

Original Research Article

OCULAR BIOMETRY USING COMPUTED TOMOGRAPHY: IN JOS, NORTH
CENTRAL NIGERIA

SUMMARY

Aims and Objective: To determine the normal ocular dimensions (AP and width) in Jos, North Central Nigeria using computed tomography scan.

Subjects and methods: The ocular images of 251 patients who had cranial CT in Jos University Teaching Hospital without obvious ocular anomaly were retrogressively studied. The antero-posterior (axial length) and width were obtained at the maximum mid-axial images showing the maximum size of the lens. Statistical information and analysis was performed using SPSS version 20. Pearson correlation was performed and the level of significance set at $p=0.05$ student t-test was also performed to compare the difference of the mean ocular dimensions and sexes.

Results: The mean axial length found was 24.61mm (right) and 24.01mm (Left) while the width was 24.31mm (Right) and 23.21mm (Left).

The ocular biometry was slightly larger in the right eyeball than the left, and also in males than females. All the axial lengths were higher than the width in both males and females.

Conclusion: The ocular biometry were noted to be higher in males compared to females. The dimensions were noted to increase with age, though not statistically significant. The axial length was higher than the width.

Keywords: Ocular, Biometry, Computed tomography.

INTRODUCTION:

The eye is the organ of vision that is housed in an orbit. It serves as a gateway for light appreciation, because it is connected to the brain by the optic nerve. Each eyeball is a cystic structure kept distended by the pressure inside it. Although, generally referred to as a globe, the eyeball is not a sphere but an ablate spheroid. The central point on the maximal convexities of the anterior and posterior curvatures of the eyeball is called the anterior and posterior pole, respectively. The equator of the eyeball lies at the mid plane between the two poles¹.

Variation of its size can cause visual abnormalities such as myopia and hypermetropia. Ocular biometric values are useful in the diagnosis of macro and micro-ophthalmia and aids explanation of the relationship between ocular size and variation in refractive index.³

Normal values of ocular biometric studies acquired through CT-scan is affected by ethical issues related to radiation dose. Such studies were on CT scans performed for other reasons. Coupled with the cost of studies, there is scanty information on CT acquired ocular biometry especially in Africa.²

There have been several studies to measure the axial length of the living human eyes in the past. Some of these studies utilized various techniques which includes the indirect radiographic, ultrasonographic and photographic methods⁵⁻⁸. However, modern advanced radiologic imaging modalities such as multi detector CT and MRI can assess the eyeball and its related ocular diseases and makes the clinical implications of such findings easily possible.^{8,9,10} Ultrasound is commonly used in interrogating the eye, but it is operator dependent. MRI provides excellent anatomical detail compared to CT but has limitations in assessing calcification in

the eye and motional artifact because of the duration needed to acquire images. It is more costly and not readily available.

CT biometry has some advantages which include the fact that it is painless, non-invasive and less time consuming. It is performed on outpatient basis with high accuracy rate and does not require strict patient positioning. It also detects abnormal ocular anatomy and there is absent magnification error.¹¹

Despite all these advantages, its routine use in ocular biometry is limited by radiation dose and cost.

MATERIAL AND METHODS

The study consisted of CT-scans taken from stored images on a 4-slice Helical BRIGHT SPEED GE CT machine. Which were performed in axial sections at 2.5mm slice thickness and a window level of 50 Hounsfield unit. All scans recorded for this study were those considered by the researchers to be of normal eyeballs without any observable intra ocular disease and whose medical records are devoid of ocular abnormality.

The medical records of two hundred and seventy (270) patients who had cranial CT Scans performed in Jos University Teaching Hospital (JUTH) from January to December 2014 were retrospectively examined. About 19 (7%) of the patients records were excluded from this study based on the exclusion criteria viz: positive ophthalmic pathology or lesions such as tumors and fractures images that are not clear such as due to motion blur, images that show deformity or irregularities of the eyeball contour and those with $> 3\text{mm}$ difference between the values obtained by the researchers.

73 Consequently, 251 consecutive patients' cranial CT examinations were recruited
74 into the study.

75 The stored images of the eyeball were magnified four time during their review to
76 reduce measurement errors. The slices chosen for ocular measurements were mid-
77 ocular slices showing the maximum axial size of the eyeball and which showed the
78 maximum size of the lens.

79 Ocular dimensions were obtained in axial length (antero-posterior diameter) of the
80 eyeball and in width (transverse diameter). The antero-posterior diameter is the
81 distance through the visual axis from the anterior corneal surface to the posterior
82 wall of the choroid in axial view and it included the anterior chamber length, lens
83 thickness and the vitreous chamber length. The width or transverse diameter is the
84 maximum transverse diameter between the temporal and nasal ends of the eye in
85 axial view.

86 Statistical information and analysis was performed using SPSS version 20. For
87 each eye, the axial length was designated "AP" and the transverse length as
88 "width" as sean in fig 1.The average value of the AP and Trans was calculated for
89 each eye and designated "AV RT and AV LT" for the right and left eye
90 respectively. An average of all the dimensions in each individual was calculated
91 and designated "Both eyes". Pearson correlation was performed and the level of
92 significance set at $d=0.05$ student t-test was also performed to compare the
93 difference of the mean ocular dimensions and sexes.

94

95 RESULTS

96 A total of 251 patients made up of 175 males (69.7%) and 76 (30.3%) females
97 were studied. The difference in the mean age of the sexes was not statically
98 significant. The minimum age was six month and the oldest in the study was ninety
99 years. Table I.

100 There was slightly larger mean ocular dimensions in males than females though
101 not statistically significant. The AP and width are higher in the right eye compared
102 to the left. The AP was noted to be higher than the width in both sexes.

103 RT AP 24.9mm $t = 3.534$, $P = 0.001$, LT AP 24.3mm, $t = 4.613$, $P = 0.001$

104 RT width 24.4mm $t = 4.923$, $P = 0.001$, LT width 23.6mm $t = 3.902$, $P = 0.001$. Table II.

105 Ocular dimensions were consistently smaller in children less than 10 years of age
106 than in adults. Also, the ocular dimensions with age was noted to be higher in the
107 age groups of 21-30 and 31-40 years of age. There was a drop in the observed
108 dimensions among 41-50 years. Table III

109 Again, the mean ocular dimension of the right eye is slightly greater than that of
110 the left eye with increasing age. Also the mean ocular dimensions were greater in
111 males compared to females with increasing age. The increase in ocular dimensions
112 with age correlated significantly. Table IV

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114 DISCUSSIONS

115 The knowledge of the ocular normogram in an environment is important evaluating patients that
116 present with disease condition of the eyes. The eye is the organ of sight and its variation in size
117 can cause visual abnormalities such as myopia and hypermetropia. Ocular biometric values are

useful in the diagnosis of macro and micro-ophthalmia and aids explanation of the relationship between ocular size and variation in refractive index.³

A total of 251 patients made up of 175 males (69.7%) and 76 (30.3%) females were studied.

From the results obtained, the mean antero-posterior diameter and width for the right eye was 24.91mm and 24.41mm and left eye 24.31mm and 23.61mm for males; and 24.31mm and 23.61mm for the right eye and 24.31mm and 22.81mm for left eye for the females respectively. Hence, the axial length was higher than the width. The antero-posterior (axial) length value is similar to that obtained elsewhere; in India 24.5mm,¹¹ mongolians 23.13mm,¹² caucasians children 23.49mm¹³ Therefore, racial differences does not play any significant role in evaluating dimension. However, similar study in Nigeria (Benin) shows that the width was longer than the axial length which vary significantly with the findings here.³

Ocular dimensions (AP and width) increase with advancing age, however, 80% of adult eye size was achieved by age 4. Hahn et al documented rapid growth of the eyeball during the first 24 months of age, peaks between 18 and 30 years after which reduction was observed.¹⁴ In this study however, similar observations was made, but the onset of reduction of ocular dimensions occurred later (from age 41yrs) and peaked at age 61yrs and above. Two peaks of increase in ocular dimensions was noticed in ages between 21-30 years and 31-40 years which was not observed in the study by Hahn et al. In the adult, axial length remains practically unaltered. A slight but steady change towards hyperopia is the rule, especially after the age of 40. The human eye grows extensively after birth. The full term newborn eye has a mean axial length of 16-18

143 mm. The mean adult values for axial length are 22-25 mm.¹⁹ This is
144 similar to our findings.

145 In another study, the axial length was found to increase rapidly until age 10^{1/2}
146 years and this slowly increase without observing any decrease in two ocular
147 dimension.¹⁵

148 Although not statistically significant, right globe measurement were higher than
149 the left. It was also noted that the right globe measurement was higher than that of
150 the left in the studies in Nigeria by Ogbeide et al¹⁶ and elsewhere.^{16,17,18}

151 It was noted that the AP dimension and width in males was higher than that of
152 females, which is statistically significant. Similar findings was noted in the study
153 done by Ogbeide et al in Benin on ocular biometry using ultrasound.¹⁶ The factor
154 that may attributed to this may be from human sexual dimorphism in which the
155 male body habitus (and possibly organs) is generally bigger than that of the
156 females.³

157 The radiation associated with CT and the cost of the investigation has made usage
158 for routine biometry an ethical dilemma.³ Other imaging modalities that can be
159 used in ocular biometry are ultrasonography and magnetic resonance imaging.
160 Ultrasound is operator dependent and MRI is not readily available and very
161 expensive.

162 CONCLUSION

163 The ocular dimension increased with age. The antero-posterior dimensions were
164 higher than the width in both sexes. The dimensions in males were higher than that
165 of females. Financial cost, increases irradiation and other factors make the use of

166 computed tomography unlikely in the routine measurement of the eyeball
167 diameters.

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220 Table I: Age distribution of study subject according to gender

Gender	N	Mean±SD	t	p	Min.	Max.
Male	175	37.2±21.1	0.188	0.851	0.5	80
Female	76	36.6±23.2			0.5	90
Total	251	37.0±21.7			0.5	90

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223 Table II: Mean values of globe diameter with respect to gender

Parameter	Gender		t	P
	Male	Female		
Rt AP	24.9±1.5	24.3±1.6	3.534	0.001
Lt AP	24.3±1.4	23.4±1.4	4.613	0.001
Rt Width	24.4±1.3	23.6±1.3	4.923	0.001
Lt Width	23.6±1.6	22.8±1.3	3.902	0.001

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227 Table III: Mean, age and sex distribution of globe diameter

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Age	Sex	Fr	Rt AP	Rt Width	Lt AP	Lt With
≥10	M	20	23.41.8	22.91.5	22.51.6	22.21.7
	F	14	22.21.7	22.01.4	21.41.4	21.41.1
	T	34	22.91.8	22.61.5	22.11.6	21.91.5
11-20	M	19	24.61.2	24.11.3	23.81.2	23.41.4
	F	10	24.41.2	23.80.6	23.50.5	22.80.6
	T	29	24.51.2	23.91.1	23.71.1	23.21.2
21-30	M	41	25.51.0	24.90.9	24.90.9	23.91.1
	F	5	25.51.1	24.61.1	24.60.9	23.81.1
	T	46	25.51.0	24.80.9	24.90.9	23.91.1
31-40	M	31	25.61.1	25.01.1	24.91.0	24.41.1
	F	10	25.01.2	24.31.1	24.31.1	23.50.9
	T	41	25.51.1	24.81.1	24.81.0	24.21.1
41-50	M	11	24.71.3	24.31.0	24.30.9	23.51.4
	F	16	24.41.1	23.61.1	24.41.1	22.91.2
	T	27	24.51.2	34.91.1	24.51.2	23.21.3
51-60	M	26	25.11.4	24.71.3	24.51.2	23.81.4
	F	11	25.01.0	24.20.9	23.91.1	23.60.9
	T	37	25.11.3	24.51.2	24.41.2	23.71.3
>60	M	27	24.91.4	24.31.2	23.91.7	23.32.2
	F	10	24.61.4	23.51.1	23.60.9	22.71.3

	T	37	24.81.4	24.11.2	23.91.6	23.12.0
Total	M	175	24.91.5	24.41.3	24.31.4	23.61.6
	F	76	24.31.6	23.61.3	24.31.6	22.81.3
	T	251	24.81.5	24.21.4	24.81.5	23.41.5

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231 Table IV: Correlation between age (in years) and globe diameter (in mm)

Globe diameter (in mm)	Correlation coefficient (r)	P
Right AP	0.277	0.001
Left AP	0.254	0.001
Right Width	0.246	0.001
Left Width	0.171	0.007

232 Correlation is significant at the 0.01 level

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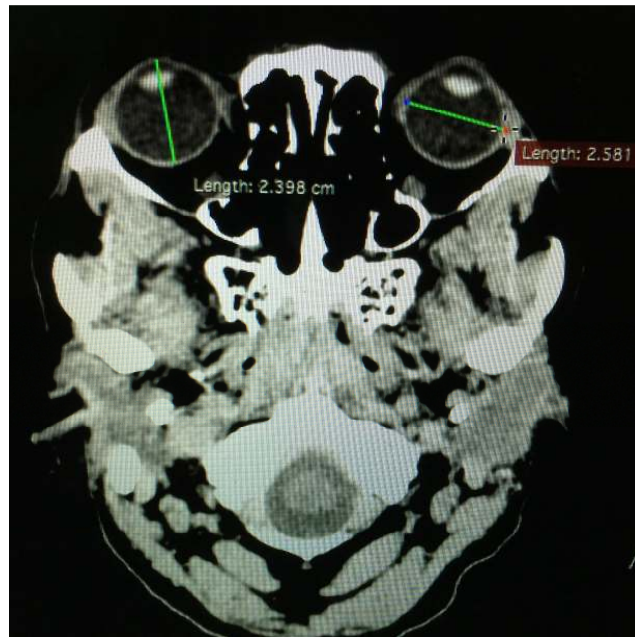
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Figure 1: Axial CT scan showing measurement of length and width of the eye