Original Article

Normative magnetic resonance imaging measurements of orbital structures in pediatric population of North-Eastern India: A retrospective cross-sectional study

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Purpose: The people of Northeast India comprise mostly of Mongoloid descent with characteristic craniofacial features. The purpose of this study was to evaluate the normal orbital structures with MRI and determine normative data in the Northeast Indian pediatric population. **Methods:** MRI images of the 302 orbits of 151 pediatric patients below 16 years of age were retrospectively evaluated to measure the various orbital structures. Both axial and coronal MRI images were utilized for various orbital measurements. An independent sample *t*-test was done to compare various orbital data according to the sex and side. Linear regression was also done. **Results:** The mean age of the pediatric population was 9.64 ± 1.47 years with a male: Female ratio of 1.13:1. The mean interzygomatic line was 88.4 ± 9.09 mm and the interorbital line was 22.18 ± 3.62 mm. The mean thicknesses of medial, lateral, superior, and inferior recti muscles were 2.58 ± 0.46, 2.34 ± 0.42, 2.16 ± 0.40, and 2.53 ± 0.49 mm in males and 2.41 ± 0.41, 2.08 ± 0.34, 2.08 ± 0.46, and 2.46 ± 0.49 mm in females. The mean horizontal orbital, vertical orbital diameters, orbital index, mean volume of eyeball, and orbital cavity were 30.27 ± 2.97,3 7.06 ± 3.57, 122.58 ± 7.39, 4.63 ± 0.84, and 15.29 ± 3.52 in males, while 29.16 ± 3.23, 34.96 ± 3.99,119.96 ± 7.31, 4.49 ± 0.87, and 14.65 ± 3.47 in females, respectively. With an increase in age, the interzygomatic line ($r = 0.883$, $r^2 = 0.780$; $P < 0.0005$), anterior medial interorbital line ($r = 0.808$, $r^2 = 0.652$; $P < 0.0005$), mean volume of eyeball ($r = 0.915$, $r^2 = 0.838$; $P < 0.0005$), orbital cavity ($r = 0.924$, $r^2 = 0.854$; $P < 0.0005$), and distance between the optic nerve entry site ($r = 0.829$, $r^2 = 0.687$; $P < 0.0005$) were increased. **Conclusion:** This study provides normative data of various orbital structures in a pediatric population and these data likely to be useful for diagnosing various pediatric orbital disorders and helps in the planning of various surgical procedures of orbits.

Key words: Magnetic resonance imaging (MRI), optic nerve, pediatric

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The human population has a great deal of genetic diversity. There are morphometric variations of the skull and the orbit among people of different races. Moreover, various pathologies can involve the orbit and its contents and may result in volume changes in the orbital structures.[1]

Thickening of extraocular muscles may occur in multiple conditions like thyroid ophthalmopathy, metastatic tumor, primary neoplasms, vascular malformations, nonspecific inflammation, acromegaly, infections, and following trauma.[2,3] Likewise, thickening of the optic nerve can be seen in conditions like optic neuritis, meningioma, and optic nerve glioma.[4] Furthermore, craniofacial malformations including orbital clefts, hypertelorism, and hypotelorism often involve the eyes.[5] Also, the relative position of the globe to its surrounding bony landmarks is vital for the diagnosis of exophthalmos and proptosis.[6]

Therefore, quantitative measurement of normal orbital structures plays a vital role in the diagnosis and management of these various orbital conditions. Currently, computed tomography (CT) with 3D reconstruction and magnetic resonance imaging (MRI) are widely used imaging modalities that are noninvasive and accurate for quantitative measurement of the various orbital structures.[1,7] MRI is superior to CT because of its high soft-tissue resolution, lack of ionizing radiation, and high diagnostic accuracy as reported by several studies in the previous literature.[2] The available data in the literature is mostly based on the western population, with only limited data from India.[6] Moreover, only a few studies were focused on the pediatric population.[8] No study has yet been done to assess the normative data of the Northeast Indian pediatric population.

In this study, we aim to evaluate normal orbital structures with MRI and determine normative data in the Northeast Indian pediatric population.

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Methods

After approval from the institutional ethics review committee, a hospital-based retrospective study was conducted in a tertiary care hospital in North Eastern India from November 2018 to February 2021. The study group comprised of 151 pediatric patients below the age of 16 years who underwent MRI scans of the brain and orbits. Informed consent was obtained from patients/guardians before undergoing an MRI scan.

Inclusion criteria: Children below 16 years of age undergoing MRI for any neurological disorder or other causes.

Exclusion criteria: Children with

- Orbital pathology
- Congenital craniofacial malformations
- Previous orbital surgery
- Neoplasm involving bony orbital walls or orbital structures
- Systemic disease affecting the orbital structures like Graves disease
- Recent orbital trauma or orbital wall fracture
- Raised intracranial tension/intracranial space-occupying lesion

MRI protocols

All patients were subjected to an MRI scan of the brain, and orbits were obtained with various conventional MRI sequences. All patients were subjected to an MRI scan using Philips Ingenia 1.5 Tesla machine (The Netherlands). Various MRI sequences of orbits comprised of a combination of transverse and coronal images of orbits with 3 mm slice thickness using the following sequences:

1. Axial T2-weighted spin-echo sequence (TR/TE range: 3000/100–110 ms; flip angle: 90° matrix size: 230 × 240)
2. Axial T1-weighted spin-echo sequence (TR range/TE range, 450–600/11–13 ms; flip angle: 90°, matrix size: 150 × 140) without fat saturation.
3. Axial T2-weighted SPAIR (spectral attenuated inversion recovery) sequence (TR/TE range: 3000/90–100 ms; flip angle: 90°, matrix size: 280 × 260)
4. Coronal T2-weighted spin-echo sequence: TR/TE range: 6000/110–120 ms; flip angle: 90°, matrix size: 256 × 256)

Image interpretations

All MRI images were reviewed and evaluated on a dedicated workstation. Two neuroradiologists with 8–13 years of experience of neuroimaging independently reviewed the MRI images of 302 normal orbits of 151 patients, and the various orbital measurements were obtained. MRI images in primary gaze were assessed for various orbital measurements, and oblique or lateral gaze images were excluded from the study analysis. The various measurement orbital measurements obtained are shown in Tables 1 and 2.

Interzygomatic line

It is the distance between the anterior margins of zygomatic bones at the level of plane of optic nerves and obtained in axial T1W image [Fig. 1a].

Anterior medial interorbital line

It is the minimum distance measured between the medial and lateral orbital walls on coronal scan [Fig. 1a].

Globe protrusion

It was determined by measuring the distance between the interzygomatic line and the anterior ocular surface on axial MRI scans in the mid globe section [Fig. 1b].

Globe position

It was determined by measuring the distance between the interzygomatic line and the posterior ocular surface on axial MRI scans in the mid globe section [Fig. 1b].

Transverse diameter of globe

It is the maximum transverse diameter of the eyeball measured in an axial MRI scan [Fig. 1c].

Length of an intraorbital segment of the optic nerve

It measures in axial MRI images [Fig. 1d].

Angle between the medial and lateral orbital walls

The angle was obtained between the medial and lateral orbital walls in axial MRI scan at the level of optic nerves [Fig. 1e].

Distance between the optic nerve entry points

The distance between the optic nerves where they enter the eyeballs [Fig. 1f].

Angle between the optic nerves

The angle was obtained between the optic nerves in the axial MRI images [Fig. 2a].

Optic nerve thickness

The measurements were obtained in axial and coronal MRI sections at 3 mm (retrobulbar) and 7 mm (mid aspect of the intraorbital segment) posterior to lamina cribosa [Fig. 2b and c].

Thickness of recti muscle

The maximum thickness of the medial and lateral recti muscles was measured on axial MRI images, while superior and inferior recti muscles on coronal MRI scans [Fig. 2d and e]. The axial and coronal images were scanned, and the point of maximum thickness of muscle belly was obtained for measurement.

Orbital index

It is the maximum vertical distance of orbital cavity/maximum horizontal distance of orbital cavity × 100. The horizontal orbital diameter was the maximum distance between the medial and lateral orbital walls on an axial MRI scan. The maximum vertical diameter was obtained in a coronal MRI scan and was the maximum distance between the superior and inferior orbital wall [Fig. 2f].

Eyeball and orbital cavity volume

We used the Intelli Space portal 7.0 (ISP Philips) for 3D reconstruction and volume calculation of the eyeball [Fig. 2g] and orbital cavity volume [Fig. 2h] in the volume viewer by the clip and segmentation technique.

Statistical analysis

The statistical analyses were done using the SPSS program (Statistical Package for the Social Science version 16. SPSS Inc., Chicago, USA). An independent sample *t*-test was done to compare various orbital data according to the sex and side (correlation was significant at P value < 0.05). Pearson correlation was done to find out the correlation with various variable data (correlation was significant at P value < 0.01). The interzygomatic line, anterior medial interorbital line, mean

Table 1: Various orbital measurements in 151 patients

Orbital measurement		Mean mm/ degree ± [SD]	Range (mm or degree)	Difference range (mm or degree)	95% confidence interval of the Difference	
					Lower	Upper
Interzygomatic line		88.4±9.09	58.9-106.1	-	86.95	89.88
Interorbital line		22.18±3.62	10.8-29.8	-	21.59	22.76
Globe position	Right	7.19±1.63	3.54-11.4	0.1	6.92	7.44
	Left	7.2±1.61	3.55-11.3		6.94	7.46
Globe protrusion	Right	14.23±2.31	7.8-20.4	0.02	13.85	14.62
	Left	14.21±2.39	7.81-20.6		13.82	14.59
Transverse diameter of the globe	Right	22.39±1.54	17.2-25.2	0.04	22.14	22.64
	Left	22.43±1.53	17.3-25.1		22.17	22.66
Distance between the optic nerve entry point		46.19±6.83	36-70.9	-	45.09	47.29
Length of the intraorbital optic nerve	Right	22.32±3.25	12.7-36.5	0.03	21.80	22.84
	Left	22.35±3.24	12.8-36.7		21.82	22.87
Angle between the optic nerves		65.77±6.54	45.5-79.2	-	64.71	66.82
Optic nerve thickness -3 mm posterior to the lamina cribosa	Right	2.34±0.37	1.4-3.21	0	2.28	2.40
	Left	2.34±0.37	1.41-3.2		2.28	2.40
Optic nerve thickness -- 7 mm posterior to the lamina cribosa	Right	2.35±0.37	1.47-3.25	0.01	2.29	2.41
	Left	2.36±0.37	1.48-3.3		2.30	2.42
Thickness of medial rectus	Right	2.5±0.44	1.45-3.8	0	2.43	2.577
	Left	2.5±0.44	1.46-3.81		2.43	2.57
Thickness of lateral rectus	Right	2.22±0.4	1.19-3.21	0.01	2.15	2.28
	Left	2.23±0.39	1.21-3.2		2.17	2.30
Thickness of superior rectus	Right	2.12±0.43	1.3-3.2	0	2.05	2.19
	Left	2.12±0.42	1.31-3.2		2.5	2.19
Thickness of inferior rectus	Right	2.5±0.49	1.37-3.8	0.01	2.42	2.58
	Left	2.51±0.49	1.38-3.81		2.43	2.59
Angle between the medial and lateral orbital walls	Right	51.45±3.58	43.2-59.7	0.02	50.87	52.03
	Left	51.47±3.55	43-59.6		50.9	52.04
Horizontal orbital diameter	Right	29.75±3.14	20-36.3	0.05	29.25	30.26
	Left	29.80±3.12	20.1-36.2		29.29	30.30
Vertical orbital diameter	Right	36.07±3.91	21.4-46.6	0.08	35.45	36.70
	Left	36.15±3.89	21.5-46.5		35.52	36.78
Orbital index	Right	121.34±7.45	106.5-146	0.07	120.14	122.54
	Left	121.41±7.45	106-144		120.23	122.59
Eye ball volume	Right	4.56±0.85	2-6.3	0.01	4.42	4.69
	Left	4.57±0.85	2-6.28		4.43	4.71
Orbital cavity volume	Right	14.96±3.5	5.13-21.20	0.06	14.39	15.52
	Left	15.02±3.5	3.19-21.50		14.45	15.58

volume of eyeball, and orbital cavity were compared using linear regression according to the age.

Results

The study sample comprised of 302 normal orbits of 151 patients ($n = 80$ males and $n = 71$ females) with ages ranging from 4 days to 16 years with a mean age of 9.64 ± 1.47 [SD] years and male: female ratio of 1.13:1.

The mean values and normal ranges for various orbital measurements and differences are shown in Tables 1 and 2.

The mean interzygomatic line was 88.4 ± 9.09 [SD] mm, while 89.76 ± 8.55 [SD] mm in males and 86.90 ± 9.49 [SD] mm in females. The mean interorbital line was 22.18 ± 3.62 [SD] mm, while 22.66 ± 3.25 [SD] and 21.63 ± 3.94 [SD] mm for males and females, respectively. The globe position was 7.19 ± 1.63 [SD] and 7.2 ± 1.61 [SD] mm for the right and left side, respectively. The globe protrusion was 14.23 ± 2.31 [SD] mm on the right side and 14.21 ± 2.39 [SD] mm on the left side. The transverse globe diameter was 22.82 ± 1.43 [SD] and 21.90 ± 1.51 [SD] mm for males and females, respectively. The average distance between optic nerve entry points was 47.00 ± 6.18 [SD] mm in males and 5.27 ± 7.43 [SD] mm in females. The average length of the intraorbital optic nerve segment measured 22.63 ± 3.01 [SD] mm in males and 21.98 ± 3.48 [SD] mm in females. The optic nerve thickness 3 mm posterior to the lamina cribosa was 2.32 ± 0.35 [SD] mm in males and 2.36 ± 0.38 [SD] mm in females, while optic nerve thickness was 2.36 ± 0.36 [SD] and 2.35 ± 0.38 [SD] mm measured 7 mm posterior to the

Table 2: Sex difference between the various orbital measurement in 151 patients

Orbital measurement		Mean mm or degree ±[SD]	Difference range (mm or degree)	*P*
Interzygomatic line	Male	89.76±8.55	2.85	0.054
	Female	86.90±9.49		
Interorbital line	Male	22.66±3.25	1.03	0.08
	Female	21.63±3.94		
Globe position	Male	7.32±1.49	0.29	0.262
	Female	7.02±1.76		
Globe protrusion	Male	14.47±2.30	0.50	0.197
	Female	13.96±2.51		
Transverse diameter of globe	Male	22.82±1.43	0.92	0.0005
	Female	21.90±1.51		
Distance between optic nerves entry point	Male	47.00±6.18	1.73	0.121
	Female	45.27±7.43		
Length of the intraorbital optic nerve	Male	22.63±3.01	0.65	0.218
	Female	21.98±3.48		
Angle between the optic nerves	Male	65.07±6.80	1.47	0.167
	Female	66.55±6.18		
Optic nerve thickness -3 mm posterior to the lamina cribosa	Male	2.32±0.35	0.045	0.448
	Female	2.36±0.38		
Optic nerve thickness -7 mm posterior to the lamina cribosa	Male	2.36±0.36	0.013	0.821
	Female	2.35±0.38		
Thickness of medial rectus	Male	2.58±0.46	0.177	0.015
	Female	2.41±0.41		
Thickness of lateral rectus	Male	2.34±0.42	0.255	0.0005
	Female	2.08±0.34		
Thickness of superior rectus	Male	2.16±0.40	0.081	0.248
	Female	2.08±0.46		
Thickness of inferior rectus	Male	2.53±0.49	0.069	0.391
	Female	2.46±0.49		
Angle between the medial and lateral orbital walls	Male	51.85±3.44	0.854	0.144
	Female	51.00±3.70		
Horizontal orbital diameter	Male	30.27±2.97	1.1	0.03
	Female	29.16±3.23		
Vertical orbital diameter	Male	37.06±3.57	2.1	0.001
	Female	34.96±3.99		
Orbital index	Male	122.58±7.39	2.61	0.031
	Female	119.96±7.31		
Eye ball volume	Male	4.63±0.84	0.133	0.341
	Female	4.49±0.87		
Volume of the orbital cavity	Male	15.29±3.52	0.639	0.265
	Female	14.65±3.47		
Ratio of the eyeball to orbital cavity volume	Male	0.30±0.03	0.01	0.362
	Female	0.31±0.03		

lamina cribosa, respectively. The angle between optic nerves was 65.07 ± 6.80 [SD] degree for males and 66.55 ± 6.18 [SD] degree for females.

The mean thickness of medial, lateral, superior, and inferior recti muscles was 2.5 ± 0.44 [SD], 2.22 ± 0.4 [SD], 2.12 ± 0.43 [SD], and 2.5 ± 0.49 [SD] mm for right orbits and 2.5 ± 0.44 [SD], 2.23 ± 0.39 [SD], 2.12 ± 0.42, and 2.51 ± 0.49 [SD] mm for left orbits, respectively. The mean thickness of medial, lateral, superior, and inferior recti muscles was 2.58 ± 0.46 [SD], 2.34 ± 0.42 [SD], 2.16 ± 0.40 [SD], and 2.53 ± 0.49 [SD] mm in males and 2.41 ± 0.41 [SD], 2.08 ± 0.34 [SD], 2.08 ± 0.46 [SD] and 2.46 ± 0.49 [SD] mm in females, respectively.

The angle between the medial and lateral orbital walls was 51.85 ± 3.44 [SD] degree in males and 51.00 ± 3.70 [SD] degree in female.

The mean horizontal orbital, vertical orbital diameters, orbital index, mean volume of eyeball, and orbital cavity were 30.27 ± 2.97 [SD], 37.06 ± 3.57 [SD], 122.58 ± 7.39 [SD], 4.63 ± 0.84 [SD], and 15.29 ± 3.52 [SD] mm in males, while 29.16 ± 3.23 [SD], 34.96 ± 3.99 [SD], 119.96 ± 7.31 [SD], 4.49 ± 0.87 [SD], and 14.65 ± 3.47 [SD] mm in females, respectively. The mean ratio of eyeball volume to orbital cavity volume was 0.31 ± 0.03 [SD]

The interzygomatic line, interorbital line, transverse diameter of the globe, distance between the optic nerve entry points, angle between the optic nerves, horizontal and vertical orbital diameter, and orbital index are larger in males than female patients. Statistically significant difference (P value < 0.05) was found between the data for the male and female patients in their globe diameter, thickness of medial and lateral recti muscles, horizontal and vertical orbital diameter, and orbital index, as shown in Table 2.

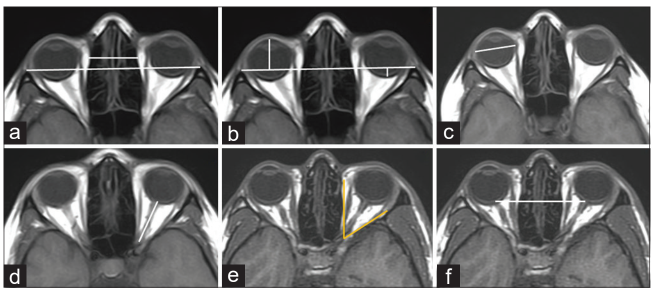

Figure 1: Axial T1W image (a) showing measurement of interzygomatic and interorbital lines. Image (b) showing measurement of globe protrusion and position. Image (c and d) showing measurement of transverse globe diameter and length of the intraorbital segment of the optic nerve. Image (e) showing measurement of the angle between the medial and lateral orbital walls and image (f) showing measurement of the distance between the optic nerves entry points

The length of the interzygomatic line was positively correlated with the thickness of extraocular muscles (P value ≤ 0.0005, $r \geq 0.447$). With an increase in age of pediatric population, the interzygomatic line ($r = 0.883$, $r^2 = 0.780$; $P < 0.0005$), anterior medial interorbital line ($r = 0.808$, $r^2 = 0.652$; $P < 0.0005$), mean volume of eyeball ($r = 0.915$, $r^2 = 0.838$; $P < 0.0005$), orbital cavity ($r = 0.924$, $r^2 = 0.854$; $P < 0.0005$), and distance between the optic nerve entry site ($r = 0.829$, $r^2 = 0.687$; $P < 0.0005$) were increased [Fig. 3]. The ratio of eyeball volume to orbital cavity volume ($r = 0.543$, $r^2 = 0.285$; $P < 0.0005$) decreases initially and increased at around 1 year of age. [Fig. 3]

Discussion

Normative measurements of the orbital structures act as a standard based on which various pathological conditions involving the orbit and its contents can be assessed. Moreover, in posttrauma reconstruction and preoperative planning, measurements of the orbital structures are essential.[9] In the literature, various studies on normative measurements of the orbit reported variation based on race, region, and ethnicity.[8]

Northeast Indian population comprises people of several racial descents: The Mongoloids, the Indo-Aryans, the Austrics, and a small number of Dravidians. Assam being the most populated among the North Eastern states, the original settlers are of Mongoloid descent, who has characteristic craniofacial features different from other racial groups. Wood-Jones and Brothwell have reported the anthropological variations of various populations, including people of Mongoloid descent.[10,11]

People in these North Eastern states, like the rest of India have a high burden of ocular disease. Presently, no imaging

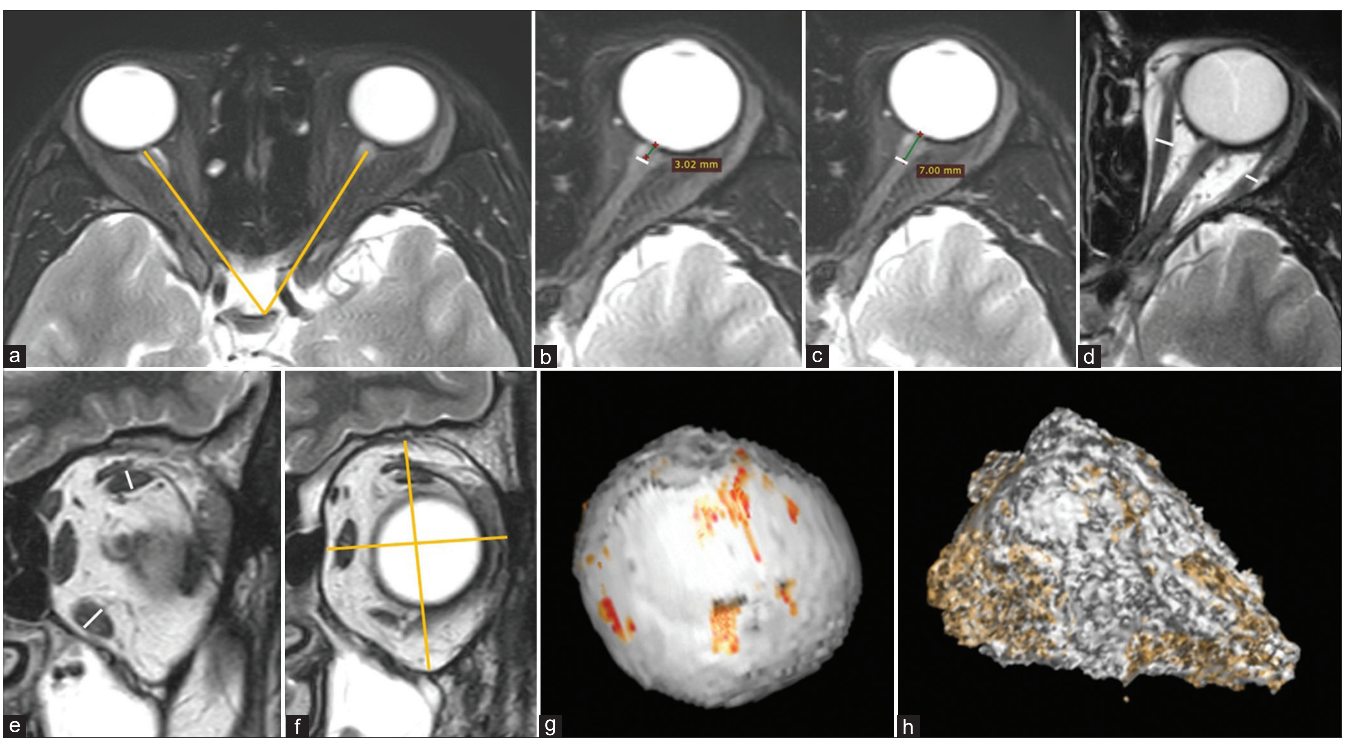

Figure 2: Fat-suppressed axial T2W image (a) showing measurement of the angle between the optic nerves, measurement of optic nerves thickness at 3 mm (retrobulbar) and 7 mm (mid aspect of intraorbital segment) posterior to lamina cribosa in images (b and c). Axial and coronal T2W images (d– f) showing measurement of the thickness of extraocular muscles' maximum vertical and horizontal diameters of orbit. 3D-reconstructed surface-shaded display (SSD) images (g and h) showing volume of the eyeball and orbital cavity

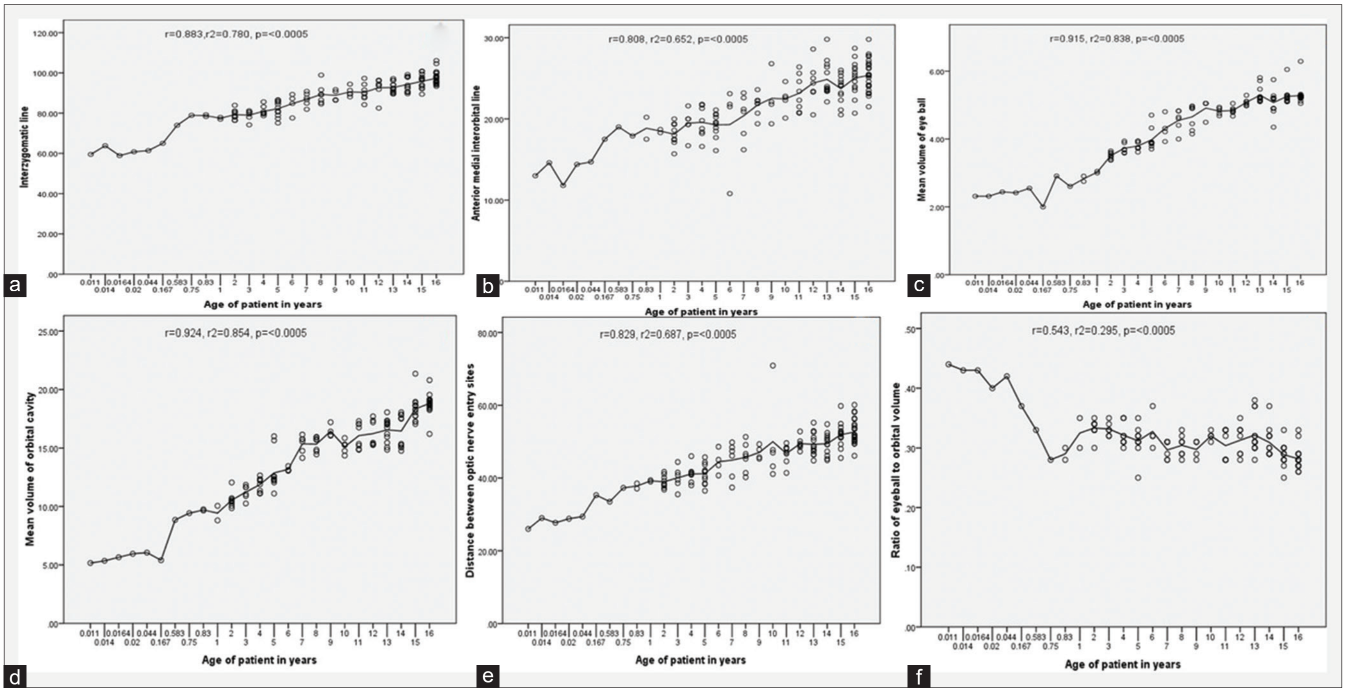

Figure 3: Scatter plots showing a correlation between the interzygomatic line (image a), anterior medial interorbital line (image b), mean eyeball volume (image c), mean orbital cavity volume (image d), distance between the optic nerves entry sites (image e), and ratio of eyeball volume to orbital cavity volume (image f) according to the age of pediatric population with linear regression values

normative data is yet available from this part of India. Thus, the present study has been done to provide normative data of orbital structures in the pediatric population of North Eastern India based on MRI measurements.

Dhanwate *et al*.[12] reported a mean horizontal orbital diameter of 37.52 mm ± 1.95 [SD] for the right orbit and 37.08 mm ± 1.96 [SD] for the left orbit in their study of dry skull bones of a segment of the Indian population. They reported the vertical orbital dimension of 32.64 mm ± 2.07 [SD] and 32.39 mm ± 2.18 [SD] for right and left orbits, respectively. Their study reported an orbital index of 87.52 ± 6.15 [SD] and 88.24 ± 5.22 [SD] for the right and left side, respectively. In our study sample using MRI, the vertical orbital diameter and orbital index were found to be of greater dimensions than the horizontal orbital diameter. Similarly, higher values of horizontal orbital diameter were also reported by Gupta *et al*.[6] in their study in the Indian population with CT, which probably may be due to the genetic, racial factors, and difference of methodologies used (dry skull measurement vs cross-sectional imaging with MRI/CT).

In the present study, the thickness of all extraocular muscles was evaluated with MRI and found medial rectus muscle to be the thickest of all the extraocular muscles with a maximum diameter of 2.58 mm, and superior rectus to be the thinnest of all the extraocular muscles with a minimum diameter of 2.12 mm. All extraocular muscles are thicker in males while comparing with females. Considerable variability occurs across different studies and in different population groups in the literature.

Lee *et al*.[13] and Lerdlum *et al*.[14] in their studies reported the inferior rectus to be the thickest of all the extraocular muscles.[9] Gupta *et al*.[6] in their study reported that the medial rectus to be the thickest of all the extraocular muscles, and the lateral rectus to be the thinnest of all the extraocular muscles. In another study by Zhang *et al*.[15] the inferior rectus was reported to be the thickest, and the lateral rectus to be the thinnest of all the extraocular muscles. Also, Sacca *et al*.[16] reported that in the adult population, the medial rectus has the maximum average thickness out of all the extraocular muscles. The size variation of the extraocular muscles might probably be due to genetic factors, differences in race, region, ethnicity, and population. Moreover, the thickness of the extraocular muscles is increased in several pathological conditions like Grave's ophthalmopathy, infections, neoplasms, inflammatory pseudotumor, and vascular malformations.[17] Therefore, for the detection and diagnosis of these conditions, one should be familiar with the normative measurements of the extraocular muscles, which again justifies the purpose of the present study.

The optic nerve diameter can also be varied in the pediatric population in several pathological conditions such as optic nerve atrophy or hypoplasia, multiple sclerosis, Leber optic neuropathy, with enlargement of the optic nerve seen in conditions like neurofibromatosis type-1, from glioma, etc.[7] So, for the diagnosis of such conditions, the measurement of the optic nerve is vital. Despite the technical challenges faced in the pediatric population, MRI is reliable in the quantitative assessment of the size of the optic nerve proper as confirmed by previous studies,[7,18-20] and the same was found in the present study.

In the present study, the globe position was found to be 7.19 ± 1.63 [SD] mm on the right side and 7.2 ± 1.61 [SD] mm on the left side. Considerable variation was again seen across several studies in the literature.

In their study, Lee *et al*.[13] reported a mean value of 11.7 mm. In another study, Aiyekomogbon *et al*.[21] reported a value of 6.5 mm in a Nigerian cohort. Furthermore, Gupta *et al*.[6] reported a mean normal globe position of 7.8 mm on the right side and 7.9 mm on the left side. It was suggested that this result might be influenced by the variability of myopia prevalence in different subgroups in addition to the inherent difference in genetic and racial factors.[6] These values are important for the evaluation of exophthalmos, which may result from various causes such as vascular, infective, neoplastic, inflammatory, endocrine, traumatic, and extraorbital causes.[22]

In our study, the mean interorbital distance was found to be 22.18 ± 3.62 [SD] mm, while 22.66 ± 3.25 [SD] and 21.63 ± 3.94 [SD] mm for males and females, respectively. Mafee *et al*.[5] reported a mean interorbital distance of 2.67 cm in males and 2.56 cm in females on evaluation with CT scan. Similar findings were also reported by Gupta *et al*.[6] This parameter is important for the evaluation of hypertelorism and hypotelorism. Hypertelorism with increased interorbital distance can be seen as a manifestation of different craniofacial deformities like Crouzon syndrome, Apert syndrome, craniofacial dysplasia, and clefts.[22] On the other, hypotelorism can be associated with conditions like craniosynostosis and holoprosencephaly.[23]

In the literature, the normal interzygomatic distance has been reported to lies between 9 and 109 mm.[6,13,21,24] Similar values were also seen in the present study, with the mean interzygomatic distance of 88.4 ± 9.09 [SD] mm, 89.76 ± 8.55 [SD] mm in males and 86.90 ± 9.49 [SD] mm in females.

Limitations

One of the limitations of our study is the limited sample size. Moreover, children have rapid cranial growth during the first 2 years. So the normative values should ideally be obtained every 3 to 4 months for the first 2 years and then at an interval of every 2 years till teen age. Also, ideally normative data are measured on dry skull bones,[6] but in our study, we used MRI. Moreover, measurement of the same structure may vary depending on the plane of imaging, and MRI sequences used.

Conclusion

In conclusion, our study has provided normative measurements of various orbital structures on MRI that helps in the assessment of extraocular muscles, optic nerve, exophthalmos, and diagnosis of various pathologies affecting the orbit and its contents.

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Conflicts of interest

There are no conflicts of interest.

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