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Original Research Article

Measurement of normal optic nerve for Sudanese pediatric using magnetic resonance imaging

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ABSTRACT

Background: Much congenital and intracranial pathology may affect optic nerve (ON) and caused increased or decreased in size, so the measurement is crucial and aiding in diagnosed of some neurogenic and endocrine disorders. The aim of this study was to measure the normal ON length and diameter by magnetic resonance imaging among pediatric at Khartoum state Sudan.
Methods: This was descriptive, cross section study, done in 100 Sudanese pediatrics with age from 1 month to 15 years came to Magnetic resonance imaging (MRI) department for MRI brain at three hospitals in Khartoum state (Al-Amal national hospital, Al-Zaitona hospital and Modern Medical Center) during the period from December 2019 to March 2020, all of patients had no pathological or medical condition that may affect the orbits and optic nerve (OON), any child with and medical condition or pathology related to orbits excluded from study sampling. The data were collected by data collection sheet designed especially for this study then analyzed.
Results: The study found that the mean diameter of ON was 2.06±0.44 mm, the mean length of right ON was 31.54±4.11 mm, there is no significant different in measurement between males and females ($p>0.05$), there was strong significant correlation between ON length and diameter with children age ($r=0.592^{**}$, 0.654^{**}, $p<0.001$ respectively).
Conclusions: The study concluded that there was strong correlation between right and left ON diameter and length with age.

Keywords: Magnetic resonance imaging, ON, OON

INTRODUCTION

Various pathologies affecting the ONs, isolated or associated with other intracranial abnormalities, measuring the optic pathway is important and aid in the diagnosis of many pathologies, congenital malformations, and acquired diseases are affect the ON and associated structures, increased in ON diameter is seen in increased idiopathic intracranial hypertension, small optic pathways can be indicative of several disorders, with the most severe of them being septo-optic dysplasia and ON hypoplasia, a large optic pathway may be indicative of glioma, meningioma, lymphoma, or hemorrhage.[1,2] MRI an outstanding depiction of the complicated anatomy of the ON because of its determinizations of tissue contrast without using ionizing radiation, it was a higher delineation of the whole visible pathway and correct assessment of related intracranial pathologies.[3]

Many studies found that there was an importance of measuring the ONs to make a standard scale for evaluation of ON abnormalities.[2,3,5] There is no Sudanese comprehensive anthropometric study on normal measurement of normal ON and therefore undertake this study to measure the normal ON in Sudanese paediatric population.

METHODS

This was descriptive, cross section study carried out at Khartoum state in (Al-Amal national hospital, Al-Zaitona hospital and modern medical center) departments of MRI during the period from December 2019 to March 2020. The target population for this study was 100 scan of patients with no abnormalities related to eye or ON came to skull of facial MRI, any child suffering from pathology affecting ON and orbits excluded from sampling of the study. The ON were examined on 1.5 tesla system (Philips and Toshiba MRI machine). The study was approved by the research committee of Alzaiem Alazhari faculty of radiological sciences and medical imaging, ethical approval was taken from departments in area of study and verbal consent from relative of the patients was also taken. The patient lies in supine on the examination couch with their head within the channel head coil. The head is adjusted so that interpapillary line is parallel to the couch and the head was straight. The patient was positioned so that the longitudinal alignment light lies in the midline, and the horizontal alignment light passes through the nasion. Straps and foam pads were useful for immobilization, sedation was used for child who have trouble relaxing in an enclosed space (claustrophobia). The length of ON was measured in axial section. Taken from the posterior part of the eyeball to the optic chiasma in the base of skull, the widths of the ON measurements were obtained on axial sections at 3- and 5-mm posterior to the lamina cribrosa (retrobulbar) (Figures 1,2).

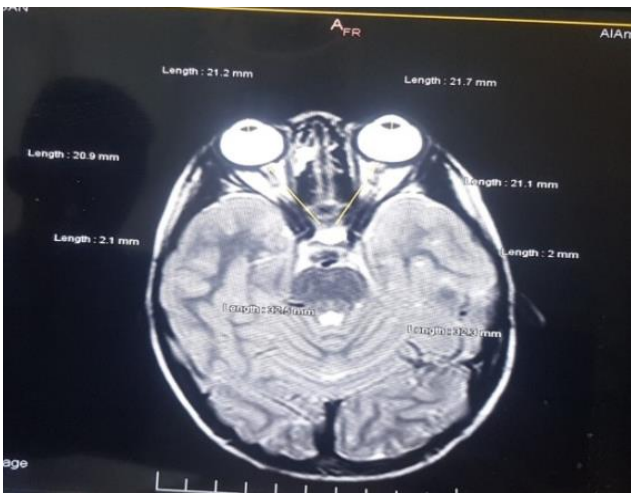

Figure 1: The method of ON and eye globe measurement (7 years female).

Figure 2: The method of ON and eye globe measuring (1-year female).

Data analysis

data was analysed using SPSS version 16, ANOVA test was used to compare the mean of the orbit measurements with different age group then relationship between age and ON length and diameter are obtaining by Pearson's correlation and linear regression analysis (p value<0.05) consider statistically significant, independent sample t test should be done to assess if there was significant difference in measurement of ON in different gender.

RESULTS

The mean age of paediatric in which ON diameter and length are measure is 5.37 years. The study clarified that the mean measurement of ON length and diameter are 31.54±4.11 mm, 2.06±0.44 mm respectively, as shown in (Table 1).

Table 1: Mean measurement of paediatric age and ON measurement.

Variables	Mean±SD
Age (years)	5.37±4.25
Diameter of the right ON (mm)	2.07±0.44
Diameter of the left ON (mm)	2.05±0.44
Length of the right ON (mm)	31.58±4.22
Length of the left ON (mm)	31.50±4.03
Mean length of ON (mm)	31.54±4.11
Mean diameter of ON (mm)	2.06±0.44

The study demonstrated that the mean measurement of the right and left ON diameter increased by increasing age as in 1month to 5 year were 1.9±0.3 mm and 1.9±0.3 mm; 5-10 years: 2.2±0.4 mm and 2.2±0.4 mm; 10-15 years: 2.7±0.3 mm and 2.7±0.3 mm as shown in Table 2 respectively. There was a significant difference in measurements of the both ON diameter between age groups (p<0.01), all measurements increase with age, as shown in (Table 2).

Table 2: Compare mean of the ON measurements in different age groups.

Age group (years)	Length of right ON (mm)	Diameter of right ON (mm)	Length of left ON (mm)	Diameter of left ON (mm)
	Mean±SD	Mean±SD	Mean±SD	Mean±SD
1 (month)-5 (group1)	30.32±3.44	1.89±0.32	30.26±3.27	1.86±0.31
5, 1d-10 (group 2)	32.10±3.80	2.22±0.41	31.95±3.66	2.20±0.41
10, 1d-15 (group 3)	37.26±4.17	2.71±0.30	37.18±3.54	2.68±0.28
Total	31.58±4.22	2.07±0.44	31.49±4.03	2.04±0.43
P value <0.01**				

Table 3 (A): Compare mean measurements in different gender.

ON measurements	Gender	Mean±SD (mm)	Std. Error Mean
Length of the right ON	Male	31.98±3.88	0.5932
	Female	31.27±4.47	0.5928
Diameter of the right ON	Male	2.05±0.45	0.0701
	Female	2.09±0.42	0.0568
Length of the left ON	Male	31.93±3.61	0.551
	Female	31.17±4.32	0.573
Diameter of the left ON	Male	2.02±0.45	0.0694
	Female	2.06±0.42	0.0560
Mean length of ON	Male	31.95±3.74	0.57072
	Female	31.22±4.38	0.58051
Mean diameter of ON	Male	2.04±0.45	0.06950
	Female	2.08±0.42	0.05601

Table 3 (B): T-test for equality of means measurement in different gender.

Variables (mm)	T-test for equality of means						
	t	df	Sig. (2 tailed)	Mean Diff.	Std. Error Diff.	99% CI of difference	
						Lower	Upper
Length of right ON	0.843	95.982	0.401	0.7071	0.8386	-1.4968	2.9110
Length of left ON	0.959	96.939	0.340	0.762	0.795	-1.327	2.852
Diameter of right ON	-0.444	87.137	0.658	-0.0401	0.0902	-0.2776	0.1975
Diameter of left ON	-0.421	86.819	0.674	-0.0376	0.0892	-0.2724	0.1972
Mean length of ON	0.903	96.441	0.369	0.73474	0.81407	-1.4044	2.87394
Mean diameter of ON	-0.435	86.811	0.665	-0.0388	0.08927	-0.2739	0.19627

The length of the right and left ON slightly larger in males than the females with no significant difference in length of right ON between male and female (t 95.98=0.84, p>0.05 with 99% confidence interval), the average diameter of right ON for male more than average for female by 0.71 mm, also there was no significant difference in length of left ON between male and female (t 96.93=0.959, p>0.05 with 99% confidence interval), the average length of left ON for male more than average for female by 0.762 mm, also no significant difference in mean diameter of ON between male and female (t 96.44= 0.369, p>0.05 with 99% confidence interval), the average length of ON for male more than average for female by 0.73 mm (Table 3 A and B, Figure 3).

The diameter of the right and left ON slightly larger in females than the males with no significant difference in diameter of right ON between male and female (t 87.13=-0.444, p>0.05 with 99% confidence interval), the average diameter of right ON for male less than average for female by 0.401 mm, also there was no significant difference in diameter of left ON between male and female (t 86.81=-0.4421, p>0.05 with 99% confidence interval), the average diameter of left ON for male less than average for female by 0.0376 mm, also no significant difference in mean diameter of ON between male and female (t 86.81=-0.435, p>0.05 with 99% confidence interval), the average diameter of ON for male less than average for female by 0.038 mm, as shown in (Table 3 A and B, Figure 4).

The study found that there was strong positive significant correlation between right and left ON diameter with age (r=0.651, p<0.01). Strong positive significant correlation between right and left ON length with age (r=0.584, 0.595, p<0.01). The mean ON diameter and length also had strong significant correlation with age (r= 0.654**,

p<0.01 and 0.592**, p<0.01 respectively, as shown in (Table 4).

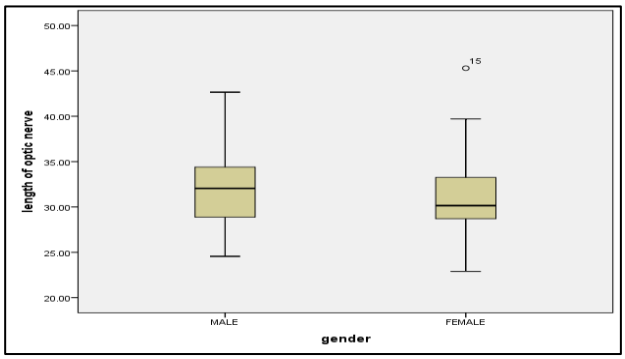

Figure 3: Plot box of mean ON length in different gender.

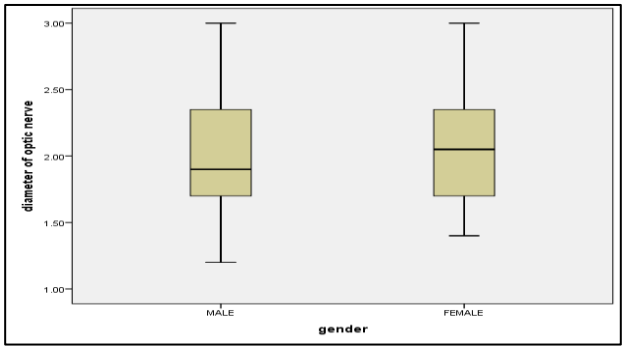

Figure 4: Plot box of mean ON diameter in different gender.

Table 4: Correlation between measurement of both length and diameter for ON with children age.

Variables (mm)		Age (years)
Length of right ON	Pearson Correlation	0.584**
	Sig. (2-tailed)	0.000
diameter of right ON	Pearson Correlation	0.651**
	Sig. (2-tailed)	0.000
Length of left ON	Pearson Correlation	0.595**
	Sig. (2-tailed)	0.000
Diameter of left ON	Pearson Correlation	0.651**
	Sig. (2-tailed)	0.000
Mean length of ON	Pearson Correlation	0.592**
	Sig. (2-tailed)	0.000
Mean diameter of ON	Pearson Correlation	0.654**
	Sig. (2-tailed)	0.000

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

Moderate linear relationship found between age and ON diameter, and length of ON respectively, Regression analysis was made to predict the ON diameter and length in paediatric by knowing age as shows in (Figure 5 and 6).

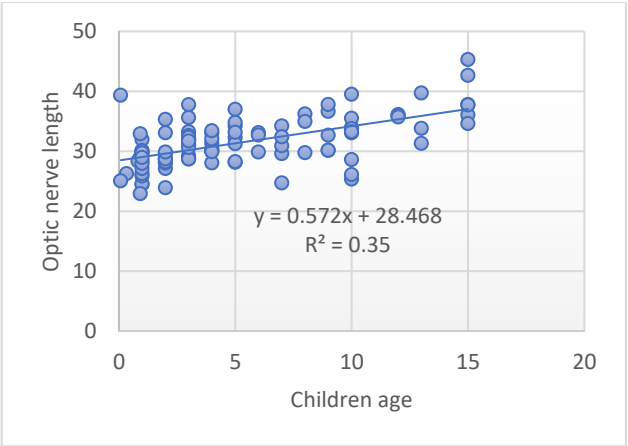

Figure 5: Scatter plot of moderates linear relationship between age and ON length.

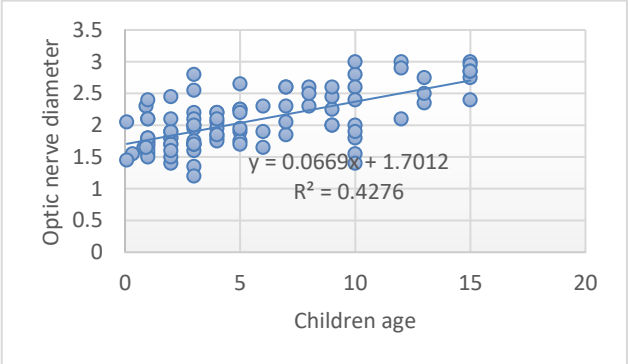

Figure 6: Scatter plot of moderate linear relationship between age and ON diameter.

DISCUSSION

In this study the mean measurement of ON length and diameter in Sudanese children are 31.54±4.11 mm, 2.06±0.44 mm, respectively, while Janthanimi et al in 77 children below 4 years found that the mean diameter of ON was 2.5 mm.[5]

The study demonstrated that the mean measurement of ON diameter and length increased by increasing age, there was a significant difference in measurements of the both ON diameter between age groups, the mean ranged from 1.89±0.32 mm in 1 month 5 years to 2.71±0.30 mm in 10-15 years, this agreement with study of Al-Haddad et al found that the ON diameter increased by age specifically in first two years of life.[3] Also this study agreement the study done by Maresky et al found that a strong positive correlation was established between age and mean diameter of OON and the measurement of OON increase with age.[2]

The diameter of ON slightly more in females than the males with no significant difference, this result agreement with study done by Al-Haddad et al whom found that optic nerve diameter not differ in both sexes.[3]

The study demonstrated that the mean measurement of the right and left ON diameter increased by increasing age as in 1 month to 5 year were 1.9±0.3 mm and 1.9±0.3 mm; 5-10 years: 2.2±0.4 mm and 2.2±0.4 mm; 10-15 years: 2.7±0.3 mm and 2.7±0.3 mm respectively. There was a significant difference in measurements of the both ON diameter between age groups ($p<0.01$), all measurements increase with age, as shown in table 2 this result also showed no differ right and left ON diameter this result agreement with study done by Al-Haddad et al found-ON diameter measurements did not differ between the right and left eyes.[3]

The study found that there was strong positive significant correlation between right and left ONs diameter with age ($r=0.651$, $p<0.01$). This, result online with study done by Hillel et al found that a strong positive correlation found between age and mean diameter of OON ($r=0.73$, $p<0.001$).[2]

Also, this study found that strong positive significant correlation between right and left ON length with age ($r=0.584$, 0.595, $p<0.01$). The mean ON diameter and length also had strong significant correlation with age ($r=0.654$**, $p<0.01$ and 0.592**, $p<0.01$ respectively).

These indicate that the knowing of normal values of ON diameter in paediatric help in diagnosis and management of many neurologic disorders.

The study found moderate linear relationship between age and ON diameter, and length of ONs, respectively.

CONCLUSION

The study was concluded that there was strong significant positive correlation between ON diameter and length with age of paediatric, the measurements of ON increased gradually by increasing age of children. No significant difference in length and diameter of optic nerve with gender, but in general the length of right and left ON it slightly larger in male than the female but the diameter of right and left ON slightly larger in female than male. The measurement was a reliable reference to diagnose ON abnormalities in children.

Recommendations

The study recommended that MRI measurement of ON used as tool for diagnosing the ON pathology in paediatric.

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Conflict of interest: None declared
Ethical approval: The study was approved by the Institutional Ethics Committee

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