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Selected Immunoglobulins (IgA, IgG, IgM) and Lambda Free Light Chain Levels in Persons with HIV-Malaria Co-infection

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ABSTRACT

This study set out to evaluate immunoglobulin classes (IgA, IgG, IgM) and Lambda light chains in HIV-malaria coinfection. One hundred and thirty four subjects stratified into 3 groups: HIV-malaria co-infected subjects (Group 1; n=40), HIV seropositive subjects without malaria (Group 2; n=54) and HIV seronegative subjects without malaria (Control subjects) (Group 3; n=40) were recruited. CD4 T-cells were counted using cyflowmetric technique; Immunoglobulin classes (IgA, IgG, IgM) were determined using immunoturbidimetric method while lambda light chains were determined using nephlometric method. Due to the current policy of test and treat, all the HIV seropositive subjects recruited were on antiretroviral treatment. (ART). The CD4 cell count showed no significant difference between HIV-malaria co-infected subjects and HIV seropositive subjects without malaria (P=0.918). The lambda light chains were significantly higher in the HIV seropositive patients (with or without malaria) when compared with the control group respectively (P=0.003, 0.04). There was significant difference in the mean IgG between the non-HIV group (Control group) and each of the HIV groups (P=0.013, 0.018). The mean IgA and IgM of HIV-malaria coinfected subjects were significantly higher when compared with that of HIV seropositive subjects without malaria (P=0.03, 0.01) respectively. The CD4 cell count correlated inversely with IgG (r = -0.559) and λ light chains (r = -0.598) While λ light chains correlated positively with IgG (r= 0.604). In conclusion, the levels of IgA and IgM are significantly higher in persons with HIV-malaria co-infection than in HIV seropositive individuals without malaria infection but CD4 cell counts, IgG and Lambda light chains are similar in persons with HIV either having malaria co-infection or not.

Keywords: HIV-malaria co-infection, Immunoglobulins, Lambda lights chains.

INTRODUCTION

Human immunodeficiency virus (HIV) is a lentivirus (a subgroup of retrovirus) that causes HIV infection and acquired immunodeficiency syndrome (AIDS) [1]. HIV infects vital cells in the human immune system such as helper T cells (specifically CD4+ T cells), macrophages, and dendritic cells [2]. HIV infection leads to low levels of CD4+ T cells through a number of mechanisms, including apoptosis of uninfected bystander cells [3], direct viral killing of infected cells, and killing of infected CD4+ T cells by CD8 cytotoxic lymphocytes that recognize infected cells [4]. Globally about 36.7 million

people are living with HIV [5]. In Nigeria, about 1.9 million adults aged 15 to 49 are living with HIV, with prevalence rate of 1.5% [6].

Malaria is caused by Plasmodium parasites. The parasites are spread to people through the bites of infected female Anopheles mosquitoes, called "malaria vectors." There are 5 parasite species that cause malaria in humans, and 2 of these species – P. falciparum and P. vivax – pose the greatest threat. Plasmodium falciparum is the most prevalent malaria parasite in sub-Saharan Africa, accounting for 99% of estimated malaria cases in 2016. Outside of Africa, P. vivax is the predominant parasite in the WHO Region of the Americas, representing 64% of malaria cases, and is above 30% in the WHO South-East Asia and 40% in the Eastern Mediterranean regions. [7]. Sub-Saharan Africa continues to carry a disproportionately high share of the global malaria burden. The WHO African Region accounted for 91% of all malaria deaths in 2016, followed by the WHO South-East Asia Region (6%) [7].

Combined, malaria and HIV cause more than two million deaths each year. Given the considerable geographical overlap between malaria and HIV/AIDS, substantial number of co-infections occurs. In areas with stable malaria transmission, HIV increases the risk of malaria infection and clinical malaria in adults, especially in those with advanced immunosuppression. In settings with unstable malaria transmission, HIV-infected adults are at increased risk of complicated and severe malaria and death [8]. Malaria infection is associated with strong CD4+ cell activation and up-regulation of proinflammatory cytokines and it provides an ideal environment for the spread of the virus among CD4+ cells and for rapid HIV 1 replication [9].

Immunoglobulins are glycoprotein molecules produced by the lymphocytes and are found in fraction of blood called gamma globulin. The various immunoglobulin isotopes differ in their biological features, structure and target specificity. Hence the assessment of the immunoglobulin isotype can provide useful insight into complex humoral immune response [10]. Structurally, the immunoglobulin is a "Y"-shaped molecule that consists of four polypeptide chains; two identical heavy chains and two identical light chains connected by disulfide bonds [11]. Each chain is composed of structural domains called immunoglobulin domains. These domains contain about 70–110 amino acids and are classified into different categories according to their size and function [12]. The mammalian immunoglobulin heavy chain has five sub-types which are denoted by the Greek letters: α, δ, ε, γ, and μ [10]. The type of heavy chain present defines the class of antibody; these chains are found in IgA, IgD, IgE, IgG, and IgM antibodies, respectively [13].

The immunoglobulin light chain is the small polypeptide subunit of an antibody (immunoglobulin). There are two types of light chain in humans (as in other mammals); Kappa (κ) chain and Lambda (λ) chain. [10]. In a healthy individual, the total kappa to lambda ratio is roughly 3:1 in intact whole antibodies or 1:1.5 if measuring free light chains, with a highly divergent ratio indicative of neoplasm [14]. "Free" light chains (FLC) are light chains that are not bound to heavy chains within an immunoglobulin molecule. They can exist in monomeric, dimeric, or higher oligomeric and polymeric forms [15]. Kappa free light chains (κFLCs) are described as generally monomeric in form, but can exist as a noncovalently linked dimer. On the contrary, λFLCs are usually dimeric in form with covalent bonds between them [15]. Light chains are polypeptides containing both a variable and a constant region. The amino acid sequence of the variable region of light chains is unique to each free light chain, and the number of amino acid residues in this region can differ [15]. Free light chains (FLCs) have a serum half-life of 2–6 hours as they are rapidly cleared by the glomeruli and metabolized in the proximal tubules. When FLCs are produced in excess, the re-

absorptive capacity of the tubules can be overwhelmed, thus leading to an accumulation of FLCs in the serum [16]. This can occur in a number of clinical conditions including inflammation, immunological disorders, renal failure, and plasma cell neoplasms [17].

Previous authors have demonstrated raised free light chains in several inflammatory and infective diseases [18, 19, 20]. Others have demonstrated elevated intact immunoglobin classes and serum FLCs levels in HIV infection [21, 22, 23, 24, 25]. But none has described free light chains in HIV-malaria co-infection. Nigeria as a country in Sub-Sahara African region faces the challenge of HIV-malaria co-infection. This research work was designed to investigate the level of Lambda free light chains and immunoglobins in patients with HIV-malaria co-infection. The research provided useful insight into humoral immune response with regard to HIV-malaria co-infection.

MATERIALS AND METHODS

Study area: This study was carried out at Nnamdi Azikiwe University Teaching Hospital (NAUTH) Nnewi, Anambra State, Nigeria. NAUTH is a 450 bed capacity tertiary health institution and a regional site for HIV testing and treatment.

Study design: Cross sectional study

Sample population.

One hundred and thirty four (134) subjects were recruited for this study. Forty (40) HIV-malaria coinfected patients, fifty-four (54) HIV seropositive patients without malaria and forty (40) HIV seronegative control subjects.

Exclusion Criteria

This study excluded pregnant women.

Ethical Consideration

Ethical approval was obtained from the Ethics Committee of Nnamdi Azikiwe University Teaching Hospital, Nnewi, Anambra state, Nigeria.

Informed Consent

Informed consent was obtained from the participants after a clear explanation of the study was given to them.

Specimen collection, preparation and storage

Standard venepuncture technique as described by Lewis and Noriyuki (2008) [26] was employed. A sterile, plastic syringe of 10ml capacity was used for the collection of blood. Eight millilitres (8mls) of blood was collected. Three millilitres (3mls) of blood was delivered into a bottle containing dipotassium salt of ethylenediamine tetra-acetic acid (K_2-EDTA) at a concentration of 1.2mg/ml of blood. This was used for CD4 count by Cyflow method and malaria parasite detection by rapid test method. Five millilitres (5mls) of the blood was delivered into a plain specimen bottle. This was allowed to coagulate; serum was obtained by spinning at 1,500 RPM for five minutes. With the aid of sterile pasture pipette, the serum was delivered into a fresh clean plain specimen bottle and was used for HIV rapid testing. The remainder was stored at -20°C until required for the determination of immunoglobulin classes (IgA, IgG, IgM) using spectrometric method and evaluation of Lambda free immunoglobulin light chains using nephlometric method.

LABORATORY METHODS.

Human Immunodefieciency Virus rapid testing.

The rapid HIV test kits were used for the diagnosis of HIV infection by serial testing algorithm. The first test was performed using Alere Determine kit (Abbott laboratories, USA) (Screening test) and if positive, a second test was performed using Unigold (Trinity Biotech, Ireland), the third test was carried out using Stat pak (Chembio Diagnostic system, USA) which acted as a tie breaker. All the tests were carried out according to manufacturer's instructions.

Malaria parasite detection (rapid diagnostic testing method using SD bioline malaria Ag P.f device)

Procedure

The procedure was described by the manufacturer of the kit (SD bioline malaria kit). The test kit components and specimens were brought to room temperature prior to testing. The SD malaria test device was removed from the foil pouch and placed on a flat dry surface. The circular end of the disposable inverted cup (5ul) provided was dipped into the blood specimen and the carefully placed into the round specimen well. Four drops of the assay diluent was vertically dispensed into the square assay diluent well. Results were read at 30minutes. The presence of only one colour band at the control region indicates a negative result while the presence of colour band at both the control and test region indicates a positive result. The result is considered invalid if no visible colour band is seen on the control region.

CD4 determination (Flow cytometric method)

Procedure

Twenty microliters of blood specimens were added to twenty microliter of PE antibody in Rohern tubes respectively. These were adequately mixed and incubated in the dark for 15 minutes at room temperature. Eight hundred microliters (800µl) of the buffer were then added to the tubes and mixed adequately. Each sample tube was plugged onto the sample port of the cyflow machine for counting of the CD4+ T cell. The monitor displayed the result and this was recorded as the number of cells /µl of blood.

Determination of immunoglobulin classes (IgA, IgG and IgM).

Procedure

The procedure was described by the manufacturer of the kit (Cromatest Linear Chemical S.L, Barcelona Spain). Preparation of plasma protein calibrator curve of IgA, IgG and IgM were made at given dilutions. The concentration of IgA, IgG and IgM in each dilution was determined by multiplying the concentration of IgA, IgG or IgM protein calibrator by the corresponding factor. The reagents were pre-warmed to 37^{o}C. A 1000ml of reagent for IgA, IgG and IgM was delivered into separate test tubes labeled accordingly. Then 7ul of the sample was added into test tubes for IgA, 7ul of the sample to test tubes IgG and 10ul of the sample to test tubes for IgM. The sample and the reagent were mixed very well and were then pipetted into cuvette for reading. They were read after 2 minutes of sample or calibrator addition, spectrophotometrically at 540nm wavelength and Absorbance recorded. The calibration curve was plotted for the different absorbance values (A) against the IgA, IgG or IgM concentration of each calibrator dilution. IgA, IgG or IgM in the sample was calculated by interpolation of its (A) value in the calibration curve.

Determination of lambda light chains (Nephlometric method)

Procedure

The test procedure and the calibration data were provided in the smart card along with the kit (AGAPE diagnostics Switzerland GmbH). When the card is inserted to the card reader slot, display prompts to add R1+sample (1/2 diluted with R3). 150µl of R1 (MES buffer) was then pipetted into the cuvette, 7µl sample was added and the cuvette placed in to the cuvette holder. After incubation, display prompted to add R2 (polyclonal goat anti human), 150µl of R2 was pipetted using attached sensor pipette to the cuvette. The result was shown in display and was printed out.

Statistical analysis

The data was analysed using Statistical Package for Social Science (SPSS) version 22. The significant of difference between groups were analysed using student T-test and within groups by analysis of variance (ANOVA). Games-Howell's post-hoc test was used to compare combination of groups. Results were regarded as significant at $p<0.05$. Pearson's correlation coefficient (r) was used to test possible relationship between parameters.

RESULTS

The Mean±SD value of $CD4^{+}$ counts of participants across group was

significantly different, generally being lower for groups comprising of HIV seropositive individuals (F=27.14, P<0.001). The mean value of CD4+ counts of subjects who are HIV-malaria co-infected was similar when compared with HIV seropositive subjects without malaria (P=0.918) Table 1.

The Mean ± SD value of IgA was also significantly different across groups (F=3.73, P=0.029). But the observed difference was actually between HIV-malaria co-infected subjects and HIV seropositive subjects without malaria (P=0.03) Table 1.

The compared Mean ± SD values of IgG showed statistical significant difference among groups (F=5.40, P=0.007). The significant differences were between the HIV seropositive groups (with or without malaria) and the control subjects (P=0.013, P=0.018) respectively Table 1.

There was significant difference among the groups when the Mean ± SD value of IgM were compared (F=6.52, P=0.003). The significant differences were between HIV-malaria co-infected subjects and HIV seropositive subjects without malaria (P=0.01) Table 1.

The Mean ± SD value of λ light chains (mg/dl) were significantly different among the studied groups (F=5.76, P=0.005). The significant differences were between the HIV seropositive groups (with or without malaria) and the control subjects (P=0.003, P=0.04) Table 1.

Table 1: Mean ± SD value of $CD4^+$, IgA, IgG, IgM and λ Light chain in HIV-malaria co-infected subjects (Group 1), HIV seropositive subjects without malaria (Group 2), HIV seronegative subjects without malaria (Group 3) (Control).

PARAMETER	$CD4^+$ (cells/mm^3)	IgA (mg/dl)	IgG(mg/dl)	IgM(mg/dl)	λ Light(mg/dl)
GROUP 1 (n =40)	327.9±242.9	447.9±75.1	1381.3±162.7	240.6±51.2	319.9±104.2
GROUP 2 (n =54)	357.4±269	396.1±48.9	1336.6±109.6	200.7±27.5	277.8±99.5
GROUP 3 (n =40)	871.3±289.7	404.6±78.4	1257.3±82.2	214.8±33.2	227.9±21.3
F	27.14	3.73	5.40	6.52	5.76
P-value	<0.001*	0.029*	0.007*	0.003*	0.005*
1 vs 2 p-value	0.918	0.03*	0.544	0.01*	0.352
1 vs 3 p-value	<0.001*	0.189	0.013*	0.157	0.003*
2 vs 3 p-value	<0.001*	0.905	0.018*	0.283	0.04*

KEY: * = Significant at P<0.05, n = Sample size, Group 1 = HIV-malaria co-infected subjects, Group 2 = HIV seropositive subjects without malaria, Group 3 = HIV seronegative subjects without malaria (Control).

$CD4^+$ count values correlated negatively with IgG ((r= -0.559, P=0.01) and Lambda (λ) light chain values (r=-0.598, P=0.005) but not with IgA and IgM. Significant correlation existed between Lambda (λ) light chain values and IgG (r= 0.604, P=0.005) but not with IgA and IgM. No significant correlation could be established among the Immunoglobulin classes Table 2.

Among the HIV-malaria co-infected subjects and HIV seropositive subjects without malaria, no observable differences were found between males and females when the mean ± SD of IgA, IgG, IgM and λ Light chain levels were compared. In the control group, the only parameter that showed statistical significant difference between the males and females was IgA. It was significantly higher in the males (t-value=3.148, P=0.006). Other parameters showed no significant difference Table 3.

Table 2 Correlation analysis among $CD4^+$, Immunoglobulin classes (IgA, IgG, IgM) and λ Light chain levels in HIV-malaria coinfection (n=40).

PARAMETERS	r-value	P-value
$CD4^+$ vs IgA	0.415	0.069
$CD4^+$ vs IgG	-0.559	0.01*
$CD4^+$ vs IgM	-0.197	0.405
$CD4^+$ vs λ	-0.598	0.005*
λ vs IgA	0.142	0.550
λ vs IgG	0.604	0.005*
λ vs IgM	0.291	0.213
IgA vs IgG	0.083	0.727
IgA vs IgM	0.013	0.958
IgG vs IgM	0.059	0.805

KEY: r = Pearson Correlation coefficient**, * =** Significant at P<0.05.

Table 3 Mean ± SD value of $CD4^+$, IgA, IgG, IgM and λ Light chain of male and Female subjects

Groups	Gender	IgA (mg/dl)	IgG (mg/dl)	IgM (mg/dl)	λ(mg/dl)
HIV-malaria co-infected	Male	458.8±85.5	1376.1±183.1	238.6±48.9	319.8±118.2
	Female	439±68.4	1385.5±153.1	242.3±55.3	320±97.2
P-value		0.572	0.902	0.44	0.997
HIV seropositive subjects without malaria	Male	406±37.2	1322.9±125.9	192.1±10.2	249±137.9
	Female	439±68.4	1385.5±153.1	242.3±55.3	320±97.2
P-value		0.545	0.708	0.351	0.385
Control subjects	Male	460.4±78.5	1227.7±103.4	215.5±18.2	218.5±16.2
	Female	367.4±54.2	1276.4±62	214.3±41.2	234.1±22.6
P-value		0.006*	0.204	0.937	0.111

KEY: * = Significant at P<0.05.

There was no statistical significant difference between the mean ± SD values of IgA, IgG, IgM and λ Light chain levels in young adult and middle aged adult subjects Table 4.

Table 4: The Mean ± SD value of $CD4^+$, IgA, IgG, IgM and λ Light chain of young adults and Middle aged adults

Groups	Age	IgA (mg/dl)	IgG (mg/dl)	IgM (mg/dl)	λ(mg/dl)
HIV-malaria co-infected	Young adults	438.8±34.5	1361.8±186.3	257.5±62.3	312±77
	Middle aged adults	459±108	1405±135.5	220±22.4	329±135
P-value		0.564	0.569	0.44	0.725
HIV seropositive subjects without malaria	Young adults.	389.9±50.9	1338.5±113.2	202.7±31.9	274.2±108.8
	Middle aged adults	408.4±45	1332.8 ±108.5	196.6±16.2	285±83.2
P-value		-0.923	0.125	0.542	0.563
Control subjects	Young adults.	402.3±82.1	1260.6±84.4	217.2±30.9	228.9±22.2
	Middle aged adults	425±38.2	1225±70.7	192.5±60.1	218.1±3.6
P-value		0.709	0.576	0.331	0.507

KEY: * = Significant at P<0.05.

DISCUSSION

The overlap of the distribution of HIV and Malaria infection in sub-Sahara Africa has been demonstrated to pose public health challenges. An understanding of immunological processes and interaction between malaria and HIV are important for management and/or control of these diseases.

There was significant difference in CD4 counts across groups but observed difference were actually between the non-HIV groups (Control group) and each of the HIV groups. The mean value of CD4+ counts of subjects who are HIV-malaria co-infected was lower but not significantly different from HIV seropositive subjects without malaria. The presence of malaria coinfection did not seem to have any effect on the CD4 counts. This is similar to the report of Audu *et al*., 2005 [27], who reported that there is a progressive depletion of $CD4^+$ cells in HIV infection while co-infection with malaria did not have any impact on the $CD4^+$ cells of HIV infected subjects. A study in Cameroon also reported that the mean CD4 count in HIV and malaria co-infection was not significantly different from that of HIV mono infection [28]. It may be inferred that malaria infections do not result in the depletion of CD4+ cells but there is an increasing risk of malaria infections with lower $CD4^+$ cells counts (advancing HIV immunosuppression) [27], probably because $CD4^+$ T cells play a major role in the development and maintenance of antimalarial immunity which HIV interferes with [29]. However, Tagoe and Boachie, 2012 [30] and Jegede *et al*., 2017 [31] contradicted this, opining that malaria and HIV co-infection significantly reduces CD4 count.

The highest level of λ light chains were recorded in HIV malaria co-infected subjects though not statistically significant when compared to HIV patients without malaria. This may infer that malaria infection does not have an effect in excessive production of lambda light chains. This study to the best of the researchers' knowledge is the first to demonstrate λ light chain levels in HIV-malaria coinfection in the area. Results of this study showed significant difference between the mean λ light chain levels of HIV infected subjects (with or without malaria) and the control group. This is consistent with previous

studies [24, 25, 32] who demonstrated that there is significant increase in λ light chain levels in HIV patients as compared to healthy individuals. FLCs are produced as an excess by-product of antibody production by B cells [18]. B-cell hyperactivity in HIV-infected individuals includes increased polyclonal B-cell activation, cell turnover, expression of activation markers, differentiation of B cells to plasmablasts, production of autoantibodies, and hypergammaglobulinemia leading to overproduction of FLCs. This B-cell dysfunction and activation are driven by continuous HIV replication and the constant effort of the immune system to clear HIV infection [33].

The results of this study showed that the mean IgA levels of HIV malaria co-infected subjects were significantly higher than that of HIV patients without malaria. Sukla *et al*., 1995 [34] observed that human individuals residing in malaria endemic area with a history of repeated malaria attacks have substantial amount of antigen-specific IgA in circulation. Studies have shown that the rates of malaria infection increased with advancing HIV immunosuppression [35, 36]. These HIV-malaria co-infected subjects probably had a history of repeated attacks of malaria. On the other hand, malaria parasites may have some components, which can trigger the IgA response and aid in development of protective immune response by providing defense mechanism to the invading organisms [34].

This study observed that there was no significant difference between the mean IgA levels of HIV infected Subjects (with or without malaria) and the Control subjects. This is in line with the findings of Devi *et al* 2008 [37] and Ifeanyichukwu *et al*., 2016 [38] who observed that there was no significant variation between the mean IgA level of HIV carriers and control subjects. Contrarily, Pascale *et al.,* 1997[39] and Lugada *et al.*, 2004 [22] observed elevated serum IgA in HIV patients when compared to healthy individuals.

The mean IgG level in HIV malaria co-infected subjects levels was not statistically significant when compared with that of HIV patients without malaria. Eze and Christian, 2016 [40], in their study compared the mean IgG value of malaria infected subjects and the control subjects and discovered that malaria infection did not have any significant influence on the IgG of the infected subjects. Nothwistanding, there was statistical significant difference when HIV infected subjects (with and without malaria), were compared with the control group respectively. The findings of increased serum IgG in persons with HIV infection is consistent with studies conducted by McGowan *et al.,*2006[41], Devi *et al* 2008[37] and Ifeanyichukwu *et al*., 2016. [38] Immunoglobulin G have been shown to have neutralisation activity on HIV and also mediate opsonophagocytic antibody responses against virions thereby playing critical roles in antiviral immune responses [42]. Therefore, this increase could have a link with the increased need for IgG to clear the HIV virus from the system [38]. Increase in IgG concentration in HIV infected participants may also suggest evidence of increased opportunistic infection requiring IgG response and the involvement of this class of immunoglobulin in possible protective immunity [23].

This research observed that the mean IgM levels of HIV malaria co-infected subjects were significantly higher than that of HIV patients without malaria. This is basically because IgM is the predominant class of natural antibodies binding to the surface of plasmodium falciparum infected erythrocytes [43]. In their study, Krishnamurty *et al*., 2016 [44] demonstrated that IgM memory cells function as first responders in malaria infection. In agreement, Boyle *et al.,* 2019 [45] identified IgM activity against blood stage malaria parasites. They found that merozoite-specific IgM appears rapidly in *Plasmodium falciparum* infection and blocks merozoite invasion of red cell in complement

dependent manner. Therefore the increase in IgM appears to be a protective immune response of the body system against malaria infection. Contrarily, Eze and Christian, 2016 [40] did not find any observable variation in IgM levels as regards to malaria infection.

The inverse correlation between $CD4^+$ cell count and IgG levels (r= -0.559, P =0.01) demonstrates that increased $CD4^+$ cell count correlated with decreased IgG levels and vice versa. This is classical in HIV infection in which high $CD4^+$ cell count is associated with immunocompetence and decreased susceptibility to opportunistic infections.

The inverse relationship between Lambda (λ) light chain values and $CD4^+$ cell count (r=-0.598, P=0.005) shows that increased Lambda (λ) light chain is correlated with decreased $CD4^+$ cell count and vice versa. This shows that while the HIV virus attacks and depletes $CD4^+$ cells, the B-cell, in effort to clear the virus, activates and differentiates excessively. This observation is consistent with a role of prolonged HIV infection and T-cell dysfunction in causing B cell dysfunction in HIV infected individuals [25]. Furthermore, the association between Lambda (λ) light chain values and IgG levels shows a non-independent activity of B cell in HIV infection i.e. increases in Lambda (λ) light chain levels has a relationship with concomitant increases in IgG and vice versa. Ipp et al., 2013 [46] observed this in treatment-naïve HIV infected individuals, however Zemlin *et al*., 2015[32], demonstrated that free light chain concentrations were significantly correlated with markers of HIV disease severity, suggesting ongoing B cell dysfunction despite ART use.

To check for the effect of confounders on the result obtained, within group analysis for possible gender and age related differences in result was conducted. No significant difference was found among gender and age groups.

The unavailability of Kappa free light chain reagent as at the time of this research prevented the assessment of Kappa light chains. This would have given a better picture of the free light chains. Futhermore, including a fourth group: malaria infected patients who are HIV negative; in the research would have buttressed this research results.

CONCLUSION

Lambda free light chains are significantly increased in persons with HIV infection and the levels of IgA and IgM in persons with HIV-malaria co-infection are significantly higher than the levels in HIV seropositive individuals without malaria infection. However, the values of immunological markers such as CD4 cell counts, IgG and Lambda light chains are similar in persons with HIV either having malaria co-infection or not.

Recommendations

1) Measurement of Lambda FLCs may serve as alternative marker of immunocompetence in HIV patients.

2) Longitudinal follow up study can be carried out to assess any changes in IgA and IgM levels after treatment of malaria infection in HIV patients.

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