of Abuja and the Rubuka tribe of the Plateau state in Northern Nigeria has shown that blood group B was the predominant ABO blood group. The reason for this exception may be due to high rate of intra-family marriages prevalent among the predominantly Muslim people of Gwari and Rubuka tribe. Muslims practice cousin marriage preferentially and polygyny is allowed if the husband can support multiple wives. The high frequency of group O observed in our study among pregnant women seems an advantage in terms of availability of blood for transfusions. One of the major challenges in sub Saharan Africa is accessing safe and adequate quantity of blood for transfusion. Blood group O individual lacks ABO blood group antigens on their red cell and thus their blood are usually given in this environment to people of blood groups A, B and AB. However, there is a caveat to this practice particularly since the plasma of some group O blood individuals are known to contain high titer of potent A and B immune haemolytic antibodies (haemolysins). It is recommended

that routine haemolysin testing should be carried out on all group O donor blood particularly those meant for transfusion against ABO blood group barrier to A, B and AB individuals. All donor units which test positive for high titre alpha and beta haemolysins must be reserved for group O individuals only. Those samples which are negative for high titer haemolysin could be given to groups A, B and AB individuals particularly in emergency situations, where ABO group specific units are unavailable.

The Rhesus blood group system is the second most clinically significant and the most immunogenic after the ABO blood group system. In this study we observed that a significant number of our cohort of pregnant women was Rhesus D positive (94%) compared to Rhesus D negative (6%). Our observed Rhesus D positive phenotype of 94% is consistent with previous report in Nigeria [42] and other parts of the developing world 96.6% [43] in Nepal, 94% in Kenya [44], 93% [45] in the Eastern region of Saudi Arabia, 97.7% in West Bengal India [38], 95.94% in Guinea [36] and 92.8% [46] in Southwest of Saudi Arabia.

Our finding of Rhesus D negative phenotype of 6% is consistent with previous reports obtained from different part of Nigerian which observed Rhesus D negative phenotypes of ≤ 7 [10-12,24,26,27,29,30]. This percentage of Rh (D) negative observed in our study is significantly lower than the prevalence rate of >14% observed among Caucasians [47,48]. There is however some obstetric advantages associated with the low prevalence of D-negative among pregnant women in Sokoto. The risk of Rh (D) alloimmunization resulting from Rhesus D blood group incompatibility between mother and developing foetus is significantly reduced. Alloantibody D produced as a result of such immunization has serious clinical significance including haemolytic disease in the newborn and/or transfusion reactions. Such immunization can be prevented by the use of prophylactic anti-D immunoglobulin offered to Rhesus D negative women following a potentially sensitizing event during pregnancy. However lack of universal access and unaffordability of anti-D immunoglobulin is responsible for the sensitization of such women in Nigeria. This often put their babies at risk for Haemolytic disease of the foetus and newborn.

In this study, we observed that HbAA, was more prevalent among group O subjects, HbAS and HbAC was more prevalent among group A while HbSC was concentrated among blood group O subjects. There seems a relationship between the prevalence of hemoglobin variants and blood groups. The reason for this association is not fully understood. However, previous reports [49,50] indicates that the prevalence of hemoglobinopathies differs among populations due to genetic differences and due to the protective effects of the heterozygote (carrier) state against malaria.

Conclusion

We conclude that homozygous haemoglobinopathies HbSS and HbCC were not encountered in this study. The results from this study also shows that blood group O is predominant over other blood groups, while group AB remains the least prevalent, however, blood group A has the highest proportion of HbAS followed by blood group B.

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