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ESTABLISHING THE OPTIC NERVE SHEET DIAMETER (ONSD) CUT–OFF FOR DIAGNOSIS OF RAISED INTRACRANIAL PRESSURE (RICP) AT LAFIA, NORTH-CENTRAL NIGERIA USING OCULAR ULTRASONOGRAPHY

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ABSTRACT

Objective: Certain clinical conditions are associated with Raised intracranial pressure (RICP). Early diagnosis and timely intervention is crucial to prevent secondary brain damage and death. Optic nerve sheath diameter (ONSD) measurement by ultrasound is increasingly used to detect RICP. Knowledge of normal ONSD in a healthy population is essential to interpret this measurement. **Aim:** To evaluate normal optic nerve sheath diameter in Lafia, north central Nigeria. **Methodology:** 156 healthy volunteers 15 years and above were used in this study. The ONSD was measured at 3 mm posterior to the globe using a 7.5 MHz linear transducer placed on the superior and lateral aspect of the orbit against the upper eyelid with the eye closed. **Result:** The study consist of 75 males and 81 females with mean age of 34.6 ± 1.5 years. The median and mean ONSD for both eyes were 4.50mm and 4.48 ± 0.05mm respectively with a range 3.20-6.00mm. On the right, the median and mean ONSD values were 4.50mm and 4.48 ±0.52 respectively with a range of 3.20–6.00 mm, while the median and the mean left ONSD were 4.50 mm and 4.47 ± 0.49mm respectively with a range of 3.50–6.00 mm. No statistically significant variation in ONSD was found between the right and left sides (P = 0.85) and also between male and female participants (P = 0.10 and 0.13 right and left respectively). **Conclusion:** ONSD mean value of 4.48mm has been obtained here in Lafia, north central Nigeria with no significant correlation with age and sex, height, weight and BMI. Values above 6mm with clinical suspicion could therefore be adopted for diagnosis and management as cases of RICP.

KEYWORDS: ONSD, RICP, Nigeria, Ocular Ultrasonography.

INTRODUCTION

Raised intracranial pressure (RICP) is a complication not just of traumatic brain injury but also of a number of general medical conditions including stroke, hepatic encephalopathy, epilepsy, meningitis among others.[1] Clinical signs of RICP are often unreliable or too late to manifest and may lead to unacceptable delay in therapeutic intervention leading to Catastrophic deterioration of brain function and death.[2,3] In sedated patients, clinical signs frequently appear well after the internal damage has been done.[1]

The optic nerve sheath is an anatomical extension of the duramater and the subarachnoid space around the optic nerve is continuous with the intracranial subarachnoid space. Any pressure rise within the intracranial compartment results in dilatation of the optic nerve sheath, impacts on the optic nerve head as swelling of the optic disc and papilledema which evolve over time; however dilatation of the optic nerve sheath has been shown to be a much earlier manifestation of slight increase in intra cranial pressure (ICP).[4,5]

Various methods have been employed for investigating RICP. The invasive approach which is the gold standard include ventriculostomy and microtransducers. They are however not easily available and are typically restricted to neurosurgical centres.[1] The use of cross sectional imaging like Computed tomography (CT) and Magnetic resonance imaging (MRI) however entails transfer of a critically ill patient out of the Intensive Care Unit (ICU); besides they are not impracticable tools for repeat examinations at frequent intervals as may be necessary in patients with raised ICP.[6] Papilledema which the Ophthalmologist use in assessment of ICP evolves over time and may be a delayed manifestation unlike dilatation of the optic nerve sheath which has been shown to be a much earlier manifestation of RICP; besides, it requires a skilled observer for its precise identification.[7,8]

Ultrasound for measurement of the optic nerve sheath diameter (ONSD) is a simple and non-radiating imaging modality that is readily available in most critical care areas, and by examination of optic nerve by bed side it allows detection of changes in diameter which may include intracranial hypertension.[9] It also allows repeated non-invasive and non-radiating assessments of intracranial pressure and facilitates evaluation of the response to treatment.[10,11]

Various articles have been published on measurement of ONSD in the western world and pockets of such among the healthy population in our environment and to the best of our knowledge, data on this has not existed in the north-central region. This therefore prompted us to undertake this study which aimed at determining the normal ONSD through orbital sonography and to correlate the ONSD with sex, age, height, weight and BMI. We believe the study will add to the body of knowledge that supports the use of ONSD as a bedside tool to diagnose intracranial hypertension in general ICU setting.[5]

MATERIALS AND METHOD

Ethical considerations

The study was approved by the ethics and research committee of Dalhatu Araf Specialist Hospital, also informed written consents were obtained from the participants; They were adequately informed about the study and were at liberty to opt out if they so wish.

Measurements were taken from a population of apparently healthy volunteers without any visual symptoms or symptoms related to the CNS and who were above 16 years of age. The volunteers were all Nigerians residing within the region of study. Individuals with known Ophthalmic diseases, Diabetic and Hypertensive patients, head or Ocular trauma, patients with intracranial lesions, suspected or confirmed cases of raised intracranial pressure by the ophthalmologist were excluded. Also excluded were those with unilateral or bilateral enuclation, individuals with incidental ophthalmic findings in the course of the study and non-Nigerians.

Technique

Age and sex of each participant were recorded. Proper clinical history with examination were done. The height in meters (m) and weight in kilograms (Kg) were taken using a bathroom scare and standiometer respectively.

Participants were asked to lie supine on the Ultrasound examination couch with their eyes closed but maintaining a straight forward gaze. Copious coupling gel was then applied on one eye. A 7.5MHz linear transducer of mindray DC-3 was placed lightly over the gel in a transverse scans with the probe marker oriented laterally. With small subtle movement, scan from temporal to nasal side gently angulating the probe superiorly or inferiorly to bring the optic nerve to view. To avoid underestimation of the ONSD, ensure that either or both the lens and the Iris is seen in the image in order to bring it in axis. The optic nerve appears as a black stripe running posteriorly from the real of the globe and the optic nerve sheet has a high reflectivity around the homogenously dark optic nerve. Attention was paid to avoid compressing the eye with the transducer.

In order to minimize active scanning time, once the optimal image was obtained, image was frozen and the probe removed from the eye. The caliper function of Ultrasound was used for precise measurement. At a point 3mm located posterior to the optic disk along the optic nerve, the calipers were placed at 90^0 to the axis of the optic nerve in order to measure the Optic Nerve Sheet Diameter which is a distance from one side to the other. Average of 2-3 measurements were taken. The same procedure was repeated for the other eye.

RESULTS

A total of 156 subjects were recruited for this study; 75 (48.1%) males and 81 (51.9%) females (Table 1). The mean age (Table 2), height and weight of the subjects were 34.0 ± 1.46 years, $1.63.2 \pm 0.075$m and 60.4 ± 1.1 kg respectively.

Table 1: Sex and Frequency.

Sex	Frequency	%
Male	75	48.1
Female	81	51.9
Total	156	100

Table 2: Age frequency distribution.

Age	Frequency	%
<20	23	14.7
20-29	44	28.2
30-39	45	28.8
40-49	17	10.9
50-59	10	6.4
60-69	16	10.3
70+	1	0.6
Total	156	100

The median value of ONSD in this study was 4.50mm with mean value of 4.48 ± 0.05 ranging from 3.20-6.00mm.

The median and mean of the right ONSD was 4.50mm and 4.48 ± 0.52 mm respectively with a range of 3.20-6.0 mm, while the median left ONSD was 4.50 mm with mean value of 4.47 ± 0.49 mm ranging from 3.5 mm to 6.0 mm. No statistically significant difference was observed between the right and left ONSD values (P = 0.85) (Table 3).

Table 3: Measured ONSD values for combined, right and Left eyes.

	Combined	Right eye	Left eye	p-value
Mean ± SD	4.48 ± 0.05	4.48 ± 0.52	4.47 ± 0.49	0.85
median	4.50	4.50	4.50	-
Range	3.20 - 6.00	3.20 - 6.00	3.50 - 6.00	-

Among male participants, the mean right ONSD was 4.65 ± 0.53 mm, while that of the left was 4.66 ±0.51 mm. For female, the mean right ONSD was measured 4.32 ± 0.46 mm while the left side measured 4.30 ± 0.41. There was no statistically significant variation in ONSD between males and females (P = 0.10 and 0.13 for the right and left ONSD respectively) (Table 4).

Table 4: Sex and mean OSND for right and left eyes.

Side	Male	Female	P value
Right	4.65 ± 0.53	4.32 ± 0.46	0.10
Left	4.66 ± 0.51	4.30 ± 0.41	0.13

The mean values of ONSD for the various age groups in shown in Table 5. The higher values were observed in the age groups > 50 years whereas the lowest was at age group <20 years. However, no statistically significant correlation was found between ONSD and age group. (P=0.18 and 0.14 for right and left eye respectively).

Table 5: Showing mean ONSD of both eyes in the various age groups.

Age (years)	Mean ONSD ± SD(mm) (Right)	Mean ONSD ± SD(mm) (Left)
<20	4.18 ± 0.24	4.27 ± 0.40
20-29	4.40 ± 0.44	4.45 ± 0.48
30-39	4.51 ± 0.51	4.43 ± 0.57
40-49	4.43 ± 0.35	4.42 ± 0.29
50-59	5.00 ± 0.61	5.06 ± 0.50
60-69	4.65 ± 0.54	4.62 ± 0.60
70+	5.60 ± 0.00	5.40 ± 0.00
P-value	**0.81**	**0.14**

Table 6 showed relationship between ONSD of both eyes and 3 variables: height, weight and body mass index (BMI). We obtained a negative Pearson's correlation co-efficient (r) between the measured ONSD and the variables signifying no statistically significant relationship.

Table 6: Correlation between measured ONSD (of both eyes i.e. n=156) and weight, height and BMI.

Variable	Pearsons correlation	Sig.(2-tailed)
Weight	-0.38	0.63
Height	-0.55	0.49
Body Mass Index (BMI)	-0.17	0.83

NB: Correlation is significant at the 0.01 level (2-tailed).

DISCUSSION

Over the last few years, ONSD been used successfully to monitor and predict ICP.[12] The cutoff point of ONSD has however been a topic of considerable dispute.[13,14,15] While less than 5 millimeters has been accepted as a cutoff for a normal optic nerve sheath diameter (ONSD), no study has actually confirmed this in a healthy population.[16]

Results of this study showed that the cutoff for the upper limit of normal ONSD in our environment was 4.48 mm and the range varied from 3.2 mm-6.0 mm. There was no correlation of ONSD with age, gender, height, weight and body mass index and it was similar in both eyes. In a similar study by Garcia et al.[17] on 32 volunteers, their cutoff value of ONSD was 4.8mm ranging between 3.9–5.9 mm. their slightly higher cutoff value though within the accepted normal range could be due to smaller sample size used. In another study with a large sample size, conducted by Anas et al.[18] in the far north of the country from this study however, the range of ONSD obtained (4.01 mm - 4.38 mm) was not as wide as the range obtained here in our study (3.20-6.00mm) this could partly be due to the differences in study design, nevertheless, the measured ONSD in the present study is still less than 5 mm, a critical value that is usually considered abnormal, especially if bilateral, it may suggest raised ICP.[19]

Chan et al.[20] in China with one hundred volunteers established the normal mean ONSD values on the right and left eyes as 4.04 mm and 4.05 mm respectively. The values in their study are little lower than the numbers we obtained corresponding to 4.48 mm and 4.47mm respectively. However, in agreement with their findings, we also found no statistically significant difference in ONSD between males and females as well as between right and left eyes.

Similar but few studies showed value of ONSD higher than 5mm, the value considered abnormal. Bauerle et al with German population[21] found mean ONSD of 5.4 mm with a range of 4.3 mm - 7.6mm. After a year, he conducted another study with the same population using MRI which has better resolution power to determine the normal range of ONSD and reported values of ONSD 5.69 ± 0.77.[22] Similarly in Britain, Geeraerts et al also used MRI for ONSD measurement and found that ONSD was 5.08 ± 0.52 mm in healthy volunteers.[23] This implies the Europeans probably have a thicker Optic nerve than the other studied populations.

CONCLUSION

There is regional variation with the values of ONSD. Mean value of 4.48mm has been obtained here in Lafia, north central Nigeria with no significant correlation with age and sex, height, weight and BMI. The values above 6 mm could be considered abnormal especially if bilateral with clinical suspicion and therefore should be adopted here in our study area for diagnosis and management of patients with suspected cases of raised intracranial pressure. In future larger studies are recommended to reflect the whole population of Nigerians.

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