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Reference Values of Ocular Dimensions in Emmetropic Children in South West Nigeria

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Abstract
Background: *Ocular dimensions are important in determining the refractive status of the eye.*
Aim: *To determine the reference values for ocular axial dimensions including anterior chamber depth (ACD), lens thickness (LT), and vitreous chamber depth (VCD) inemmetropic Nigerian Children.*
Methodology: *A cross-sectional study of Four hundred and ninety five (468) children from selected pre nursery, nursery and primary schools with normal visual acuity were recruited into the study. Lens thickness, anterior chamber depth, and vitreous chamber depth were measured using a B-mode CLEA Vue 550 PHILLIP ultrasound Machine 2013 model, with a 4-12 MHz Linear transducer.*
Data were entered into personal computer and analyzed using the SPSS statistical package version 21.
Results: *The 468 children consisted of two hundred and forty one boys (48.7%) and two hundred and fifty four girls (51.3%) with a ratio of 1: 1.02. Mean age for the study participants as a whole, 8.81±3.81years. The mean ACD, LT, and VCD were 03.61±0.43cm, 03.71±0.39cm, and 17.41±01.15cm in the RE and 03.68±0.42cm, 03.77±0.38cm, and 17.42±0.10 in the LE, respectively. The reference values for ACD, LT and VCD were 3.52 – 3.69mm, 3.62 – 3.85 mm, and 17.17 – 17.65mm, respectively. There was correlation between the right and left eyes in all the dimensions. Only lens thickness shows sex differences in both right and left eyes.*
Conclusion: *The reference ranges obtained in this study should be taken into consideration in determining ocular refractive status in children in our environment.*
Keywords: *Ocular Dimensions, Emetropic Children, Nigeria.*

Introduction

Ocular dimensions include axial ocular length, anterior chamber depth, lens thickness and vitreous chamber depth. Axial ocular dimensions are important indicators of refractive error. Advancement in ophthalmic practice has increased the need for ocular parameters e.g AL is necessary for IOL power calculation during cataract surgery and keratorefractive surgery. These dimensions can be measured by using B-mode ultrasound devise[1]. Axial length and vitreous chamber depth had been reported to be

the strongest determinants of refractive status of the eye[2].

The anterior chamber depth (ACD) is one of the important pre-operative parameters in anterior segment surgery because of its usefulness in IOL power calculations[3]. It has been discovered that 42% of refractive error after IOL implantation is due to inaccuracy in the ACD measurements[4]. A shallow ACD during cataract surgery also increases risk of corneal endothelial injury. It is also important because its variations have been implicated in different subtypes of glaucoma in adults[3]. While a shallow ACD has been associated with angle closure glaucoma in adults[5]. While a shallow ACD has been associated with angle closure glaucoma, a deeper one has been associated with pigment dispersion syndrome[6].

It was found that the depth and volume of the anterior chamber diminish with age and are related to the degree of ametropia[7]. Some other studies also suggest that by age 13 years, the eye has reached its adult emmetropic axial length, the anterior chamber its maximum depth and the crystalline lens its minimum thickness about 15 years of age because the crystalline lens decreases in power during the slow coordinated growth period of the eye in childhood[8,9]. The ACD has also been found to be affected by ethnicity[10].

The Crystalline lens thickness is an important determining factor in conditions such as refractive errors especially myopia, presbyopia, and angle-closure glaucoma in adults[11,12]. Accurate measurement of the lens thickness is necessary when studying these conditions, more so the normal values for better understanding of variations.

This study was aimed at determining the reference values of anterior chamber depth, lens thickness, and vitreous chamber depth, among emmetropic children in South West of Nigeria.

Materials and Method

Four hundred and sixty-eight children from selected prenursery, nursery and primary schools were involved in the cross sectional study. Approval for the study was obtained from the Institutional Health Research Ethical Committee, the education authorities, and school head teachers. Consents were obtained from parents and where necessary, assent was obtained from the child. No form of coercion or inducement was involved. No sanction for dropping out of study was involved. Visual acuity, ocular examination and fundoscopy were done to ascertain normalcy. Ocular measurements were carried out by the Radiologist using a B-mode CLEA Vue 550 PHILLIP ultrasound Machine 2013 model. Anterior chamber depth (ACD), lens thickness (LT), and vitreous chamber depth (VCD) were measured using a 4-12 MHz Linear transducer. Single ophthalmologist and radiologist were involved to prevent inter observer error. Axial scan of the two eyes (Right & Left) were done and measurements taken with the children lying supine on a couch in a child friendly ultrasound room, while toggling with the images obtained in the last 10 seconds to obtain the best image for appropriate measurements. The Anterior chamber depth (ACD) was measured as the distance from the anterior corneal surface to the anterior lens surface. The lens thickness was measured at the widest antero-posterior surface of the lens (LT), while the vitreous chamber depth (VCD) measured from the outer surface of the lens (midpoint) to the surface of the retina epithelium. The age and sex were also recorded in an approved proforma for the study.

All measurements were taken in full consciousness with no anaesthesia. Analysis of data was done with SPSS version 21.

The variables were summarized by descriptive statistics followed by correlation testing by Pearson's Correlation Coefficient r. Results were tabulated and statistically correlated. Chi square test was employed to test for significant difference in categorical variable between subgroups. Statistical significance was considered when $p < 0.05$. Means were expressed with standard deviations.

Results

Four hundred and sixty-eight children were involved in the study. There were two hundred and thirty-five boys (50.2%) and two hundred and thirty-three girls (49.8%) with a ratio of 1: 1.01. Mean age for the study participants as a whole, 8.8±3.81years, the mean age was 9.0±3.9 years and 8.6±3.75years for boys and girls respectively with boys statistically slightly older than girls.

The mean anterior chamber depth in the right eyes was3.64cm±0.42 mm, 3.58±0.45 mm; while in the left eyes they measure 3.69cm±042 mm, 3.66±0.42 mm in the boys and girls respectively. The mean anterior chamber depth in the studied population was 3.61±0.43mm, 3.68±0.42mm, in the right and left eyes. There was no significant sex difference in the AC depth.

Mean lens thickness in the right eyes was 3.74±0.40mm, 3.67±0.38mm, while in the left eyes 3.81±0.35mm, and 3.72±0.40mm in the boys and girls respectively. The mean lens thickness for the study population was 3.71±0.39mm, 3.77±0.38m in both the right and left eyes. Statistically significant difference between the sexes exists only in lens thickness in the right and left eyes (p=0.016, and p=0.011, respectively).

The mean vitreous chamber depth was 17.48±1.07mm, 17.33±1.22cm in the right eye in boys and girls respectively. In the left eyes, they measure 17.52±1.00mm, 17.32±1.19mm boys and girls respectively. The mean VCD in whole studied population was 17.41±1.15Mm, 17.42±1. 10Mm in the right and left eyes respectively.

The reference values for ACD, LT and VCD were 3.52 – 3.74mm, 3.62 – 3.89 mm, and 17.31 – 17.65mm, respectively. Table 2 shows reference ranges in the three dimensions according to gender.

There were significant correlations in the three dimensions (ACD, LT, and VCD) between the right and left eyes (F=35.9, p<0.001; F=23.2, p<0.001;) F=438.7, p<0.001), respectively.

In the right eye, there were significant negative correlations between ACD and LT (F=9.7, p=0.002), and positive correlation between ACD and VCD (F=14.1, p<0.001). In the left eye, there were significant negative correlation between LT and VCD (F=16.5, p<0.001), and positive correlation between ACD and VCD (F=5.7, p=0.18). See Table 3.

Table 1: Gender and Mean Ocular Dimensions

Gender	N	Ocular Dimensions (mm)					
		Anterior Chamber Depth		Lens Thickness		Vitreous Chamber Depth	
		Right Eye	Left Eye	Right Eye	Left Eye	Right Eye	Left Eye
Male	23	3.64±.042	3.69±0.42	3.74±.040	3.81±0.35	17.48±1.07	17.52±1.00
Female	23	3.58±0.45	3.66±0.42	3.67±.038	3.72±0.40	17.33±1.22	17.32±1.19
Total	46	3.61±0.43	3.68±0.42	3.71±.039	3.77±0.38	17.41±1.15	17.42±1.10

Table 2: Reference Values of Ocular Dimensions

Gender	Ocular Dimensions (mm)					
	Anterior Chamber Depth		Lens Thickness		Vitreous Chamber Depth	
	Right Eye	Left Eye	Right Eye	Left Eye	Right Eye	Left Eye
Male	3.57 - 3.69	3.64 – 3.74	3.69 - 3.80	3.76 – 3.85	17.34 - 17.62	17.39 - 17.65
Female	3.52– 3.64	3.61 – 3.71	3.62 - 3.72	3.67 – 3.77	17.17 - 17.49	17.17 - 17.47
Total	3.57 – 3.65	3.64 – 3.72	3.67 - 3.74	3.73 – 3.80	17.31 - 17.51	17.32 - 17.52

Table 3: Correlations between Occular Dimensions

Parameters	r	F value	p value
ACD right vs. ACD left	0.268	35.9	< 0.001
LT right vs. LT left	0.218	23.2	< 0.001
VCD right vs. VCD left	0.70	438.7	< 0.001
ACD left vs. VCD left	0.110	5.7	0.018
ACD right vs. VCD right	0.171	14.0	< 0.001
LT right vs. ACD right	0.143	9.7	0.002
LT left vs. VCD left	0.185	16.5	< 0.001
LT right vs. VCD right	0.072	2.50	0.112
LT left vs. ACD left	0.019	0.173	0.68

Discussion

The mean anterior chamber depth of 3.6mm and 3.7mm in the right and left eyes respectively obtained in this study was similar to the report of Li et al among Chinese children[13].

It is however in contrast to the findings of Lee et al[14] who reported a lower mean of 3.11mmand Abijilt[1] who reported 3.08mm. The variation could be due to age and other environmental factors. Variation in methodology may also play a role since Abijit study included ammetropic patients unlike our own study (which was mainly on emmetropes). We also found that ACD was deeper in the Left Eye than Right Eye. But there was no gender difference, as reported by other researchers[6].

This study found that the mean lens thickness was 3.7mm. This is similar to the findings of Yung-Feng et al among school children in Taiwan[15,1]but slightly higher than the mean found among Chinese 14 year olds[13]

This study found that mean vitreous depth was 17.4mm in the RE and 17.3mm in the LE which was higher than the that reported by Abhijit[1] and Nover et al[16] who reported a mean range of 14.42mm to 16mm. VCD was the same for both eyes and there was no gender difference. This is in contrast with the other researchers who had reported sex differences. In fact Hassan et al[17] has reported a higher ocular dimensions (ACD, AND VCD) in men compared to women. Our study found that the VCD was deeper in the left eye in both sexes and slightly deeper in boys than girls, though this was not statistically significant. This sex variation had also been reported by other researchers[18].There was a positive correlation between the anterior chamber depth and vitreous chamber depth which was statistically significant in the RE

We conclude that the mean ACD and LT are longer in the left eye than in the right, and there is no difference in VCD between both eyes. The LT is longer in boys than girls in both eyes. Reference ranges for the three dimensions are as shown in Table 3.

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