

Plasmodium Parasitaemia And Blood Groups Among Blood Donors In University Of Port Harcourt Teaching Hospital, Nigeria.

Kennedy T. Wariso¹, Ibinabo L. Oboro¹, Caroline Iyalla²

¹(Department of Medical Microbiology, Faculty of Basic Medical Sciences, College of Health Sciences, University of Port Harcourt, Nigeria.

²(Department of Haematology, Blood Transfusion and Immunology, Faculty of Basic Medical Sciences, College of Health Sciences, University of Port Harcourt, Nigeria.

Abstract: Malaria is a common transfusion-transmissible infection. There has been growing evidence that ABO blood group antigens influence susceptibility and resistance to parasitaemia. This study was aimed at determining the prevalence of parasitaemia in blood donors and the association between blood group antigens and parasitaemia. Malaria parasitaemia was determined by microscopy of Giemsa-stained thick and thin blood smears made from donor samples. The blood group of donors was also determined by direct slide method. A total of 200 blood donors were recruited for the study, 67.50% (135/200) of them were positive for malaria parasitaemia. The prevalence of parasitaemia was proportionately higher among female donors and donors ≤ 25 years of age (P -value=0.001). Most of the blood donors were of blood group O Rh positive; however parasitaemia was significantly more in donors who were B Rh positive and O Rh negative. Donors with blood group O Rh positive had a higher parasite density compared to the donors with other blood groups. Findings from this study indicate that the prevalence of parasitaemia in blood donors is unacceptably high and persons with blood group B Rh positive and O Rh negative are more susceptible to malaria parasitaemia. However, further study is necessary to establish the influence of blood group antigens on malaria Parasitaemia.

Keywords: Malaria, Parasitaemia, Blood Groups, Donor, Transfusion.

I. Introduction

Despite concerted efforts over the years, Malaria has continued to be a major cause of morbidity and mortality affecting more than 100 countries in the world. The World Health Organisation reports that in 2012, an estimated 207 million malaria cases (80% in the African region) and 627 000 global malaria deaths occurred worldwide (90% were in the African Region) [1]. While in 2013, an estimated 198 million cases and 584 000 deaths from malaria occurred, mostly among African children [1]. This indicates some achievement in the efforts towards control of malaria.

Malaria is a common but highly febrile illness caused by five different species of Plasmodium (*P. falciparum*, *P. vivax*, *P. malariae*, *P. ovale*, and *P. Knowlesi*) and transmitted by the Anopheles mosquito; however *falciparum* is more prevalent and virulent. Malaria parasites spend a good part of their life cycle invading and growing within red blood cells (RBCs). These parasites at the merozoite stage have specific receptor-ligand interactions to facilitate RBC binding, some of which involve blood group antigens. The association between ABO blood group and malaria have both been studied and researched for a long time now. Preliminary evidence had suggested increased susceptibility to life-threatening malaria in blood group A persons and resistance in blood group O [2,3], other results were contradictory [4,5]. However with much recent studies, it has been confirmed that O blood group confers resistance while blood group A is associated with severe malaria. Rosetting is implicated in the pathogenesis of severe malaria. Studies have shown that larger, stronger rosettes are formed in non-O blood groups (A, B or AB) than in group O RBCs. Also, infected RBCs that form rosettes are significantly lower in clinical isolates from O blood group patients [6, 7].

Besides being spread by mosquito bites, malaria can be spread by the inoculation of blood from an infected person to a healthy person following blood transfusion [8, 9, 10]. Transfusion malaria first reported in 1911 is one of the most common transfusion-transmissible infections being more than HIV, HBV and HCV [11]. It is a significant problem and could be fatal particularly in children under five years, pregnant women, immunosuppressed persons and acute blood loss victims who require blood. This is because asexual forms are directly inoculated into the blood and pre-erythrocytic development of the parasite in the liver does not occur leading to a shorter incubation period. Whole blood and red blood cell concentrates are most common for transmitting malaria [12] and the malaria parasites survive for 3 weeks at 2-6^o C [13]. The infective dose sufficient to cause infection is 1-10 parasites per unit of blood [14].

Blood transfusion can be lifesaving and there has been an increased demand for blood [15]. In areas with high transmission intensity, the immunity to uncomplicated malaria develops slowly, after repeated infections and is usually incomplete [16], thus blood donors may carry low levels of parasites without clinical symptoms. The prevalence of parasitaemia among blood donors in endemic regions ranges between 10.2%-77.4% [17-25]. Screening of blood donors for malaria is not done routinely in these endemic regions. One reason for this maybe because turning away donors with parasitaemia could lead to severe shortages of blood. Microscopic examination of stained blood smears remains the “gold standard” for detection of malaria parasitaemia. It however has limited sensitivity, is laborious and time-consuming [26, 27]. Serologic tests are also not effective as majority of residents in endemic regions such as Nigeria has antimalarial antibodies [28]. Despite the risk of transmission of malaria parasites from blood donors to recipients, there is no documented policy on the prophylactic use of anti-malaria drugs in transfused patients. There is also a paucity of statistics on the prevalence and epidemiology of Plasmodium parasitaemia and association with the blood groups among blood donors in Port Harcourt. The aim of this study was to determine the prevalence of Plasmodium parasitaemia and its association with blood group antigens in blood donors in the University of Port Harcourt Teaching Hospital (UPTH), Port Harcourt, Rivers State, Nigeria.

II. Methods

Study site

This cross-sectional study was carried out in the University of Port Harcourt Teaching Hospital located in Port Harcourt, at the heart of the oil-rich Niger delta region of Nigeria. The University of Port Harcourt Teaching Hospital is one of the only two tertiary health institutions in Rivers state and is highly patronized by a large proportion of people living in the south - south and south-east geo-political zones of Nigeria.

Study population and blood collection

All consenting blood donors were consecutively recruited until the sample size of two hundred was achieved. Ethical approval was obtained from the ethical committee of the hospital before commencement. Two millilitres (2ml) of venous blood was collected from each study participant using an Ethylene Diamine Tetra-acetic Acid-containing vacutainer tube and needle.

Blood preparation

Thick and thin blood smears were made from these, allowed to air-dry and the thin films were fixed in methanol. All smears were then stained with 3% Giemsa solution for 30 minutes, thereafter washed with clean water and after air-drying, was viewed under the light microscope at x100 magnification under oil immersion. Asexual stages of Plasmodium parasites were identified where present and quantified.

The blood group of donors was determined by direct slide method using commercially prepared Anti – A, -B and –D sera which produced strong agglutination within 1-2minutes.

Data was analysed using the statistical package Epi-info version 7.02. The level of significance was set at <0.05.

III. Results

A total number of 200 blood donors were screened, 5(2.5%) were females while 195 (97.5%) were males. The mean age of the donors was 32.13 ± 6.25 , age range between 21-45years. Most of the donors were within 26-35years. The prevalence of parasitaemia among blood donors at the UPTH was 67.50% (135/200), the age and sex prevalence of parasitaemia is presented in TABLE I. Malaria parasitaemia was proportionately higher in females, this was statistically significant (p-value=0.001). The prevalence of parasitaemia was also proportionately higher among donors ≤ 25 years of age (p-value=0.001). Most of the blood donors (47.5%) had mild degree of parasitaemia while 40 (20%) had moderate degree of parasitaemia. TABLE II shows the prevalence of parasitaemia in relation to the blood group of the donors. Most of the blood donors were of blood group O Rh positive; however parasitaemia was more in the blood group B positive and O negative donors. (P-value=0.001). On the other hand, parasite density was significantly more in blood group O Rh positive blood donors; this is illustrated in TABLE III.

Table I: Prevalence of malaria parasites in relation to sex and age of blood donors

	Positive (n%)	Negative (n%)	Total	chi-square	p-value
SEX				131.64	0.001*
Males	130(66.7)	65(33.3)	195		
Females	5(100)	0(0.0)	5		
AGE				64.50	0.001*
<25	30(75)	10(25)	40		
26-35	75(68)	35(32)	110		
36-45	30(60)	20(40)	50		

*p-value is significant

Table II. Prevalence of parasitaemia in relation to blood group of donors

DONOR BLOOD GROUP	DONOR MP		TOTAL
	POSITIVE Freq (%)	NEGATIVE Freq (%)	
A POS	10 (33.33)	20 (66.67)	30 (15.0)
B POS	10 (100.0)	0 (0.0)	10 (5.0)
O POS	105 (70.0)	45 (30.0)	150 (75.0)
O NEG	10 (100.0)	0 (0.0)	10 (5.0)
TOTAL	135 (67.5)	65 (32.5)	200 (100.0)

Chi-Squared= 26.021, p-value=0.001

Table III: Degree of parasitaemia in relation to blood group of donors

Donor Group	Blood	Donor Mp			Total	Chi-square (X ²)	p-value
		+	2+	NEG			
A POS		10 (33.33)	0 (0.0)	20 (66.67)	30 (100.0)	44.3185	0.001*
B POS		10 (100.0)	0 (0.0)	0 (0.0)	10 (100.0)		
O NEG		10 (100.0)	0 (0.0)	0 (0.0)	10 (100.0)		
O POS		65 (43.33)	40 (26.67)	45 (30.0)	150 (100.0)		
TOTAL		95 (47.50)	40 (20.0)	65 (32.50)	200 (100.0)		

*p-value is significant

IV. Discussion

The prevalence of parasitaemia in blood donors in this study is unacceptably high. Erhabor and colleagues working in the same region had reported a prevalence rate of 10.2% in 2010 [17]. The rates obtained in the study is also higher than the 28% and 27.3% reported in Lagos [18] and Kwara[24], but is at par with prevalence rates of 51.5% [21], 55% [23] and 77%[22] obtained in south east Nigeria. While these studies were all conducted in regions endemic for malaria, the differences in prevalence of parasitaemia reported could be due to the time of the year the studies were performed. Although malaria has an all year endemicity, parasitaemia is reportedly higher during the rainy months [29]. Studies done in low transmission season tend to record lower rates than those done during seasons of high transmission [28]. The high prevalence observed in this study shows that the issue of plasmodium parasitaemia in blood donors can no longer be ignored. The implication for this high prevalence of parasitaemia in donors is transfusion transmission of malaria to recipients which could be fatal for pregnant women and infants who form the bulk of blood recipients in sub-Saharan Africa.

As appears to be the case in most studies, majority of blood donors in this study are within the 25-35years age range. Plasmodium parasitaemia however, was significantly higher among those ≤25years. The prevalence of parasitaemia decreased with increasing age. This pattern of age prevalence of parasitaemia was also reported by Uneke et al [20]. This is expected as acquired natural immunity to malaria (especially uncomplicated malaria) is slow to develop and occurs usually after repeated infections. In adults, immunity is still incomplete and low level parasitaemia still occurs but the older one gets, the stronger the immunity against uncomplicated malaria [16, 30]. Only 5% of donors were females, low incidence of female blood donors have been a consistent finding from studies [17-24]. In this study, all of the female donors had plasmodium parasitaemia, thus there was a higher percentage of prevalence among females than male donors. This is in variance with studies from Nigeria which report higher percentages among males [18, 22, 24], but at par with other studies which reported higher percentage of parasitaemia in females [31, 32].

Most of the blood donors in this study were of the O Rh positive blood group. Several studies report a higher proportion of blood O donors and this reflects the blood group distribution among the general population in these regions. There is a higher frequency of blood O persons and low frequency of blood A persons in malaria endemic areas, while blood group A is predominant in colder regions not endemic for malaria [33, 34]. This may be explained as an evolutionary selective advantage for survival as blood O has been associated with

survival from malaria. The origin, distribution and relative proportion of ABO blood group antigens in humans may have been influenced by genetic pressure from plasmodium falciparum infection.

Plasmodium parasitaemia was significantly higher in blood group B positive and O negative donors. The studies on the association between parasitaemia and blood group have been contradictory. Some studies report that A, B and AB are more susceptible to parasitaemia [2, 3, 35]. Other studies however, did not find any significant association between blood group and malaria infections [4, 5, 18, 20, 22]. However, blood group antigens A and B on the red blood cells membrane act as receptors for rosetting ligands on Plasmodium falciparum erythrocyte membrane protein 1 (PfEMP1) [36, 37], rosetting is responsible for features of severe malaria. Thus the association between ABO and malaria is more with disease severity, blood group A and B are associated with severe and cerebral malaria [5, 6]. Blood group O is said to form smaller rosettes while A and B form larger rosettes [37, 38]. The role of Rh antigen in resistance to malaria infection is still being investigated.

In this study, a higher degree of parasitaemia was observed in the blood group O positive donors. Though parasitaemia was more prevalent among the blood group B positive and O negative, the degree of parasitaemia was significantly more among the blood group O positive donors. Moderate degree of parasitaemia was observed in about 27% of blood group O donors while only mild degree of parasitaemia was noted in donors with in other blood groups positive for parasitaemia. Some studies did not find any significant difference in parasite density across the blood groups [33, 39]. The significance of the degree of parasitaemia is a likely correlation with disease severity and degree of parasitaemia. A low percentage of circulating infected red cells may reflect less severe disease; however it could also reflect a greater degree of adhesion to vascular endothelium and consequently more severe disease [40, 41].

V. Conclusion

The prevalence of plasmodium parasitaemia among blood donors in this study is high. This raises grave concern about the safety of blood transfusion especially to those who are non-immunized to malaria or are immunosuppressed. The blood groups antigens of the blood donors also appear to be associated with parasitaemia and parasite density. This however needs to be further investigated in larger and other populations. While donors positive for plasmodium parasitaemia should not be turned away, it may be necessary to avoid giving blood positive for plasmodium parasitaemia to non-immunized and immunosuppressed persons. It is also recommended that there should be a clear and documented policy on the use of prophylactic antimalarial drug in recipients of blood.

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