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Case Report

Studies on Antioxidants and Malondialdehyde in Glaucoma, Cataract, And Hypertensive Retinopathy Subjects in Imo State

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Abstract:

The eye is the essential sense organ for vision function. A saying goes that the eye is the lamp of the body. If the eye is healthy, the whole body will be full of light. This study was aimed at exploring the effect of oxidative stress on eye diseases among adults in Imo State. Five specific objectives, five research questions and four hypotheses guided the study. The study employed descriptive and analytical research designs in the collection of data from 200 subjects including 81(40.5%) males and 119 (59.5%) females ≥45 years. The subjects sampled were 50 with glaucoma, 50 with cataract, 50 with hypertensive retinopathy and 50 in the control group from across three tertiary health facilities in Imo State. Data were analysed using SPSS statistical software version 17.0. Descriptive statistics of mean and standard deviation were used to present results. Data were analysed using analysis of variance (ANOVA), Least Significant Difference (LSD) post hoc and Pearson's correlation. Findings revealed that 52.0% of subjects had normal weight, 25.0% were overweight, while 23.0% were obese. Results showed that there was no significant difference in the anthropometric indicators measured among the different eye disease groups when compared to the controls. P- values of 0.793, 0.621 and 0.990 were obtained for BMI, WC and WHR respectively and these three values were less than the significance ($p<0.05$).Mean values of Vitamin A, Vitamin C, Vitamin E, GPX and SOD were significantly lower ($p = 0.001$) in the Glaucoma group compared to the control subjects. Likewise, when examining Cataract in relation to the Control group, the Vitamin A, Vitamin C, Vitamin E, GPX and SOD were significantly lower ($p < 0.05$) while diastolic blood pressure was significantly higher ($p < 0.05$) in the cataract group compared to the control group. Furthermore, in the Hypertensive Retinopathy group versus the Control group, Vitamin A, Vitamin C, Vitamin E, GPX, SOD were significantly lower and MDA, systolic blood and diastolic blood pressure higher ($p < 0.05$) in the Hypertensive Retinopathy group compared to the control group. Male subjects with HR had lower vitamin C and higher MDA levels compared to the females ($p<0.05$), while male subjects with cataract had lower GPX compared to their female counterparts ($p<0.05$). No significant differences were observed in other indices studied between the males and females ($p>0.05$).Positive correlations were observed between GPX and vitamin E ($r=0.422$, $p=0.002$) in HR. The study concluded that individuals with Glaucoma, Cataract, and Hypertensive Retinopathy had lower levels of antioxidant enzymes and vitamins (Vitamin A, Vitamin C, Vitamin E, GPX and SOD). The hypertension associated with hypertensive retinopathy seemed to exacerbate lipid peroxidation and antioxidant depletion. Arterial hypertension occurred with changes in retinal morphology and increased oxidative stress and inflammation in ocular tissues. Antioxidant supplementation may be vital in ameliorating the development and progression of eye diseases.

Key words: antioxidants; cataract; glaucoma; hypertensive retinopathy; oxidative stress; eye diseases

Introduction

One of the five human senses, sight is what gives us our ability to see. For vision function, the eye is the most important sense organ [1]. Every facet of human existence, health, sustainable development, and the economy are all impacted by eye health and vision [2]. An estimated 285 million people have vision impairment (VI) [3]. Of this group, 246 million people were found to have low vision (LW), and 39 million were found to be blind. Additionally, there were 2.2 billion visually challenged people in the world in 2019 [4]. If the illness spread had been detected early on, perhaps one billion of these 2.2 billion cases could have been fully treated [5]. Retinal illnesses, including glaucoma, macular degeneration, diabetic retinopathy, and hypertensive retinopathy, are the main causes of vision impairments and blindness. Many of the Sustainable Development Goals (SDGs) depend on eye health. In addition to limiting fair access to and success in education and the job, poor eye health and vision impairment have a detrimental impact on quality of life. For impacted people, families, and communities, vision loss has significant financial ramifications [6]. On the other hand, human populations have a vast array of eye diseases and disorders. The eye's continuous exposure to light and a number of components with high metabolic activity make it extremely vulnerable to oxidative stress [7]. A mismatch between the production of reactive oxygen species (ROS) and the cells' antioxidant defence systems leads to oxidative stress. Because of its extensive exposure to ultraviolet (UV) radiation, the anterior region of the eye has a sophisticated antioxidant defence system that shields the retina from UV radiation. High oxygen consumption and metabolic rates in the back of the eye result in a high rate of ROS production. ROS cause ageing and cell damage, which leads to cataracts, corneal degeneration, and other eye illnesses such glaucoma and age-related macular degeneration (AMD) that affect the retina and optic nerve [8]. Additionally, oxidative stress is caused by risk factors including as inflammation, ageing, genetics, and environmental pollution, all of which increase the production of ROS while impairing antioxidant defence mechanisms [9]. Numerous eye conditions have been linked to abnormal redox status [10]. According to the World Health Organisation, eye disorders are a serious and expanding worldwide health concern. In addition to lowering life quality and posing a major threat to global health, it can cause blindness and multi-system morbidities, which raises healthcare expenses [11]. In addition to limiting fair access to and success in education and the job, poor eye health and vision impairment have a detrimental impact on quality of life. For impacted people, families, and communities, vision loss has significant financial ramifications [12]. Many alterations in the body's biochemistry and the resulting socioeconomic issues are associated with glaucoma and other eye conditions. Patients who suffer from it and those who manage it face more financial difficulties. An estimated 4.25 million persons in Nigeria who are 40 years of age or older are expected to be visually impaired [13]. According to reports, Nigeria has a 6.1% prevalence of blindness, which is much greater than the 0.5% global average. Rapid changes in sociocultural, economic, and biological indices provide the backdrop for this, including a population that is getting older, a decline in physical activity, a general lack of knowledge about wellness behaviours and healthy lifestyles, shifting food patterns, and more [14, 15]. It was in light of this that a deeper comprehension of the connection between oxidative stress and ocular disorders was considered. This would facilitate the development of therapeutic solutions to treat the disorders should they develop, as well as a better understanding of how eye diseases progress and effective preventive measures.

Materials And Methods

Research Design

Descriptive and analytical study designs were used in this study (Lucas and Gilles, 2003). Descriptive design was used to investigate the distribution of different eye diseases, while analytical design was used to analyse the determinants of the disease distribution as well malondialdehyde, vitamin C, vitamin E and enzymatic antioxidants that represent the oxidative stress.

Study Area

The study area is Imo State. Imo State is one of the 36 States inNigeria; it is located in the Southeast geopolitical zone. Imo State lies within latitudes 4°45'N and 7°15'N, and longitude 6°50'E and 7°25'E with an area of around 5,100 sq km. It is bordered by Abia State on the East, by the River Niger and Delta State on the west, by Anambra State to the north and Rivers State to the south. Besides Owerri, Imo State's major towns are Isu, Okigwe, Oguta, Orlu, Mbaise, Mbano, Mbaitoli, Mbieri, Orodo, Nkwerre and Orsu.Imo state is a predominantly Igbo speaking state, with Igbo people constituting a majority of 98%

Sample size

A total of 200 subjects were co-opted for the study. The sample size was chosen by the researcher based on the fact that the study was analytical and required a manageable number of subjects for the researcher to cope with.

Ethical consideration

Letters of approval/permission were presented to management of health institutions for approval before approaching the patients. Also, the consent of those living with various eye diseases were sought for before they were enrolled for the study.

Sampling Technique

This study involved patients who visited the Imo State University Teaching Hospital in Orlu, the Umuguma Specialist Hospital in Owerri, and the Federal Medical Centre (FMC) in Owerri. They were divided into categories and under control. Random sampling was used in collecting data from the hospitals. Patients with eye diseases had their levels of Vitamins C and E, antioxidant enzymes, a result of lipid peroxidation, measured using routine procedures. The study subjects were first sampled by the symptoms and nature of eye conditions observed. They were classified into four groups, and by gender (male and female). The four groups comprised 50patients having glaucoma, 50 having cataracts, 50 having hypertensive retinopathy and 50 having normal vision who served as the control group.

Instrument for data collection

Research instruments for data collection were materials such as test stripes, lancets, alcohol pads and Chemical analysers. Others were blood pressure measuring kits, measuring tape and weighing balance were used for physical examination.

Validity/Reliability of Instrument

The instruments were validated as they correlated with other established measures of the same construct .A pilot study was conducted to ascertain the validity of instruments of the study. The reliability of the instruments was ascertained by ensuring that all the instruments were thoroughly cleaned and were in good working condition. Also, by taking three consecutive measures and recording the average measurements, the reliability was verified using the Cronbach alpha test which gave a value of 0.76.

Laboratory Assay

All kits were purchased from Randox Diagnostic LTD, UK Determination of vitamin C, and E were carried out by standard methods while malondialdehyde , Glutathione Peroxidase, Superoxide dismutase (SOD) and catalase (CAT) were done by Elisa method

Statistical Analysis

Generated data were put into Tables and Charts. Descriptive Statistics: mean, relative standard error and standard deviation were used to measure the level of skewness among data that were obtained in relation to various parameters that were considered in this study. Data were also analysed using analysis of variance (ANOVA), LSD post hoc and Pearson's correlation.

Results

Table 4.1 showed the comparison of the mean values of age, body mass index, waist circumference, waist-hip ratio, blood pressure, vitamins A, C, and E, as well as mean serum levels of glutathione peroxidase, superoxide dismutase, catalase, and malondialdehyde among the Control, Glaucoma, Cataract, and Hypertensive Retinopathy subjects, respectively. The mean BMI levels across the four groups studied were 25.30±4.45kg/m2 for the control group, 25.82±4.90kg/m2 for the glaucoma group, 24.84±4.79kg/m2 for the cataract group, and 25.34±4.78kg/m2 for the hypertensive retinopathy group. Significant variations (P < 0.05) were observed between the groups in blood pressure levels, vitamins A, C, and E, as well as serum levels of glutathione peroxidase, superoxide dismutase, and malondialdehyde.

Parameter	Control n = 50	Glaucoma n = 50	Cataract n = 50	HRetinopathy n = 50	F-ratio	p-value
Age (years)	57.70±4.56	56.68±4.42	57.72±4.90	56.66±4.69	0.868	0.458
BMI (kg/m^2)	25.30±4.45	25.82±4.90	24.84±4.79	25.34±4.78	0.344	0.793
WC (cm)	90.19±10.30	89.88±10.58	91.52±9.63	92.52±9.66	0.592	0.621
WHR	0.88±0.04	0.88±0.04	0.89±0.04	0.89±0.04	0.038	0.990
SBP (mmHg)	114.38±15.42	114.80±15.42	110.80±13.53	144.42±21.82	43.953	0.001*
DBP (mmHg)	75.63±6.6	75.20±6.47	80.80±7.52	97.50±11.86	79.591	0.001*
Vitamin A (µmol/l)	5.46±1.15	3.30±0.83	3.28±0.59	3.52±0.61	80.223	0.001*
Vitamin C (µmol/l)	44.35±6.40	30.96±5.54	31.57±7.64	28.60±7.72	51.798	0.001*
Vitamin E (µmol/l)	13.95±3.86	8.99±1.49	8.02±1.59	6.47±1.20	99.772	0.001*
GPX (IU)	16.63±3.13	13.76±1.81	13.71±2.08	14.99±2.74	14.749	0.001*
SOD (IU)	5.04±0.81	3.33±0.83	3.30±0.57	3.51±0.52	70.346	0.001*
Catalase (IU)	36.82±9.38	34.01±9.86	37.18±9.65	34.35±9.51	1.461	0.227
MDA (µmol/l)	20.58±2.73	28.34±2.84	22.93±2.77	24.01±2.94	68.825	<0.001*

Table 4.1: Showing the comparison of age, BMI, WC, WHR, blood pressure, vitamins A, C, and E, GPX, SOD, catalase and malondialdehyde in Glaucoma, Cataract, hypertensive retinopathy and controls.

Values are expressed as mean ± standard deviation where, BMI = body mass index, WC waist circumference, WHR = waist-hip ratio, SBP = systolic blood pressure, DBP = diastolic blood pressure, GPX = glutathione peroxidase, SOD = superoxide dismutase, MDA = malondialdehyde, * = significant at p < 0.05

Discussion

The three main causes of blindness in the globe are hypertensive retinopathy, cataracts, and glaucoma [16, 17]. Although the exact causes of these multifactorial, complex eye diseases are unknown, mechanisms in their pathology have been linked to increased production of reactive oxygen species (ROS), low antioxidant defence capacity, high lipid peroxidation, oxidative stress, inflammation, and oxidative DNA damage [18, 19]. Various retinal and optic nerve degenerative illnesses, including glaucoma and age-related macular degeneration (AMD), as well as corneal degeneration and lens opacification (cataracts) are caused by ROS, which also causes cell damage and ageing [20, 21]. This study evaluated the levels of several antioxidant enzymes and vitamins in connection with the development of hypertensive retinopathy, cataracts, and glaucoma. This investigation demonstrated that, when compared to the control group, there are no appreciable differences in the anthropometric parameters examined across the various eye disease groups (Table 4.1). For BMI, WC, and WHR, respectively, P-values of 0.793, 0.621, and 0.990 were found; all three were below the level of statistical significance (p<0.05). This finding suggested that there is no correlation between adult eye disorders and anthropometric measures. The results of [22], which demonstrated compelling evidence linking obesity to age-related eye conditions such cataract and glaucoma [23], contrast with this conclusion. This could be explained by the fact that this study included normal weight, overweight, and obesity, whereas the other three groups of researchers only worked with obese patients and normal controls [24, 25]. Additionally, Table 4.1 showed that, in comparison to the control group, there are significant variations in blood pressure, antioxidant levels (Vitamins A, C, E; GPX and SOD), and oxidative stress indicators (MDA) (p=0.001 each). When comparing the various eye groups to the controls, there was no discernible variation in the p-value of the antioxidant catalase (p = 0.227). Subjects in the glaucoma, cataract, and hypertensive retinopathy groups showed significant differences (p < 0.05) in blood pressure, vitamins A, C, and E, as well as in serum levels of malondialdehyde, glutathione peroxidase, and superoxide dismutase. Vitamins A, C, E, GPX, and SOD were considerably lower (p < 0.005) in the glaucoma group than in the control group, according to LSD post hoc analysis. In the cataract group, diastolic blood pressure was substantially greater (p < 0.05) than in the control group, and the vitamins A, C, E, GPX, and SOD were significantly decreased (p < 0.05). In addition, MDA, systolic blood pressure, and diastolic blood pressure were considerably higher (p < 0.05) while vitamin A, C, E, GPX, and SOD were significantly lower in the Hypertensive Retinopathy group than in the control group. Vitamin E was significantly reduced (p < 0.05) in the cataract group compared to the glaucoma group, whereas DBP was significantly greater (p < 0.05), according to LSD post hoc analysis. SBP, DBP, and MDA were substantially greater (p < 0.05) in the group with cataract than the group with hypertensive retinopathy, although vitamin

C and vitamin E were lower in the latter group. SBP, DBP, GPX, and MDA were considerably greater ($p < 0.05$) in the Glaucoma versus Hypertensive Retinopathy study, while Vitamin E was significantly lower ($p < 0.05$) in the Hypertensive Retinopathy group than in the Glaucoma group.

Conclusion

Subjects with glaucoma, cataracts, and hypertensive retinopathy had lower antioxidant levels and lower malondialdehyde levels. This suggests that oxidative stress is more common in those who have hypertensive retinopathy, cataracts, and glaucoma.

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