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Original Research Article

A Comparative Study of the Effect of 1+ and 2+ Plasmodium Falciparum Malaria Infection on the Near Point of Convergence

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ABSTRACT

Plasmodium *falciparum* is the leading causative organism of malaria among the plasmodium species. Malaria causes a recession of near point of convergence (NPC) of the eye which leads to convergence insufficiency symptoms such as asthenopia and exophoria at near. The objective of this study was to determine if there is a significant difference in the change of NPC values of patients with 1+ and 2+ plasmodium *falciparum* malaria infection during and after recovery from malaria attack. This clinical study was carried out on 170 young adults who attended Madonna University Teaching Hospital, Elele, Nigeria. The NPC values of patients with 1+ and 2+ parasitaemia of plasmodium *falciparum*during malaria attack and after recovery from malaria attack were measured. The mean (±S.D) NPC value for patients with 1+ parasitaemia was 10.44±0.96 cm during malarial attack and improved to 7.60±0.68 cm after recovery from malarial attack. This resulted in a 37.4% recession in NPC during malaria attack. For patients with 2+ parasitaemia, the mean NPC was 10.84±1.86 cm during malaria attack and 7.68±0.72 cm after recovery showing a 41.1% recession in NPC during malarial attack. Statistical analysis with the SPSS statistical software using the Paired sample T-test at 0.05 level of significance showed that there was no significant difference in NPC values (P>0.05) with 1+ and 2+ parasitaemia of the plasmodium *falciparum* both during malaria attack and after recovery from malaria attack.

Keywords: Parasitaemia, Exophoria, Convergence Insufficiency

INTRODUCTION

Malaria is caused by a protozoan parasite of the genus plasmodium. It is one of the most important parasitic diseases that affect humans with the largest effect in the tropical regions.[(1)] The infection usually results from the bite of female anopheline mosquitoes. It can also be transmitted by transfusion of the infected blood or by needle sharing between intravenous drug users. Plasmodium *falciparu*m is the most common causative agent.[(2)] Approximately 300 million people worldwide and 103 endemic countries are affected by malaria. In Sub-Saharan Africa alone, it is currently estimated that there are more than 150 million clinical cases annually and that about 2 million people die from the disease every year. Until date, malaria is still a danger to travellers.[(2)] Plasmodium

falciparum causes malignant malaria. It causes the most severe symptoms and result in most fatalities. Plasmodium *vivax* causes benign malaria and can stay in the liver for up to three years and lead to a relapse. Plasmodium *ovale* causes benign malaria and is relatively rare while Plasmodium *falciparum* is responsible for about three quarters of reported malaria cases. Most of these other cases of malaria are caused by plasmodium *vivax* with just a few caused by the other two species. It is possible to get infected with more than one type of plasmodium parasite. Symptoms of malaria include fever, shivering, vomiting, arthralgia (joint pain), anaemia (caused by haemolysis), hemoglobinuria, retinal damage and convulsions.[(1)] Nigeria is known for high prevalence of malaria. Uzodike and Ndukwe[(3)] reported that approximately 50% of the Nigerian population suffers from at least one episode of malaria every year and that malaria accounts for over 45% of out-patient visits. This imposes great burden on the country in terms of pain and trauma suffered by victims of malaria as well as loss in man-hour and cost of treatment. In Nigeria, as in other tropical developing countries, the high level of occurrence of blood-demanding health conditions due to the increase in road accidents, pregnancy-related hemorrhage, armed robbery attacks, hepatitis and human immunodeficiency virus (HIV) increases the transmission of malaria due to transfusion of infected blood. [(4)] Plasmodium falciparum causes the severe cases of malaria and even deaths. It is generally found in tropical regions, such as Sub-Saharan Africa and South-East Asia, as well as in Western Pacific. Nineteen countries in Africa accounted for 90% of all WHO estimated cases of malaria in 2006 and that more than half of plasmodium *falciparum* clinical cases occurred in Nigeria, Myanmar (Burma) and India.[(5)] The parasite invades the red blood cells of all age groups especially young cells. The onset of the infection is insidious, with cough and mild diarrhoea, malaise, headache and vomiting and it is often mistaken for influenza. Its clinical features do not have a particular pattern. Complications include jaundice, splenomegaly and cerebral malaria manifesting as confusion or coma. Children with plasmodium *falciparum* parasite die rapidly without any symptom.[(6)] In the laboratory, the parasite load can be quantified using the semi quantitative count which depends on the asexual parasites identified in each field. It is recorded as shown below:

1-10 per 100 high power fields..... 1+
11-100 per 100 high power fields..... 2+
1-10 in every high power field.....3+
More than 10 in every high power field....4+
The + signifies the percentage of red blood cells that are infected in the blood film.[(7)]

The Near point of convergence (NPC) is the point of intersection of the line of sight when maximum fusional convergence is used. The distance from the middle forehead which is also regarded as the spectacle plane to this point of intersection is the measurement of the near point of convergence.[(8)] In measurement of the near point of convergence, non-descriptive targets are used such as penlight or another simple target on a tongue depressor to help differentiate fusional (disparity) vergence response from accommodative convergence. The accommodative and vergence subsystem are tightly cross related coupled with an accommodative response accompanied by vergence eye movement. Using an accommodative target, stimulus accommodative demand and convergence will lower the expected values for the near point of convergence and recovery. The near point of convergence is when the patient reports diplopia or when the examiner first

observes loss of bifoveal fixation by the outward turning of one eye.

The purpose of this study is to ascertain the level of change in the near point of convergence during malaria attack with plasmodium *falciparum* 1+ and 2+ parasite load and to compare the data to ascertain if the level of change differs with each parasite load. The null hypothesis of this study states that there is no significant difference in near point of convergence values between 1+ and 2+ parasitaemia of plasmodium *falciparum* during malaria attack and after recovery from malaria attack. Patients used for this study were aged between 18 and 37 years. This age group was chosen because this study focused on adults who have not reached presbyopic age. The presbyopic age starts from 40 years and it is when the accommodative mechanism of people starts to weaken making it difficult to read at near. This presbyopia will certainly affect the near point of convergence and hence the need to exclude these people.

MATERIALS AND METHODS

This study is a prospective laboratory based and clinically monitored research carried out at Madonna University Teaching Hospital Medical Laboratory located in Elele, Rivers State, Nigeria. One hundred and seventy patients diagnosed of having malaria were used for this study. The age range of the patients was 18 to 37 with a mean age and standard deviation of 22.49 ± 4.4. On confirmation of the presence of malaria parasite of plasmodium *falciparum* by a medical doctor and laboratory test by a qualified laboratory scientist, a thorough case history to rule out the presence of systemic diseases that might affect the near point of convergence was taken. An external and internal examination of the eyes with the use of pen torch and Keeler Ophthalmoscope respectively was done to rule out the presence of pathologies that can affect the near point of convergence. Pin hole acuity was also carried out to rule out refractive errors. Measurement of the first reading of the near point of convergence using the push-up method before commencement of treatment was then taken for patients with 1+ parasitaemia of the plasmodium *falciparum* and also patients with 2+ parasitaemia of the plasmodium *falciparum*. Two weeks after recovery, after which the effect of the malaria drugs had worn off, the second reading of the near point of convergence was taken.

Statistical Methods

The SPSS statistical software was used to determine the statistical values of our data such as the mean, standard deviation, standard error mean, range, maximum and minimum values. The null hypothesis was tested using Paired sample T-test at 95% confidence interval and 0.05 level of significance.

RESULTS

The NPC of 170 patients with malaria parasite were measured. 1+ parasitaemia of the plasmodium *falciparum* was found in 114 of these patients while 2+ parasitaemia of plasmodium *falciparum* was seen in 56 patients. Results of the NPC measurements of the patients during and after recovery from the malaria attack are shown in the tables and figures below. Table 1 shows the statistical values of the near point of convergence during and after recovery from malaria attack with 1+ parasitaemia of plasmodium *falciparum*. The mean, standard deviation and mean error are shown together with the maximum and maximum values. Table 2 shows the same statistical values for 2+ parasitaemia. The mean NPC for 1+ parasitaemia and 2+ parasitaemia during malaria attack and after recovery from malaria attack are shown in figures 1 and 2 respectively.

Table 1: The table below shows the statistical data output of the NPC values for patients with 1+ parasitaemia of plasmodium *falciparum.*

During Malaria Attack					After Recovery from Malaria				
Mean	Minimum Value	Maximum value	Mean error	Standard Deviation	Mean	Minimum Value	Maximum Value	Mean error	Standard Deviation
10.44	7.00	13.00	0.090	0.96	7.60	6.00	10.00	0.063	0.68

Table 2: The table below shows the statistical data of the NPC values for patients with 2+ parasitaemia of plasmodium *falciparum.*

During Attack					After Recovery				
Mean	Minimum Value	Maximum Value	Mean error	Standard Deviation	Mean	Minimum Value	Maximum Value	Mean error	Standard Deviation
10.84	1.00	16.00	0.248	1.86	7.68	7.00	10.00	0.096	0.72

DISCUSSION

The mean NPC during malaria attack for patients with 1+ parasitaemia of plasmodium *falciparum* was 10.44 cm. This reduced to 7.60 cm after recovery from malaria resulting in a 37.4% recession in NPC during malaria attack. For patients with 2+ parasitaemia of plasmodium *falciparum*, the NPC reduced from 10.84 cm to 7.68 cm after recovery from malaria attack. The recession in NPC during malaria attack was 41.1%. A study on the effect of malaria on the near point of convergence found a 32.39% recession in the NPC during malaria attack. [(3)] On a study on the effect of some malaria drugs on the near point of convergence, there was an 18.2% recession in NPC values; [(9)] thus the need to ensure that the malaria drugs was out of the system before the second measurement of NPC values. In our testing of hypothesis, the first null hypothesis which stated that there is no significant difference in NPC values between patients with 1+ and 2+ plasmodium *falciparum* during malaria attack was accepted as the p value (0.183) was greater than the 0.05 level of significance used in the Paired sample T-test. The SPSS data output for this analysis is shown in Table 3. The testing of the second null hypothesis using the Paired sample T-test at 0.05 level of significance also showed no significant difference in NPC values between patients with 1+ and 2+ plasmodium *falciparum* after recovery from malaria attack. The SPSS data output is shown in Table 4. There was however a significant recession in NPC values for both 1+ and 2+ parasitaemia of plasmodium *falciparum* during malaria attack. Uzodike and Ndukwe [(3)] also found a significant recession in NPC during malaria attack. A recession in the near point of convergence caused by malaria leads to asthenopic symptoms at near, high exophoria at near, low accommodative convergence ratio (AC/A ratio) which eventually leads to convergence insufficiency and interference in visual functioning and performance.

Table 3: SPSS Statistical data output for testing the first hypothesis using the Paired sample T-Test. The null hypothesis states that there is no significant difference in NPC values between patients with 1+ and 2+ plasmodium *falciparum* during malaria attack. From the table, since the p value (0.183) is greater than the 0.05 level of significance, we accept the Null Hypothesis.

	Paired Differences					t	df	Sig. (2-tailed)
	Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference Lower	Upper			
Pair 1 NPC1P1 - NPC1P2	-.393	2.180	.291	-.977	.191	-1.349	55	0.183

Table 4: SPSS Statistical data output for testing the second hypothesis using the Paired Sample T-Test. The null hypothesis states that there is no significant difference in NPC values between patients with 1+ and 2+ plasmodium *falciparum* after recovery from malaria attack. From the table, since the p value (0.576) is greater than the 0.05 level of significance, we accept the Null Hypothesis.

	Paired Differences					T	df	Sig. (2-tailed)
	Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference Lower	Upper			
Pair 1 NPC2P1 – NPC2P2	-.071	.951	.127	-.326	.183	-.562	55	0.576

CONCLUSION

Plasmodium *Falciparum* being the most common cause of malaria attack causes a recession in the Near Point of Convergence and this study has shown that for 1+ and 2+ parasite load, the recession of NPC values is insignificant. Thus, 1+ parasitaemia causes as much damage as 2+ parasitaemia. Further studies are recommended on higher parasite load such as 3+ and 4+ parasitaemia. Eye care practitioners are advised on the need to allow malaria patients to fully recover before carrying out tests on binocularity and refractive errors.

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