

Normal Sonographic Optic Nerve Sheath Diameter among Children in South Western Nigeria

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ABSTRACT

Introduction: Optic Nerve Sheath Diameter (ONSD) correlates with intracranial pressure and can be utilised for monitoring in emergency situations.

Aim: To determine the reference values of optic nerve sheath diameter in healthy school going children in South western Nigeria by using B-mode sonography.

Materials and Methods: A cross-sectional study was conducted in children from three selected schools after consent and approval from the parents and Institutional Health Research Ethics committee, respectively. B-mode sonography using a 4-12 MHz probe was carried out on children with normal visual acuity and fundoscopy. Demographics of the children and the optic nerve sheath diameter were recorded in a proforma. Data was analysed with SPSS version 21 and were represented

as mean and standard deviation. Paired t-test was used to compare ONSD between the right and left eye. Independent t-test was used to compare ONSD between males and females. Significance was set at p-value <0.05.

Results: Optic nerve sheath diameter was measured in both eyes of 468 children. There were 235 (50.2%) boys and 233 (49.8%) girls (M:F Ratio=1.01: 1) and age range was 2 to 16 years. Mean ONSD in the right eyes was 0.56 ± 0.08 cm while in the left eye it was 0.58 ± 0.09 cm for boys, while in girls in the right eyes it was 0.55 ± 0.08 cm and in left eye it was 0.57 ± 0.07 cm. The mean ONSD of the left eyes was longer than the right eyes. ($p < 0.001$). There was no significant difference in ONSD measurement between males and females ($p = 0.275$).

Conclusion: Mean ONSD in children was longer in the left eye than the right, and increases with age.

Keywords: Emmetropes, Eyes, School children, Ultrasonography

INTRODUCTION

Anatomically, the optic nerve is a continuation of the brain and hence, carries along with it the membranes of the brain as well as the cerebrospinal fluid. It is surrounded by Cerebrospinal Fluid (CSF) and dura mater, which forms the Optic Nerve Sheath (ONS) [1]. This makes it vulnerable to the changes within the brain, surrounding coverings and the fluid [2,3].

Neurological disorders or diseases often result in raised intracranial pressure which impacts on the optic nerve resulting in its swelling and resultant papilloedema. Raised intracranial pressure is usually diagnosed with invasive methods like Computerised Tomography (CT), Magnetic Resonance Imaging (MRI) or Lumbar puncture. CT and MRI are quite expensive for the majority of the populace in a developing economy like ours, apart from their unavailability in most hospitals except tertiary care centres which are mostly located in cities. Plain film findings involving erosion of the clinoid processes and thumb printing appearances on the skull are part of the radiological ways of assessing raised intracranial pressure in most health care facilities in the country, which is grossly inadequate especially in emergency situations. However, optic nerve sheath dilatation has been shown to be a much earlier manifestation of increased intracranial pressure [4]. Several studies [1-13] have shown a correlation between ONSD measurement and raised intracranial pressure. A mean ONSD of >5.2 mm is considered abnormal in some of the cases and thus increased intracranial pressure should be suspected [3,8]. This knowledge can be useful in intracranial hypertension which is a common life threatening syndrome caused by a variety of neurological and non-neurological diseases [5]. The rapid diagnosis of intracranial hypertension is usually needed for therapeutic reasons which in various clinical settings can rarely be achieved without invasive procedures [1-3].

However, Zaidi SJH et al., has suggested that there is need for establishment of a normal range that is not age or size dependent,

if the ONSD must be used as a screening measure [14]. This is because ONSD can easily be done using ultrasonography. B scan ultrasonography was used in the ONSD assessment of 1998 study by Beatty S et al., and was found to be accurate [15]. This accuracy has been verified by other researchers like Ballantyne SA et al., and Lochner P et al., [16,17]. The distension of Optic Nerve Sheath is maximal 3 mm behind the eye. This became the landmark used in the measurement of the ONSD globally [18].

Ultrasound is readily available, affordable, portable, non-invasive, and comfortable and does not usually require sedation in children. It is also said that ultrasound provides a quick, accurate well-tolerated, non-invasive tool for evaluating potentially vision threatening conditions at the bedside [12]. This study therefore aims at producing baseline data of normal range value of ONSD for children in the country (Nigeria) and contributing to the body of knowledge worldwide.

MATERIALS AND METHODS

The cross-sectional observational study was done in a South Western Nigerian tertiary hospital, from August 2016-March 2017. Children from three schools within the Local Government Area of the Hospital, including both public and private institutions were recruited for the study after a certificate was obtained from the Institutions Health Research Ethics Committee. The Local Government Education board was informed and the Head teachers of the schools involved were duly informed and educated about the study. Informed consents were duly obtained from the parents of all participants. No child was coerced into the study. All the children had the normality of their eyes ascertained by the Ophthalmologist in the study who checked their visual acuity, did ocular examination, fundoscopy and refraction for them. A total of 495 children were screened for the study, however, 468 children were scanned (involving 936 eyes), aged 2 years to 16 years. Twenty-five children

who had refractive errors after examination by the Ophthalmologist were excluded. Two children were dropped off the study because of lack of cooperation.

The radiologist performed the sonography from the most upper part of the upper eyelid and the patient was asked to gently close the eyes. A linear probe with 4-12 MHz power was used on a Philips 550 clear Vue model, manufactured in 2013. Ultrasound scans were performed through the closed eye lid from the temporal side each time performing an axial cut through the eyes and including a longitudinal section of the optic nerve. The optic disc, and as long a section of optic nerve as possible, was included in the freeze-frame. The option to toggle through the last 10 seconds of images was often used to obtain the best image. Measurements were made with electronic calipers 3 mm behind the posterior sclera surface of the globe. Single Radiologist took all the dimensions to avoid inter observer error. Both eyes were measured despite the fact that previous studies have shown the presence of intraocular symmetry between the OND/ONSD of fellow eyes [16,19,20].

A protocol sheet approved for the study was filled on behalf of each child including the age, last birthday, gender, sonographic dimensions of the optic nerves and any other interesting findings seen within the eyes during the scan.

STATISTICAL ANALYSIS

Analysis of data was done with SPSS version 21.0 for windows software. (SPSS, Inc. Chicago, Illinois). Continuous variables were expressed as mean±standard deviation (SD) with student t-test analysis for comparison. Categorical variables were expressed as percentages and comparison was done by chi-square analysis. The p-value <0.05 was considered significant.

RESULTS

A total number of 468 children involving 936 eyes were studied. The youngest been 2 years while the oldest was 16-year-old. The mean age of the participants was 8.81 ± 3.82 years.

[Table/Fig-1] shows the mean ONSD for both the eyes in boys and girls. There was no statistically significant difference in the mean ONSD between the two genders. ANOVA; $F=1.194$; $p=0.275$ for right eyes and $F=0.654$; $p=0.419$ for the left eyes.

Gender	n	Mean optic nerve sheath diameter±SD (in cm)	
		Right eye	Left eye
Male	235	0.5575 ± 0.07538	0.5756 ± 0.08547
Female	233	0.5529 ± 0.07791	0.5738 ± 0.07021
Total	468	0.5552 ± 0.07660	0.5747 ± 0.07817

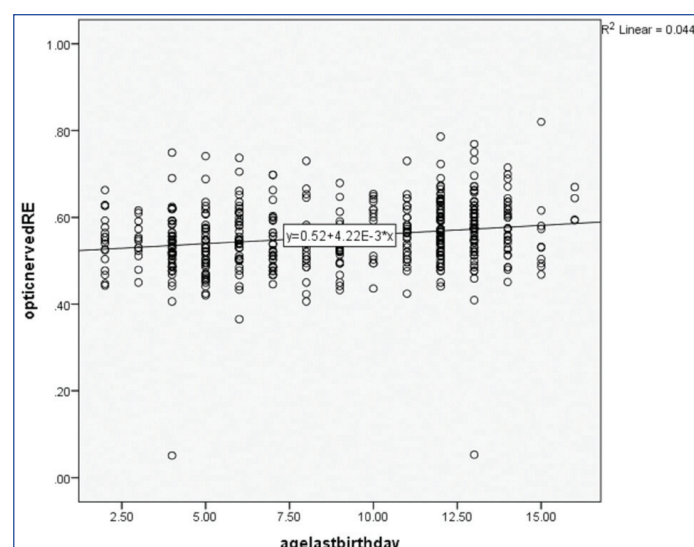
[Table/Fig-1]: Optic nerve sheath diameter and gender.

The mean ONSD of the right eyes in the total population studied was 0.56 ± 0.08 cm and 0.57 ± 0.08 cm on the left eyes. The difference was statistically significant ($p < 0.001$).

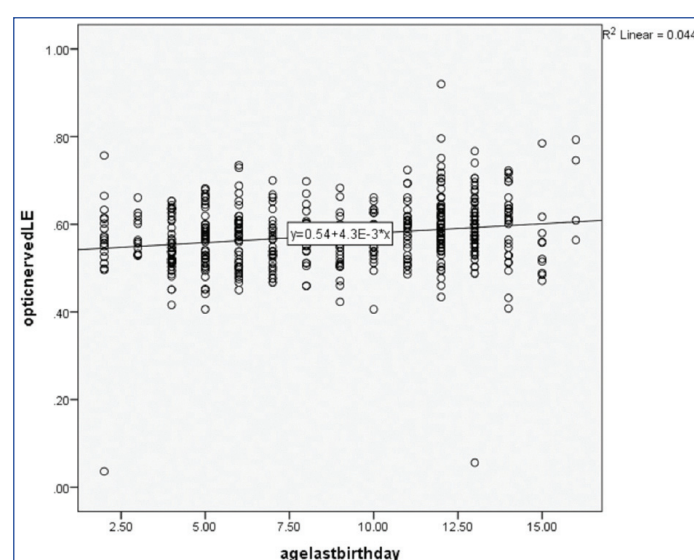
[Table/Fig-2] shows the mean ONSD in different age groups for the right eyes. The ANOVA right eyes; F value=5.4, $p < 0.001$, and eta value=0.212. The mean ONSD in the left eyes shows ANOVA; $F=5.46$, $p < 0.0001$ and the eta value=0.212. Optic nerve diameter increases with age [Table/Fig-3,4].

Age group (years)	n	Optic nerve sheath diameter±SD (cm)	
		Right eye	Left eye
2-4	78	0.5373 ± 0.08185	0.5546 ± 0.08292
5-7	123	0.5409 ± 0.06846	0.5614 ± 0.06633
8-10	66	0.5474 ± 0.06811	0.5620 ± 0.06211
11-13	157	0.5716 ± 0.07935	0.5937 ± 0.08162
14-16	44	0.5800 ± 0.07554	0.5983 ± 0.09055
Total	498	0.5552 ± 0.07660	0.5747 ± 0.07817

[Table/Fig-2]: Optic nerve sheath diameter in different age groups.



[Table/Fig-3]: Scatter plot of right eye optic nerve sheath diameter versus age-last-birthday.



[Table/Fig-4]: Scatter plot of left eye optic nerve diameter versus age-last-birthday.

When comparing the means of the right eyes with that of the left eyes, the t-value is 3.93 while the p-value=0.0001 which means the left eye mean ONSD was significantly more than the right eye mean diameter.

DISCUSSION

Generally, there was a dearth of literature concerning the normal measurement of optic nerve diameter in the black children except of cause, where they are been compared with the caucasian population or the children born by adults of African descent in the Americas or other countries of the world. In Nigeria, where this study was being done, the adults were more in focus than the children and only one study was done in the northern part [20] of the country. This study found that the mean optic nerve diameter of the right eyes was $0.55 \text{ cm} \pm 0.08 \text{ cm}$ in girls and $0.56 \text{ cm} \pm 0.08 \text{ cm}$ in boys compared well with the value that Steinborn M et al., got in their study i.e., $5.86 \pm 0.71 \text{ mm}$, $5.75 \pm 0.52 \text{ mm}$, and $5.77 \pm 0.48 \text{ mm}$ [21-23]. There was a similarity too in the age group considered in that study as in the present study. This is relatively higher than the value that Ballantyne SA et al., quoted in their study as 2.1-4.3 mm with a mean of 3.08 mm in British children [16], Malayeri AA et al., in Iranian children 2.0-4.3 mm (mean of 3.3 mm) [24] and Beare NAV et al., in Malawian children of 2.5-4.1 mm (mean of 3.5 mm) most probably due to equipment especially the model in use [13]. Zaidi SJH et al., has documented that the intrinsic value of using the ultrasound as a means of measuring optic nerve sheath diameter can be affected by model of machine, portion of the

globe where the probe is placed as well as the experience of the operator [14]. The other reason may be the dissimilarity in the ages studied which in their study involved infants, while the influence of race, environment, and nutritional status of participants may also be responsible.

The Steinborn M study [21-23], also agreed with our finding of no significant difference between the values for boys and girls ($p=0.517$ right eyes, 0.805 left eyes). The current study showed an absence of statistically significant values in the sexes as documented in both children and adult population of studies available to the authors by Beatty S et al., and Anas I, Maude RR et al., [15,20,25]. However, Ballantyne SA et al., did not find a statistically significant difference in values between the left and the right eyes, and this may not be unrelated with the possibility of the dominant use of the left hemisphere of the brain among these children [16]. Maude RR et al., also concluded that there was no relationship between ONSD and age (>4 years), gender, head circumference and no difference in left versus right eye or horizontal beam [25].

The ONSD measured in both eyes in this study showed a linearity of diameter with age, although no statistical difference was observed in the different age groups. This is in agreement with Newman WD et al., (2002) who also found that the mean ONSD increases with age [26].

LIMITATION

The study is from one local government area of Nigeria and majority of them are from one ethnic group of the country; the study does not include ammetropes.

CONCLUSION

The optic nerve sheath diameter can be done in the Nigerian children; it has a value of 5.6 mm in the normal children. It increases gradually with age. It is slightly higher in the left eyes when compared with the right. No significant sex difference.

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FINANCIAL OR OTHER COMPETING INTERESTS: None.

Date of Submission: **Sep 04, 2018**

Date of Peer Review: **Oct 29, 2018**

Date of Acceptance: **Nov 21, 2018**

Date of Publishing: **Jan 01, 2019**