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CORRELATION OF OPTIC NERVE SHEATH DIAMETER WITH HEIGHT, WEIGHT, BODY MASS INDEX AND AGE

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ABSTRACT

Background

The study was conducted to determine the relationship or association between optic nerve sheath diameter and age, weight, sex, height, and Body mass index (BMI) in children of the South West Nigeria extraction.

Methods

A cross-sectional study was carried out among 2-14-year-old children of the selected school in a suburban town in Southwest Nigeria. Approval was obtained from the institutional Human Research Ethics Research Committee, and consent was obtained from parents of the children. Where indicated, assent was obtained from the children. A pediatric ophthalmologist ascertained the normalcy of the eyes with visual acuity, refraction and fundoscopy. Height and weight were measured according to standard protocol and BMI was calculated from weight and height. The scanning was done by a radiologist with 4-12MHz Linear transducer on a gently closed upper eyelid with a B-mode ultrasound machine (Clear Vue 550 Phillips Model). No sedation was involved.

Results

The mean ONSD for the right eye was 0.54±0.07cm (5.4mm), while the left eye was 0.56±0.07cm (5.6mm). The optic nerve sheath diameter was longer in the left eye for all subjects, and this may be due to the fact that females have shorter diameter in the right eyes. ONSD did not correlate with height, weight and BMI

Conclusion

The mean ONSD is affected by sex in the right eye. This may be indicative of a relatively lower intraocular pressure in the right eyes of the girls. Therefore, in the use of the optic nerve sheath diameter as surrogate for intraocular pressure, it is preferable to use the left eye in which there is no sex difference.

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INTRODUCTION

The field of anthropometry encompasses a variety of human body measurements, such as height, weight, body mass index (BMI), circumferences, skin fold thicknesses, lengths and breaths[1]. Anthropometric measurements are used to assess growth, development, and health parameters[2] (They often indicate when a child's health and well-being are at risk and assists health providers in selecting appropriate treatment options for children and adolescents.

Average height is frequently characteristic within a population that share genetic background and environmental factors. Variations within populations such as dwarfism or gigantism are medical conditions caused by specific genes or endocrine abnormalities[3]. Body mass index is a measure of weight adjusted for height, calculated as weight in kilogram divided by the square of height in meters (Kg/m^2).A study has shown that Body mass index correlates with body fat and its future health risks[4]. Anthropomorphic measurement of height, weight and calculated BMI has been associated with ocular parameters which can be used to diagnose diseases and diseases development[1].

In recent years, intracranial pressure is being monitored by non invasive methods like ocular Sonography. Several studies have shown a close association between optic nerve sheath diameter (ONSD) and raised intracranial pressure (ICP) [5–7]. Raised ICP can be detected with an increase in ONSD due to the presence of continuity of meninges and sub arachnoid space around the optic nerve[8,9]. ONSD has also been found useful in the clinical diagnosis of acute optic neuritis and papillitis[10]. Ultrasound measurement of ONSD is readily learned, is reproducible and has been found to be reliable in predicting raised ICP[11]. Use of Ultrasound in measurement of ONSD is relatively safe with no side effect reported in the diagnostic range used. However it is said to have a potential to cause harm through hearty and cantation of soft tissue, and inadvertent damage to Optic Nerve from the application of excessive pressure[12]

It is important to note that the gold standard for the diagnosis of raised ICP is invasive and not readily available in the developing countries including Nigeria due to unavailability of the monitoring devices, lack of expertise and the associated cost of the procedure[13].

Since Optic Nerve sheath diameter (ONSD) is an acceptable index of raised intra ocular pressure, non-invasive mode of diagnosing and monitoring raised intracranial pressure, it is thus important to know the normal values in healthy normal children and its relationship with anthropometric measurements like age, height, weight, and BMI in our community so as to interpret this measurement as a marker for raised ICP[14]. This is with a view to having a baseline parameter that can serve to sensitize ophthalmologists/neurologists for better management of progression of ICP in emergency conditions. We therefore aimed at evaluating normal ONSD in healthy children and compare with anthropometric measurements.

MATERIALS AND METHOD

Four Hundred and Sixty eyes of 230 children aged 2-12 were examined in the study. Approval for the study was obtained from the institutional Health Research Ethical Committee of the hospital. Parental consents were obtained and assent was obtained from children who were above 8-year olds. Children who refuse participation were not penalized. Only children with normal visual acuity, refraction and fundoscopy were recruited. The weight of each child to the nearest 0.1kg by using a weighing scale, height measurement to nearest 0.1cm by measuring height without shoes was recorded. Ocular Sonography was performed by the same radiologist to reduce inter observer error. All the children were scanned supine with a linear 4-12 MHz transducer on closed eyelids. The structures of an eye were visualized to align the optic nerve directly opposite the probe, with the ONSD width perpendicular to the vertical axis of the scanning plane. A single ONSD was measured 3.00mm behind the globe in both eyes[15].

STATISTICAL ANALYSIS

Statistical analysis was performed using the SPSS Version 21 (0) for windows. Categorical variables summarized through the calculation of frequency. Measurable data of the study were

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presented as mean ± standard deviation (SD). Correlation analysis was performed with Pearson's correlation coefficient (r) and regression analysis. All p-values were two sided and were considered statistically significant when the values were less than 0.05

RESULTS

A total of 230 children were involved in the study. These include 116 boys (50.4%) and 114 girls (49.6%) with M:F ratio of 1.01:1. One hundred and seventy five (76.1%) were in the 2-7 year old range, while fifty five (23.9%) were 8-13years old.

The mean age of participants was 5.67±2.11years. The mean age of boys was 5.84±2.19 years, while in girls it was 5.5±2.01 years. There was no significant difference in the mean age of boys and girls

In the right eye, boys had optic nerve sheath diameter of 0.548±0.065cm, while girls had ONSD of 0.527±0.078cm. The difference was significant (F=1.54, p=0.030). In the left eye, boys and girls had ONSD 0.560±0.082mm and 0.555±0.063mm, respectively (F=0.265, p=0.607, respectively). The difference was not significant. See Table 1.

Table 1: Effect of Gender on Age, Height, Weight, BMI, and Optic Nerve Sheath Diameter

Gender	n	Age	height	weight	BMI	Optic Nerve Sheath Diameter		
						Right Eye	Left Eye	p value
Male	116	5.845±2.193	1.145±0.126	20.73±5.20	15.64±1.64	0.548±0.065	0.560±0.082	0.218
Female	114	5.500±2.014	1.136±0.129	20.82±5.79	15.86±1.81	0.527±0.078	0.555±0.063	0.003
Total	230	5.674±2.109	1.141±0.127	20.77±5.49	15.75±1.73	0.538±0.073	0.557±0.073	0.006
p value		0.216	0.618	0.909	0.329	0.030	0.607	

The mean ONSD for the right eye was 0.54±0.07cm (5.4mm), while that of the left 0.56±0.07cm (5.6mm) for all participants, showing a wider diameter on the right than left (t = 2.791, p = 0.006). The mean optic nerve sheath diameters in boys were 0.548±0.065cm and 0.560±0.082cm in the right and left eyes, respectively, while in the girls, they were 0.527±0.078cm and 0.555±0.063cm, respectively. There was significant difference between the right and left optic nerve sheath diameter in the girls, but not in boys (t = 2.982, p = 0.003, and t = 1.235, p = 0.218, respectively). See Table 1

The mean age, height, weight, and BMI in boys were 5.845±2.193 yrs., 1.145±0.126m, 20.73±5.20 kg., and 15.64±1.64, respectively, while those in girls were 5.500±2.014 yrs., 1.136±0.129m, 20.82±5.79 kg., and 15.86±1.81, respectively. There were no significant differences.

Regression analyses show no significant correlation between age, height, weight, and BMI, and optic nerve sheath diameter in both right and left eyes. See Tables 2 and 3

Table 2: Regression between Age, height, weight, BMI and Optic Nerve Sheath Diameter in the Right Eye

Factors	r	F value	P value
Age last birthday	0.004	0.004	0.947
Height	0.026	0.150	0.699
Weight	0.016	0.059	0.808
BMI	0.077	1.375	0.242

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Table 3: Regression between Age, height, weight, BMI and Optic Nerve Sheath Diameter in the Left Eye

Factors	r	F value	P
Age last	0.017	0.063	0.802
Height	0.064	0.264	0.608
Weight	0.025	0.144	0.704
BMI	0.017	0.064	0.800

DISCUSSION

The mean ONSD recorded is of importance for the possible monitoring of raised intracranial pressure. The mean age of the children in the study is 5.67±2.10 years, while a majority were 7years and below. This is important because previous study has affirmed that there is rapid eye growth within these years and that growth is fastest within the first two years of life.

The mean ONSD in the study 5.3mm and 5.5mm on the right and left respectively are in agreement, although lower in value when compared with the value of Steinborn et al. of 5.75±0.52mm[16]. The difference may be due to the machine used and other environmental factors including race affecting the growth of the children. However, of note is the fact that the population studied by Steinborn et al. is also smaller (99) composed of adolescents (5.6-18.6, mean 12 years compared to the present study comprising 230 children with mean age of 5.67 years. This compared well with the study by Malayeri et al. with a mean age of 6.8±5.5years of the control[18], but slightly higher than that of the Chinese as well as age of studied population[17].

The study by Maude et al. in 136 subjects of which only 12.5% were aged 16 years and below found optic nerve sheath diameter to be independent of age and gender as was found in this present study (p=0.947, p=0.607respectively)[19]. In the study by Ballantyne et al[21] and Malayeri et al[18] however, there was a significant correlation between age and ONSD especially in the first four years of life.

Amini et al., in their study of 222patients aged 16-90 years also found no significant relationship between age and gender[20]. A look at Table 1 in our study showed that in the right eye, boys had significantly wider ONSD than girls (p=0.030), which was not the case with the left eye, in which there was no difference. Also in comparing the ONSD in the right and left eyes, Table 2 shows that the wider dimension observed was due to the significant difference observed in the girls, which was absent in boys. The mean ONSD in the current study show no significant correlation with height and weight, in agreement with the deduction of Fahmy et al[1] in his study of Saudi females, that weight was unrelated to all ocular parameters.

Body Mass Index in this current study had no significant correlation with ONSD, which is in agreement with the finding of Annas[22] in his study of the adult population of northern Nigeria. This was not surprising because nerves generally are not known to grow thicker or longer because of biophysical parameters.

It can thus be safely concluded that ONSD is independent of age, height, weight and BMI. This may probably be why its measurement is dependable in assessing neurological disorders of the brain in both acute and critical states including assessment of Intra Ocular Pressure (IOP) of cardiac arrest. Our study, however, found gender difference in the right eye, which may indicate that the left eye may be more useful in the use of optic nerve sheath diameter for assessing pathologies.

Our study showed that ONSD has no gender difference in the right eye and did not change with Age, height, weight and Body mass index. This is similar to the report of Shirodkar et al. who found that ONSD and Intra Cranial Pressure are independent of age and BMI. That the Right eye showed some gender differences might require corroboration or use of larger sample size.

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