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ORIGINAL ARTICLE

ASSESSMENT OF THE ORBITAL STRUCTURES IN PEDIATRIC AGE GROUP USING MAGNETIC RESONANCE IMAGING

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ABSTRACT

Background: The orbital region in children may be involved in various pathologies and knowledge of normal anatomy is necessary for diagnosis and management purposes. The aim of this study was to assess the measurements of extra ocular muscles, optic nerve, eye globe and globe position in children less than 5 years age regarding any difference between the two sides and with the increase in age.

Materials & Methods: A retrospective observational study was conducted at Fauji Foundation Hospital Rawalpindi from 1st April to 30th May 2023. Previous MRIs were reviewed using Picture archiving and communication system (PACS) and measurements were taken on Constructive interference in steady state MRI sequence (CISS). Patients with abnormal findings in the orbits and children above 5 years were excluded from the study. The patients were divided into three groups based on their ages, Group-1 (0-20 months), Group-2 (20-40 months) and Group-3 (40-60 months). Diameters of extra ocular muscles, width of the optic nerve, distance from the inter-zygomatic line to the posterior margin of the globe and globe diameter were taken. The data was entered and analyzed using SPSS version 21.

Results: Total 186 patients were included in the study, out of which 107 (57.5%) were male and 79 (42.5%) were female. Group 1 included 49 patients (26.3 %), Group 2 included 87 patients (46.8 %) and Group 3 included 50 patients (26.9 %). In our study minimal increase was noted with increase in age by evaluating mean measurements, however most of them were statistically insignificant ($p>0.05$), except the Anteroposterior and Transverse diameters of the globe which were statistically significant ($p<0.05$).

Conclusion: In children less than 5 years age there was steady but minimal increase in orbital contents measurements. Also our study will help ophthalmologists of this country in precise assessment of sizes of extra ocular muscles, optic nerve size, globe position and globe size, because this is the first one study in this regard.

KEY WORDS: Magnetic resonance imaging; Orbital structures; Extra ocular muscles; Diameter; Eye; Ophthalmologist.

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1. INTRODUCTION

The orbit is a complex anatomic region. A wide range of different pathologies of the orbit occur in different age groups in paediatrics.[1] These can create a lot of challenges in diagnosis and management.[2] Diagnosis and appropriate characterization of orbital lesions depends on normative assessment of orbital structures on magnetic resonance imaging which can greatly help in treatment plans and outcome goals. The extra ocular muscles are thickened in conditions like malignancies, thyroid eye disease, metastatic disease, inflammatory and infective diseases and vascular malformations.[3,4] The optic nerve is also enlarged in different diseases like optic neuritis, orbital pseudo-tumor, meningioma and optic nerve glioma. Its normal diameter assessment will help in optic nerve pathway abnormalities including atrophy.[5-7] Furthermore, the position of the eyeball with respect to adjacent osseous structures determines proptosis and exophthalmos.[8] Magnetic resonance imaging (MRI) is a preferred imaging modality for orbital

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structures as compared to Computed Tomography (CT) due to its high soft-tissue resolution, no risk of ionizing radiation and superior diagnostic accuracy as mentioned in different studies.[9-11]

Currently there is no data available regarding measurement of normal orbital structures from Pakistan. The available data is mainly taken from European, Indian and Chinese population with some changes in the measurements due to different ethnicities of the population. The aim of this study was to assess the measurements of extra ocular muscles, optic nerve, eye globe and orbital diameter in children less than 5 years age of Pakistani population regarding any difference between the two sides and with the increase in age presenting to radiology department of Fauji foundation hospital Rawalpindi using orbital MRI.

2. MATERIALS AND METHODS

This retrospective observational study was conducted in Radiology department, Fauji Foundation Hospital Rawalpindi from 1st April to 30th May 2023. MRI records were reviewed using Picture archiving and communication system (PACS) and measurements were taken on Constructive interference in steady state MRI sequence (CISS). CISS sequence produces high resolution isotropic images using strong T2 weighted 3D gradient echo technique. Sample size was calculated by using epitools calculator with confidence level of 95%, assumed population standard deviation 20.7 and desired precision 3. Sample size was calculated as 183, however a total of 186 patients were included in study. Non-probability consecutive sampling technique was used. Patients with abnormal findings in the orbits like retinoblastoma, persistent hyperplastic primary vitreous, orbital masses and children above 5 years were excluded from the study. All examinations were performed on a Toshiba 1.5 T MRI machine with vintage titan version wide bore super conductor magnet. Patients were sedated while doing the examination.

The patients were divided into three groups according to their ages. Group 1 includes 0-20 months; group 2 includes 20-40 months and group 3 includes 40-60 months children. Diameters of extra ocular muscles (superior, inferior, medial and lateral recti) and width of optic nerve were calculated in millimeters on coronal images. Distance from the inter-zygomatic line to the posterior margin of the globe and globe diameter were calculated in millimeters on axial images for 186 normal eyes of pediatric patients, whose scans were done in last 3 years and the effects of age and sex were analyzed.

The data was entered and analyzed using SPSS (version 21.0). Descriptive statistics were utilized for qualitative and quantitative variables. Quantitative variables like Globe position relative to inter-zygomatic line (IZL), AP and transverse diameter of globe, diameter of optic nerve and extra-ocular muscle diameter were calculated as mean $\pm$ standard deviation (SD). Qualitative variables like age and sex were calculated as frequencies and percentages. The results were interpreted using statistical tests.

3. RESULTS

The total number of patients included in the study was 186, out of which 107 (57.5%) were male and 79 (42.5%) were female. Patients were divided into three groups according to age. Group 1 aged 0-20 months included 49 patients (26.3 %), Group 2 aged 20-40 months included 87 patients (46.8 %) and Group 3 aged 40-60 months included 50 patients (26.9 %).

Normal diameters as given by mean $\pm$2SDs of extra ocular muscles, optic nerve and globe and distance of posterior margin of globe from inter-zygomatic line is given for both eyes in millimeters in tables below.

Table 1: Extra ocular muscles diameters

Measurements	Group 1 (0-20 months age)		Group 2 (20-40 months age)		Group 3 (40-60 months age)		P value	
	Right	Left	Right	Left	Right	Left	Right	Left
Lateral rectus	2.9±0.5mm	2.9±0.5mm	3.1±0.5mm	3.3±0.4mm	3.0±0.4mm	3.4±0.5mm	0.57	0.37
Medial rectus	2.6±0.4mm	2.8±0.5mm	3.1±0.4mm	2.9±0.4mm	3.1±0.4mm	3.2±0.5mm	0.06	0.32
Inferior rectus	2.9±0.7mm	2.9±0.5mm	3.2±0.6mm	3.4±0.4mm	3.1±0.6mm	3.3±0.5mm	0.62	0.09
Superior rectus	2.7±0.4mm	2.7±0.4mm	3.0±0.5mm	3.0±0.4mm	3.1±0.4mm	3.0±0.4mm	0.43	0.27

Table 2: Optic nerve diameters

Measurements	Group 1 (0-20 months age)		Group 2 (20-40 months age)		Group 3 (40-60 months age)		P value	
Optic nerve diameter	Right	Left	Right	Left	Right	Left	Right	Left
	2.8±0.7mm	2.8±0.5mm	3.0±0.4mm	3.0±0.3mm	3.0±0.5mm	3.1±0.4mm	0.58	0.67

Table- 3: Distance of posterior margin of globe from interzygomatic line

Measurements	Group 1 (0-20 months age)		Group 2 (20-40 months age)		Group 3 (40-60 months age)		P value	
	Right	Left	Right	Left	Right	Left	Right	Left
Distance of posterior margin of globe from interzygomatic line	5.6±1.4mm	5.9±1.3mm	6.1±1.2mm	6.1±1.1mm	5.7±1.2mm	6.2±1.2 mm	0.43	0.25

Table-4: Eye globe Antero posterior and transverse diameters

Measurements	Group 1 (0-20 months age)		Group 2 (20-40 months age)		Group 3 (40-60 months age)		P value	
	Right	Left	Right	Left	Right	Left	Right	Left
Anterio posterior diameter	19.7 ±1.5mm	20.06 ±1.1mm	21.1 ±1.2mm	20.9 ±1.0mm	21.6 ±1.2mm	21.2 ±1.1mm	0.001	0.003
Transverse diameter	19.9 ±1.5mm	20.4 ±1.3 mm	21.3 ±1.2mm	21.1 ±1.0mm	21.8 ±1.2mm	21.7 ±1.0mm	0.007	0.05

4. DISCUSSION

The normative measurements are vital as they act as standard for evaluation of diseased states. Literature review showed studies on the subject from different countries. The normative measurements of orbit observed in different studies showed slight variations in measurements based on race, region, and ethnicity.[12]

In our study minimal increase was noted with increase in age by evaluating mean measurements, however most of them were statistically insignificant ($p>0.05$), except the Anteroposterior and Transverse diameters of the globe which were statistically significant ($p<0.05$). It is likely because in our study the age difference between each group is very less. The studies conducted at other centers included age groups up to 16 years and wide range of difference between different groups which showed significant statistical differences in different age groups.

In our study inferior rectus was the thickest muscle followed by lateral rectus, then medial rectus and superior rectus being the thinnest. Lee et al[13], *Zhang et al* [14] and Lerdlum *et al*[15] in their studies also found that inferior rectus was having the maximum thickness amongst all the extra ocular muscles. The consistent pattern of involvement of extra ocular muscles however has not been seen in all studies. The differences might probably be related to the race, regional and ethnic factors. Different studies in literature have reported substantial variability in thickness of extra ocular muscles in different groups of population. Almus E et al reported the lateral rectus muscle to be thinnest and medial rectus to be the thickest extra ocular muscle[16]. Gupta *et al*[8] also found out that medial rectus was the thickest and lateral rectus was the thinnest of all the extra ocular muscles.

In our study optic nerve maximum diameter in group1 was 2.8 mm ±0.6 SD, in group 2 was 3 mm ±0.35 SD and group 3 was 3.05 mm ±0.45 SD. In male patients mean diameter of all groups was 2.98 mm ±0.55 SD and in female patients mean diameter was 3.04 mm ±0.45 SD. The largest mean diameter of the optic nerve was 3.8 mm ±0.06 SD in study by Rffah et al,[16] mildly larger than our study due to inclusion of older paediatric population till 18 years. Boruah *et al*[17] reported that the optic nerve thickness when taken 3 mm posterior to the lamina cribrosa was 2.32 mm ±0.35 SD in males and 2.36 mm ±0.38 SD in females, while optic nerve thickness measured 7 mm posterior to the lamina cribrosa was 2.36 mm ±0.36 SD in males and 2.35 mm ±0.38 SD in females. Our study aimed at measuring the maximum diameter of optic nerve and showed minimal increased thickness of optic nerve with age by mean measurements. The globe position was measured using the perpendicular distance taken between interzygomatic line and posterior margin of the globe at the mid globe level. This distance between interzygomatic line and posterior margin is normally 9.9 ±1.7 mm in adults. This distance helps in the diagnosis of proptosis or exophthalmos.[18] Due to variable growth pattern of bony orbit and its components in children, there is no single cut-off value to be followed. Our study is going to provide help in this regard. The normal globe position in our study was 5.6-6.2 mm on axial view, however Ozgen & Ariyurek 1998 reported it to be about 9.9 mm and Demer & Kerman 1994 reported it 9.4 mm. [19] In their study, Almus et al[16] reported the distance to be 8.73

±1.34 mm and 10.81 1.69 mm in children of upto 24 and 60 months of age. The difference is likely due to difference in the race and genetics.

In our study the vertical and horizontal globe diameters were almost same in each age group, signifying more rounded configuration of the globe. Gupta *et. al.*[8] reported higher horizontal globe diameters, in their study in Indian population using CT. It was probably due to genetics, racial factors and difference in methodologies utilized. There was statistically significant difference in sizes of globe between different age groups in our study.

There were some limitations in our study. Measurement of the interzygomatic line is best done on CT as that is the best radiological investigation for the study of bones; however, we took measurements on MRI. During other studies of extra ocular muscles measurements in adults, patients were instructed to look straight and close their eyes slightly to avoid asymmetrical eye contractions. On the other hand, for our study, we could not take these measurements as the children were sedated during the MRI examination. Consequently, motion artifacts in pediatric orbital MR were also a problem.[20]

5. CONCLUSION

In children less than 5 years age there was steady but minimal increase in orbitaal contents measurements. Also our study will help ophthalmologists of Pakistan in precise assessment of sizes of extra ocular muscles, optic nerve size, globe position and globe size, because this is the first one study in this regard.

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CONFLICT OF INTEREST
Authors declare no conflict of interest.
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AUTHORS' CONTRIBUTION

The following authors have made substantial contributions to the manuscript as under:

Conception or Design:	FA, JAK
Acquisition, Analysis or Interpretation of Data:	FA, JAK, HH, MI, MJ, KFF
Manuscript Writing & Approval:	FA, JAK, HH, MI, MJ, KFF

All the authors agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.