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. This study was carried out on 170 young adults with a mean age (±S.D) of 22.49±4.4 cm. Patients with 1+ parasitaemia of the plasmodium falciparum was separated from those with 2+ parasitaemia. Their NPC values during malaria attack and after recovery from malaria attack was measured. Results showed that the mean NPC value for patients with 1+ parasitaemia was 10.44±0.96 cm during malaria attack and reduced to 7.60±0.68 cm after recovery. 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 malaria 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

1. 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 falciparum is the most common causative agent2. 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 travelers [2]. Plasmodium falciparum causes malignant malaria. It causes the most severe symptoms and result in most fatalities. Plasmodium vivax causes benign malaria and it 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), anemia (caused by haemolysis), hemoglobinuria, retinal damage and convulsions[1]. Nigeria is known for high prevalence of malaria. Uzodike and Ndukw [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

1

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plane to this point of intersection is the measurement of the near point of convergence [8]. In measurement of the near point of convergence, nondescriptive 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.

2. LITREATURE REVIEW

Uzodike and Ndukwe [3] conducted a study on the effect of malaria on the near point of convergence (NPC) and the amplitude of accommodation (AA) using a population of 100 patients from First Rivers Hospital Port Harcourt, Nigeria. The subjects included both sexes of age range 9-38 years. The base data was collected immediately after confirmation of malaria and commencement of treatment. Data collected was stratified into 3 age groups of 10 years interval (9-18, 19-28, 29-38) with their mean ages and standard deviation. The greater number of subjects was between 19-28 years (46%), 9-18 (22%) and 29-38 (32%). Malaria caused a recession on NPC and the percentage recession decreased with increase in age with age group 9-18 having the greatest recession of 3.05cm (42.07%) and age group 29-38 having the least recession of 2.75cm (24.345). These effects were statistically significant (p<0.05). A decrease was also seen in AA and the percentage reduction increased with increased age. The age group 29-38 had the greatest reduction (-2.09D; 28.79%). The near point of convergence and amplitude of accommodation was taken 2 weeks after taking the antimalarial drug to allow its effect to be eliminated from the system. The research work showed that malaria causes a recession in near point of convergence and reduction in amplitude of accommodation.

Timothy and Chima [9] conducted a study to know the effect of sulphadoxine and pyrimethamine on habitual lateral phoria and near point of convergence. Hundred volunteers within 18-29 years of age, comprising of both sexes were used in the study. The drug (Fansidar®) composed of 500mg sulphadoxine and 25mg of pyrimethamine was administered as a prophylactic to each of the subject. After 4 hours (effective period of the drug), the habitual lateral phoria and near point of convergence were again measured at intervals of 15 minutes each for 4 times for each subject and recorded. There was a slight peak increase in exophoria after 30 minutes after which it decreased to its baseline. There was a peak increase of exophoria after 45 minutes post ingestion of drug with percentage change of 18.2% after which it decreased to mean baseline. Peak increase in near point of convergence was noticed after 45 minutes and the percentage change was 3% of the mean change after which it gradually decreased towards the normal. About 26.6% of the subjects showed an increase in the near point of convergence while 13.3% reported a decrease. About 70% of the subjects showed no change at all for the habitual lateral phoria while 60% showed no change at near.

Odijemoghao and George [10] conducted a study on the effect of alcohol on the near point of convergence, amplitude of accommodation and pupil size using 150 non-habitual smokers and drinkers within the age group 20-30 years with a mean age of 24.1±2.8 years. They weighed an average of 70kg and had a light meal to avoid stomach upset during the experiment. Each subject was meant to consume 30ml of brandy (containing 40% alcohol). Measurements were repeated at an interval of 30, 60 and 90 minutes. The result showed that the mean amplitude of accommodation declined slightly while the mean near point of convergence and pupil diameter increased after consumption of alcohol. Statistical analysis using ANOVA showed that the difference between means was statistically significant in amplitude of accommodation, pupil size and the mean near point of convergence.

3. PROPOSED DESIGN

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 whole 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.

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.

4. RESULTS AND DISCUSSION

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. Tables 1 and 2 shows the statistical values of the near point of convergence during and after recovery from malaria attack with 1+ and 2+ parasitaemia of plasmodium falciparum respectively. The mean, standard deviation and mean error are shown together with the maximum and maximum values.

<table>
<thead>
<tr>
<th>Malaria</th>
<th>Mean Value</th>
<th>Min. Value</th>
<th>Max. Value</th>
<th>Mean Error</th>
<th>S.D</th>
</tr>
</thead>
<tbody>
<tr>
<td>During Attack</td>
<td>10.44</td>
<td>7.00</td>
<td>13.00</td>
<td>0.090</td>
<td>0.96</td>
</tr>
<tr>
<td>After Recovery</td>
<td>7.60</td>
<td>6.00</td>
<td>10.00</td>
<td>0.063</td>
<td>0.68</td>
</tr>
</tbody>
</table>

Table 1: Statistical data of the NPC values for patients with 1+ parasitaemia of plasmodium falciparum. The table shows the mean, minimum and maximum values, standard mean error and standard deviation.

<table>
<thead>
<tr>
<th>Malaria</th>
<th>Mean Value</th>
<th>Min. Value</th>
<th>Max. Value</th>
<th>Mean Error</th>
<th>S.D</th>
</tr>
</thead>
<tbody>
<tr>
<td>During Attack</td>
<td>10.84</td>
<td>1.00</td>
<td>16.00</td>
<td>0.248</td>
<td>1.86</td>
</tr>
<tr>
<td>After Recovery</td>
<td>7.68</td>
<td>7.00</td>
<td>10.00</td>
<td>0.096</td>
<td>0.72</td>
</tr>
</tbody>
</table>

Table 2: Statistical data of the NPC values for patients with 2+ parasitaemia of plasmodium falciparum. The table shows the mean, minimum and maximum values, standard mean error and standard deviation.

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.

Fig 1: Mean NPC of patients with 1+ parasitaemia of plasmodium falciparum during and after recovery from 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. The recession in NPC during malaria attack was 41.1%.

Fig 2: Mean NPC of patients with 2+ parasitaemia of plasmodium falciparum during and after recovery from malaria attack.
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 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.

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.

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.

**REFERENCES**


