RABMS **Journal of Research in Applied and Basic Medical Sciences**

Association of ABO blood group with plasmodium falciparum malaria in Sudanese population

Abdalla Mohamed*[1], Mohammed Abdelmotalab[2], Mohamed Elbasheir[1]

[1] *Faculty of Medical Laboratory Science-based , Alzaiem Alazhari University, Sudan*

[2] *Faculty of Medicine , International University of Africa , Sudan*

*Corresponding author: Abdalla Mohamed, **Address**: Lecturer, Faculty of Medical Labrotary Science, Alzaiem Alazhari University, Sudan, **Email**: Abdalla77fas@gmail.com, **Tel**: +00249902149195

Abstract

Background & Aims: Malaria is a febrile illness with an incubation period of one week or more. Plasmodium falciparum is responsible for the most severe forms. So, this cross-sectional hospital-based study conducted to determine the association between ABO blood group and Plasmodium falciparum infection.

Materials & Methods: The study was carried out in three different clinics: Rota Clinic, Military Hospital, and Bahri Hospital in Khartoum states, Sudan. The study was conducted from May to August 2017. The sample size investigated was 580 subjects, with 200 subjects found to have a positive malaria infection (80 females and 120 males).

Result: The results of this study revealed an overall infection rate of 34.4%. The prevalence rates reported in Military Hospital, Bahri Hospital, and Rota Clinic were 37.1%, 34.7%, and 28.2%, respectively. The study results showed that the highest prevalence rate (60%) was among males, while rate in females was 40%. The highest prevalence rate (32%) was reported among the age group 16-30 years old, and the lowest rate (13%) was among the age group 1-15 years old. The investigation revealed that the highest prevalence rate (58%) was among the O blood group, and the lowest prevalence rate (8%) was among the AB blood group. High parasitemia was strictly confined to A and B and low parasitemia in O blood group.

Conclusion: Although the results showed relation of the disease with blood group, sex, and age group, further research with more population is necessary to add more information about the role of ABO blood groups in Plasmodium falciparum malaria and to contribute to malaria prevention.

Keywords: Blood Group, Falciparum, Malaria, Plasmodium, Sudan

Introduction

The term "blood group" refers to the entire blood group system, including red blood cell antigens whose specificity is controlled by a series of genes that can be allelic or closely linked on the same chromosome. In 1900, Karl Landsteiner was credited with discovering the ABO blood group system (1).

The ABO blood groups comprise A, B, and H carbohydrate antigens that can regulate protein activities during infection and antibodies against these antigens

(2). Group O can protect against falciparum malaria by reducing rosette formation (1). A study conducted in Ghana indicates that the chance of developing complicated falciparum malaria was least in blood group O compared to other groups (3).

An Indian study on the association between malaria and ABO blood groups showed that the association of blood group B increased the risk of developing severe malaria, while blood group O is associated with a reduced risk (4).

Malaria is an acute febrile illness with an incubation period of about seven days or more. The most severe type is caused by P. falciparum, and variable clinical features include vomiting, fever, chills, headache, muscular aching and weakness, cough, diarrhea, and abdominal pain. Additionally, symptoms may arise from organ failure, such as acute renal failure, pulmonary edema, convulsions, circulatory collapse, can progress to coma, and ultimately result in death (5).

Materials & Methods

This study was a cross-sectional hospital-based study conducted at Rota Clinic, Military Hospital, and Bahri Hospital during the period from May to August 2017. The investigated sample size was 580 subjects, with 200 subjects found to have positive malaria infections of different genders (80 females and 120 males). The population in the study was classified according to sex and age.
For each individual in the study group, direct ABO blood group, thick smear, and ICT were performed.
The thick blood film was stained with Giemsa stain.

Data Collection and Analysis:

The data were collected using a designated data collection sheet that included all variables of the study. All data collected during the study were stored on CD and personal computers. The data were analyzed using SPSS (Statistical Package for the Social Sciences) version 20. Frequencies and percentages were calculated for continuous variables, and cross-tabulation was performed to correlate between variables.

Techniques used in the study
Direct ABO blood group:

A grease pencil was used to draw two circles on a clean and dry slide, labeled one (A) and the other (B). Then a drop of blood was placed on each circle. A drop of anti-serum A was added to the circle (A), and a drop of anti-serum B was added to circle (B). Each suspension was mixed with different wooden sticks.

Interpretation of ABO blood groups:

The interpretation of ABO blood groups is as follows: Agglutination on circle (A) and no agglutination on circle (B) means the ABO blood group is A. Agglutination on circle (B) and no agglutination on circle (A) means the ABO blood group is B. Agglutination on both circles (A) and (B) means the ABO blood group is AB. No agglutination on both circles (A) and (B) means the ABO blood group is O.

Preparing Thick Blood Film:

A preparation of the thick smear involved taking 50 microliters of blood with a capillary tube on the slide, spreading it over an area of 12 mm square, and allowing the slide to air-dry before staining.

Staining of Thick Blood Film:

For staining the thick blood film, the slide was first fixed with methyl alcohol. After drying, the slide was flooded with diluted Giemsa stain and allowed to remain for 30 minutes. The slide was then washed with buffered distilled water, dried in the air, and examined under an oil immersion lens.

Parasitemia Count:

The relative parasite count in positive smears was determined using a simple code ranging from one to four crosses (+ to ++++) (WHO, 1991), as follows:

+ / 1-10 parasites per 100 thick film fields.
++ / 11-100 parasites per 100 thick film fields.
+++ / 1-10 parasites per one thick film field.
++++ / More than 10 parasites per one thick film field.

Additionally, the number of parasites per microliter of blood was calculated as follows:

Parasite's count = (WBC count * parasites counted against 100 WBC / 100).

Ethical Consideration:

The ethical approval by the research committee in the Alzaem Alazhari University Faculty of graduate studies then the consent agreement from the hospitals and medical laboratory department after that verbal consent was being taken from volunteers.

Results

The investigated sample size was 580 subjects, 200 subjects were found with positive malaria infection with different genders (80 female and 120 males). The study result showed that the infection rate was 34.4%. The prevalence of malaria at the study area was noted as follows; military hospital, Bahri Hospital and Rota Clinic were 37.1%, 34.7%, and 28.2%, respectively. The study result showed that the highest prevalence rate (60%) was among males as compared to the 40% females. The highest prevalence rate (32%) was reported among the group 16-30 years old and the lowest rate (13%) was reported among the 1-15 years old. The investigation revealed that the highest prevalence rate (58%) was reported among the O blood group and the lowest prevalence rate (8%) was reported among the AB blood group. High parasitaemia (+++) was strictly confined to the A and B. Low parasitaemia was more evident with the O blood group.

Table 1: The overall number of the samples examined in each hospital

Hospital	Number of Samples Examined	Number of Positive	Percent (%)
Military Hospital	262	91	37.1
Bahri Hospital	207	77	34.7
Rota Clinic	111	32	28.2
Total	580	200	100

Table 2: The Number of malaria cases according to gender and age groups

Gender	Number of samples	Percent (%)
Male	120	60
Female	80	40
Total	200	100
Age group (years)	**No of sample**	**Percent (%)**
1-15	26	13
16-30	64	32
31-45	42	21
46-60	39	19.5
61-75	29	14.5
Total	200	100

Table 3: The number of malaria cases among each blood group

Blood group	Number of the Samples	Percent (%)
A	38	19
B	30	15
AB	16	8
O	116	58
Total	200	100

Table 4: The different levels of parasitemia for different blood groups:

Blood group	+	++	+++
A	29 (16.11%)	4 (30.76%)	5 (71.42%)
B	26 (14.44%)	3 (23.07%)	1(14.28%)
AB	14 (7.77%)	2 (15.38%)	0 (0.00%)
O	111 (61.66%)	4 (30.76%)	1 (14.28%)

Table 5: The overall number of the samples examined in all hospitals

Malaria test results	Frequency	Percent%
Negative	380	65.5
Positive	200	34.5
Total	580	100.0

Table 6: The relationship between the malaria test results and different types of the blood groups using Chi square test

Malaria test * ABO system Crosstabulation			ABO system				Total
			A	AB	B	O	
Malaria test	Negative	Count	130	12	68	170	380
		Percent	34.2%	3.2%	17.9%	44.7%	100.0%
	Positive	Count	38	17	30	115	200
		Percent	19.0%	8.5%	15.0%	57.5%	100.0%
Total		Count	168	29	98	285	580
		Percent	29.0%	5.0%	16.9%	49.1%	100.0%

Chi square test p value = 0.000

Table 7: The relation between the malaria test results and different levels of parasitemia for different blood groups using Chi square test

ABO system and levels of parasitemia			Levels of parasitemia			Total
			*	**	***	
ABO system	A	Count	29	4	5	38
		Percent	76.3%	10.5%	13.2%	100.0%
	AB	Count	15	2	0	17

ABO system and levels of parasitemia		Levels of parasitemia			Total
		*	**	***	
	Percent	88.2%	11.8%	0.0%	100.0%
B	Count	26	3	1	30
	Percent	86.7%	10.0%	3.3%	100.0%
O	Count	110	4	1	115
	Percent	95.7%	3.5%	0.9%	100.0%
Total	Count	180	13	7	200
	Percent	90.0%	6.5%	3.5%	100.0%

Chi square test p value = 0.006

Discussion

This study was conducted on 200 out of 580 positive cases, revealing the highest prevalence rate (60%) among 120 males, with an infection rate of 34.4%. The highest prevalence rate (32%) was reported among the age group 16-30 years old, while the lowest rate (13%) was reported among those aged 1-15 years old.

Numerous studies support the hypothesis that blood groups represent a risk factor for a higher chance of disease, attributed to the appearance of many molecular intracellular adhesions (6). There is a high frequency of group 'O' and a low frequency of group 'A' phenotypes in tropical regions where malaria is rampant (7).

A study by Edmond Aubyn et al. (2016) suggests that individuals with blood group O are more susceptible to P. falciparum infection than those with other blood groups, and individuals with blood group A are more susceptible to hyperparasitemia than other groups (8, 9). A study in the population of Odisha, where malaria is endemic, also showed a higher prevalence of blood group O (10).

These results align with the findings of this study, reporting that blood group O represents the highest percentage (58%) of P. falciparum infection observed among the study participants, followed by blood group A, representing 19%. Migot-Nabias et al. (2000) observed lower P. falciparum parasitemia in those with blood group O compared to non-subjects (11). Another study also reported a higher chance of severe malaria or high parasitemia cases in individuals with blood group A compared to those with blood group O (12).

Similar to the findings of this study, the lowest level of parasitemia was noted among individuals with blood group O compared to blood groups A, B, and AB. Group A is more susceptible to high parasitemia.

The mechanism by which 'A' promotes susceptibility and 'O' confers a relative protective effect against high P. falciparum parasitemia is not well understood (13). The association between the ABO system and malaria infection was not observed in other studies. Tekeste et al. (2010) mentioned the absence of a difference in the frequency of ABO blood groups between those with uncomplicated malaria and healthy controls, suggesting an insignificant effect of the ABO blood groups on uncomplicated clinical malaria disease. Rowe et al. (2020) observed no significant difference in the frequency of group O between uncomplicated malaria cases and healthy controls (14, 15).

A higher proportion of subjects with blood groups A, B, and AB, but not O, were found in the patients with P. falciparum compared to those without P. falciparum (16).

Nevertheless, the study found a strong significant association between positive malaria results and the ABO system, with 57.5% of positive malaria tests having blood group O. The levels of parasitemia was at p= 0.00, and 95.7% of them had mild parasitemia. According to the current findings, it is evident that the blood group O of the study subjects is more susceptible

to malaria, especially P. falciparum infection, as compared to subjects of other blood types.

Conclusion

Blood group O represents the highest percentage (58%) compared to other blood groups in relation to P. falciparum infection among the study participants, followed by blood group A, representing 19%. Further researches with more study population are necessary to add more information about the role of ABO blood groups in P. falciparum malaria and to prevent malaria.

Acknowledgments

Ethical statement:

The ethical approval by the research committee in the Alzaem Alazhari University Faculty of Graduate Studies, then the consent agreement from the hospitals and medical laboratory department after that verbal consent was being taken from volunteers.

Data availability:

The authors confirm that the data supporting the findings of this study are available within the article [and/or] its supplementary materials.

Author contributions:

Abdalla Mohammed collects the data, and all authors contribute to the study's design, analysis, writing, typing, and article revision.

Conflict of interest:

The authors declare no conflicts of interest.

Funding/support:

References

1. García MA, Bautista L, Palomino F. Should blood donors be routinely screened for irregular antibodies? Immunohematology 2012;28(2):60-6. https://doi.org/10.21307/immunohematology-2019-151

2. Chung WY, Gardiner DL, Hyland C, Gatton M, Kemp DJ, Trenholme KR. Enhanced invasion of blood group A1 erythrocytes by Plasmodium falciparum. Mol Biochem Parasitol 2005;144:128-30. https://doi.org/10.1016/j.molbiopara.2005.08.004

3. Adjei A, Narh-Bana S, Amu A, Kukula V, Nagai RA, Owusu-Agyei S, Oduro A, Macete E, Abdulla S, Halidou T, Sie A. Treatment outcomes in a safety observational study of dihydroartemisinic /piperaquine (Eurartesim®) in the treatment of uncomplicated malaria at public health facilities in four African countries. Malaria J 2016;15(1):1-0. https://doi.org/10.1186/s12936-016-1099-7

4. Dhangadamajhia G, Hazrab RK, Ranjitb M. Malaria in Odisha and future perspectives. Forest 2015;34(13.0):22-7.

5. DA. Cerebral malaria: clinical features, pathophysiology and treatment. Ann Trop Med Parasitol 1997;91(7):875-84. https://doi.org/10.1080/00034983.1997.11813214

6. Carlson J, Holmquist G, Taylor DW, Perlmann P, Wahlgren M. Antibodies to a histidine-rich protein (PfHRP1) disrupt spontaneously formed Plasmodium falciparum erythrocyte rosettes. Proc Natl Acad Sci USA 1990; 87:2511-5. https://doi.org/10.1073/pnas.87.7.2511

7. Avictor Hoff brand, Post graduated haematology/ (and other); Amord publisher; page (164198); fourth Edition; USA. 2001.

8. Hoffbrand V. Pediatric Hematology. John Wiley & Sons; 2008 Apr 15.

9. Afoakwah R, Aubyn E, Prah J, Nwaefuna EK, Boampong JN. Research Article Relative Susceptibilities of ABO Blood Groups to Plasmodium falciparum Malaria in Ghana. Adv Hematol 2016;5368793. http://dx.doi.org/10.1155/2016/5368793

10. Seyoum S, Dagne K. ABO and rhesus blood type frequencies in data from hospitals and the Red Cross in Ethiopia. Ethiop Med J 1985;23:1-6.

11. Migot-Nabias F, Mombo LE, Luty AJ, Dubois B, Nabias R, Bisseye C, et al. Human genetic factors related to susceptibility to mild malaria in Gabon. Genes Immun 2000;1:435-41. https://doi.org/10.1038/sj.gene.6363703

12. Fischer PR, Boone P. Short report: severe malaria associated with blood group. Am J Trop Med Hyg 1998;58(1):122-3.
https://doi.org/10.4269/ajtmh.1998.58.122

13. Mousa A, Al-Taiar A, Anstey NM, Badaut C, Barber BE, Bassat Q, Challenger JD, Cunnington AJ, Datta D, Drakeley C, Ghani AC. The impact of delayed treatment of uncomplicated P. falciparum malaria on progression to severe malaria: A systematic review and a pooled multicentre individual-patient meta-analysis. PLoS Med 2020;17(10):e1003359.
https://doi.org/10.1371/journal.pmed.1003359

14. Tekeste Z, Petros B. The ABO blood group and Plasmodium falciparum malaria in Awash, Metehara and Ziway areas, Ethiopia. Malaria J 2010;9(1):1-4.
https://doi.org/10.1186/1475-2875-9-280

15. McQuaid F, Rowe JA. Rosetting revisited: a critical look at the evidence for host erythrocyte receptors in Plasmodium falciparum rosetting. Parasitology 2020;147(1):1-1.
https://doi.org/10.1017/S0031182019001288

16. Zerihun T, Degarege A, Erko B. Association of ABO blood group and Plasmodium falciparum malaria in Dore Bafeno Area, Southern Ethiopia. Asian Pac J Trop Biomed 2011;1(4):289-94.
https://doi.org/10.1016/S2221-1691(11)60045-2