Full Length Research Paper

Effect of malaria on Near Point of Convergence (NPC) and amplitude of accommodation

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Malaria, a protozoan parasite caused disease is wide spread in tropical and sub-tropical regions and is more endemic in developing countries. The effect of malaria on near point of accommodation (NPC) and amplitude of accommodation (AA) were investigated on 100 volunteer patients of First Rivers Hospital aged between 9-38 (mean age 24.73±2.91) years. NPC and AA tests were carried out on the patients on diagnosis of malaria through laboratory results, signs and symptoms. The tests were repeated on recovery from the disease through the afore-mention criteria. Three values were taken for each visual function tested and the mean used for analysis. The mean NPC during malaria attack was 12.59±3.21cm and 9.51±3.21cm after recovery showing 32.39% recession in NPC during the attack. The mean AA during malaria attack was 8.78±3.53D and 11.05±3.53D after recovery showing 20.54% reduction in AA during the disease. The percentage recession in NPC decreased with age while percentage reduction in AA increased with age. The observed effects were statistically significant both with the different age groups and overall results (p<0.05).

Keywords: Malaria, plasmodium protozoan, mosquito, near point of accommodation, amplitude of accommodation

INTRODUCTION

Malaria is a vector-borne infectious disease caused by protozoan parasites. It is widespread in tropical and subtropical regions, including parts of America, Asia and Africa (Barat, 2006). According to World Health Organization (WHO, 2006), malaria was defined as a disease that is caused by four species of the plasmodium protozoan: *plasmodium falciparum*, *plasmodium vivax*, *plasmodium ovale* and *plasmodium malarial* transmitted by the female anopheles mosquito. These human pathogenic plasmodium species were referred to as malaria parasites. United States Department of Human Health Services (2002), defined malaria as a disease caused by parasite that lives both in mosquitoes and human. There are two categories of malaria; malignant malaria and benign malaria (Adak, 1998).

The four different types of plasmodium parasite can be grouped in terms of malaria categories. *Plasmodium falciparium* is the only parasite that causes malignant malaria. It causes the most severe symptoms and result in most fatalities. *Plasmodium vivax* causes benign malaria with severe symptoms than *plasmodium falciparum*. *Plasmodium vivax* can stay in the liver for up to three years and can lead to a relapse. *Plasmoium ovale* causes benign malaria and relatively rare (Martins, 2008). *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 hemolysis), hemoglobinuria, retinal damage and convulsions (Beare, 2006; WHO, 2008).

Each year approximately 350-500 million cases of malaria are reported, killing between one to three million people, however, 90% of the fatalities occur in sub-Saharan African, the majority of who are young children (Snow et al, 2005). Malaria is commonly associated with poverty but also a cause of poverty and a major hindrance to economic development (Greenwood, 2005). In some countries with a heavy malaria burden, the disease may account for as much as 4% of public health expenditure, 30-50% of in-patient admission, and up to 50% of out-patient visits (WHO, 2008).

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Nigeria is known for high prevalence of malaria and is a leading cause of morbidity and mortality in the country (Onwujekwe et al, 2000). Available records show that approximately 50% of the Nigerian population suffers from at least one episode of malaria each year and that malaria accounts for over 45% of out-patient visits (Ejezie et al, 1991). Therefore, it imposes great burden on the country in terms of pains and trauma suffered by its victims as well as loss in outputs and cost of treatments (Alonson et al, 2004).

Common preventive measures of malaria in Nigeria include use of medicine, insecticides (coils and sprays), ordinary mosquito nets, insecticides treated nets (ITN) and window/door nets. The disease is often treated by the use of local herb, the use of clinic or hospitals services and by self-medication. (Ezedunachi and Alariba, 2008). Anti-malaria drug mostly used in the country are usually of either quinine or artemisinin derivatives.

Accommodation is defined as a function whereby the converging power of the eye's optical system is increased so that diverging rays of light are brought to focus on the retina. During accommodation, the eye varies its refractive power in order to obtain a clear retinal image of the object at varying distances; this process is mediated by the ciliary muscles, the iris and zonular fibers. Amplitude of accommodation (AA) represents the maximum amount of accommodation which the eye is capable of, measured in diopters (Borish, 1975). According to Ciuffreda (1991), he defined AA as the maximal voluntary effort in fully corrected eve. AA is known to decrease physiologically owing to the factor of age and is influenced by disease conditions or toxic conditions of drugs used in the management of such diseases or the chemical toxicity to the eye (Grosvenor, 2002; London et al, 1991, Duke-Elder, 1980) and visual habits. Abrahams (1961), in his study implicated amblyopia in the etiology of reduction of amplitude of accommodation.

The near point of convergence (NPC) is a basic visual measure performed by eye care clinicians (Shippman et al, 1983; Rouse et al, 1997). It defines the amplitude of convergence (punctum proximum of convergence), or the closest point in space where the patient can hold fusion when the two eyes move-in to see one target (Borish, 1975). The test has a long history of clinical use because of its simplicity of administration and its value as a diagnostic tool. Although literature contains some variations in the normative values reported, these differences can be largely explained by differences in administration techniques. Binocular vision problems, evestrains (asthenopia) discomfort in performing near work and reading difficulties may occur in persons with inadequate NPC findings. As a result, NPC findings are used as a screening for obvious convergence insufficiencies (Cooper and Duckman, 1978; Brinkley amd Walonker, 1983). Von Noorden, (1990) noted that

normal NPC should be 8-10cm. NPC can be affected by sleep, drowsiness, alcohol, irritative conditions of the central nervous system (CNS), reflex irritability, anesthetic agents (Morgan, 1980).

Ocular or periocular manifestations of malaria are noticed on different structures of the eye like eyelids (blepharitis, ptosis), conjunctiva (conjunctival hemorrhages), and cornea (interstitial keratitis) to mention but a few. Based on these manifestations, the effect of malaria on visual functions like NPC and AA are investigated.

MATERIALS AND METHODS

The population for this study includes 100 patients from First Rivers Hospital, Port Harcourt. These subjects include both sexes of age range 9-38 (mean age 24.73±2.91) years. This research is a prospective; laboratory based and clinically monitored one. Subjects for this study must have done malaria parasite test and tested positive or confirmed to have the disease.

This age range (9-38years) was chosen due to the physiological changes, physical changes and decline in accommodation that arise in most people that are 40 years and above. The researcher therefore excludes these people with the problem of presbyopia. Some disease conditions of the CNS, such as cerebral syphilis, tabes, influenza, tonsillitis, typhoid, pneumonia and diabetes were excluded as they remain the common causes of accommodative deficiency (Duke-Elder, 1980). Refractive conditions such as amblyopia and physical deformation of the lens were also excluded. Amblyopia causes unilateral difference in accommodative function (Abrahams, 1961).

The patient who passed the inclusion and exclusion criteria through detailed case history, preliminary examination and ophthalmoscopy (AIT Propper Star ophthalmoscope was used) were subjected to AA test using Push-up-to blur method and NPC test using PD rule if they were confirmed to suffer from malaria through laboratory test, signs and symptoms by the medical doctors of First Rivers Hospital. Most laboratory results implicated P. falciparum as the causative organism. Reichert AO-RX Master phoropter was used for AA measurement and Optical Ruler was used to measure NPC. The baseline data was collected immediately after confirmation of malaria before commencement of treatment. The tests were repeated 2 weeks after recovery, to allow the effect of malaria treatment to wear off. The data collected from the 100 subjects were tabulated and analyzed statistically.

The subjects were grouped into 3 groups of 10years interval. The results gotten were statistically analyzed using paired T-test from Microsoft[®] Excel package.

AGE GROUP	FREQUENCY	MEAN AGE	PERCENTAGE
9 – 18	22	13.8±2.94	22%
19 – 28	46	23.5±2.88	46%
29 – 38	32	34.0±3.03	32%
TOTAL	100	-	100%

Table 1. Frequency distribution of subjects according to age

Table 2. NPC values during malaria and after recovery

Age group	Mean NPC during malaria (cm)	Mean NPC after recovery (cm)	Mean change (%)
9-18	10.30±2.47	7.25±3.59	3.05cm; (42.07%)
19-28	12.68±2.56	9.32±2.56	3.36cm; (36.05%)
29-38	14.05±3.59	11.30±3.59	2.75cm; (24.34%)

Table 3. AA values during malaria and after recovery

Age groups	Mean AA during malaria (D)	Mean AA after recovery (D)	Mean change (%)
9-18	13.32±2.27	15.87±2.27	-2.55D; (16.06%)
19-28	9.25±1.64	11.43±1.64	-2.18; (19.07%)
29-38	5.10±1.57	7.19±1.57	-2.09; (28.79%)

RESULTS

Overall mean NPC during malaria attack was found to be 12.59±3.21cm and 9.51±3.21cm after recovery showing a 32.39% recession in NPC during malaria attack. Mean NPC reading for the 3 age groups in table 2 showed NPC recessions during malaria attack and the percentage of recession decreased with increase in age from 42.07% in age group 9-18 to 24.34% in age group 29-38.

Overall mean AA during malaria attack was found to be 8.78±3.53D and 11.05±3.53D after recovery showing a 20.54% reduction in AA during the disease. Mean AA for the 3 age groups during malaria attack in table 3 showed that percentage reduction in AA increased with increase in age; from 16.06% in age group 9-18 to 28.79% in age group 29-38.

Paired T-test was used to test the significance level of the effect of malaria on NPC and AA at 95% confidence level, paired t_{cal} 7.74, 10.17 and 6.21 respectively for the 3 age groups were greater than t_{tab} ±2.08, ±2.01, ±2.04 showing a statistically significant recession in NPC during malaria attack. For AA, t_{cal} -5.81, -11.47 and -9.26 were greater than t_{tab} ±2.08, ±2.01 and ±2.04 respectively confirming the AA reduction as a result of malaria to be statistically significant. Different critical levels were used for the calculations because the patients used were not uniform for the age groups.

Generally, the effects of malaria on NPC and AA of the research subjects were statistically significant $(t_{cal}13.79>t_{tab}\pm1.98$ for NPC and $Z_{cal}-14.99>t_{tab}\pm1.98$ for AA).

DISCUSSION

One hundred volunteer patients of age on NPC and AA of First Rivers Hospital with the age range of 9-38 (mean age 24 ± 2.91) years irrespective of their sexes were used to investigate the effects of drugs (anti-malaria drugs) on NPC and AA values. Data obtained were 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%), age groups 9-18 (22%) and 29-38 (32%) (table 1).

Table 2 shows the mean NPC during malaria and after recovery. Malaria disease was found to cause 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 (24.34%). These effects were statistically significant (p<0.05). These findings were supported by Duke-Elder (1973), which identified general or debilitating disease as one of the factors that leads to convergence insufficiency. Malaria is a debilitating type of disease.

Mean AA during malaria and after recovery as shown in table 3 indicates that malaria disease decreased AA and the percentage reduction increased as age increases with age group 29-38 having the greatest reduction (-2.09D; 28.79%) and age group 9-18 having the least reduction (-2.55D; 16.06%). Statistical analysis found the effect of malaria on AA to be statistically significance (p<0.05). According to London et al (1991), accommodation decreases with age. This might be due to disease conditions, drugs and intake of alcohol that affect the older patients. Duke-Elder (1980) also believes that paralysis of accommodation may be the result of diseases.

In this study, effect of age on AA was accounted for as the patients acted as their own control (the measurements of AA were taken on the same subjects during and after malaria attack). Effects of drugs (antimalaria drugs) on the AA values were taken care of by the two weeks interval allowed as a "wash-off" period before reassessing the visual function. Artesimin, the drug used in combination with mefloquine or amodiaguine for the patients in this study is eliminated from the system within two weeks after treatment (De Vries and Dien, 1996; De Vries et al, 1997). Hence, the observed effect most likely was due to disease condition malaria.

This research work has shown that malaria causes recession in NPC and reduction in accommodation which might lead to report of asthenopic complaints by the patients during the attack, hence, eye care practitioners are advised to allow the patients to recover before they are subjected to refraction and binocularity tests.

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