



MRI-Based Normative Measurement of the Ocular Globe Position in Relation to Inter-Zygomatic Line among Nepalese Subjects

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Abstract

Introduction: Many orbito-ocular and systemic disorders have proptosis and enophthalmos as their hallmark symptoms. As visual compromise is a severe consequence if they are not recognized and treated early, the requirement for an imaging parameter that will aid in its early diagnosis is important. This study was carried out to measure the normal ocular globe position in relation to inter zygomatic line among Nepalese population.

Methodology: This prospective study was performed in the Department of Radiology and Imaging, Tribhuvan University Teaching Hospital. Data were collected over the period of January to April 2021 with total of 300 normal ocular globes of 150 patients who underwent MRI scan of brain and PNS. The age and gender of the patients were noted. The measurement was done at the level of lens (mid-globe section) on T2- weighted axial image.

Results: The normal position of the posterior margin of the right globe was 5.68 ± 1.31 mm from inter zygomatic line (ranged 2.7-8.7 mm) while that of the left globe was 5.78 ± 1.24 mm (ranged 3.0-8.9 mm). The distance between the anterior margin and inter zygomatic line of the right ocular globe was 16.95 ± 1.48 mm (ranged 14.2-20.5 mm) and that of left was 16.86 ± 1.38 mm (ranged 14.2-20.3 mm). The position of the globes showed no statistically significant differences among gender groups in our study and the position of the right globe within the orbit was significantly different from that of the left orbit.

Conclusion: The position of the globes showed higher values in males than in female. But, there was no significant difference between male and female patients. However, a statistically significant difference in globe position was observed between right and left orbits. The distance between the posterior margin of the globe and the inter zygomatic line was found to be lower among the Nepalese population compared with Caucasians, Koreans, Nigerian and Canadian.



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Introduction

The interzygomatic line (IZL), a line connecting the anterior edge of the zygomas, is used to objectively measure the position of the ocular globe within the orbit [1,2]. On axial MRI images, the position of the globe within the orbit could be precisely identified by measuring the perpendicular distance of the anterior and posterior margins of the globe to the IZL at the level of the lens [2]. The establishment of a crucial nomogram will aid in the early detection of proptosis and enophthalmos. Proptosis is the abnormal protrusion of the eyeball(s) or anterior displacement of one or both globes within the bony orbit [1,2]. Any increase in orbital contents that occurs from the side or the back will push the eye forward since the orbit has inflexible bony components and only the anterior aperture can expand. It is a crucial symptom that denotes the presence of an orbital space-occupying lesion and can be caused by a variety of illnesses, such as infections, inflammations, tumors, injuries, metastases, endocrine lesions, vascular diseases, and extra-orbital lesions [1]. Whatever the underlying cause, proptosis can impair eye health and vision. Exposure Punctate keratopathy can occur in a proptotic eye that is not sufficiently shielded by the lids [3]. Such disruption of the finely orchestrated homeostatic mechanism to protect the eye will result in corneal compromise, epithelial death, ulceration and possible corneal perforation in severe cases [3]. Therefore, it is crucial to detect proptosis early in order to avoid any detrimental effects. Now, Enophthalmos is defined as a posterior displacement of the globe within the orbit [1,2]. Trauma, chronic maxillary atelectasis (silent sinus syndrome), neoplasms, vascular issues, scleroderma, and fat atrophy, especially in the elderly, are some causes of it [4,5,6]. If not identified and treated at an early stage, visual impairment may also occur. The documented values in literature are findings among the Europeans, Koreans, Nigerians. As there may be a racial variations, there is a need for research to establish a nomogram which will stand as a baseline for Nepalese subjects.

Materials and Methods

This was a quantitative cross-sectional study conducted at the Department of Radiology and Imaging, Tribhuvan University Teaching Hospital (TUTH) for the period of four months from January to April 2021. All the Patients referred for MRI scan of Brain/ PNS between the ages of 18 years and above but without clinical or radiological evidence of Proptosis were included in the study. Patients with endocrine diseases which affect the orbit, particularly thyroid ophthalmopathy, patients with asymmetric scans, scans with artifacts for any reason (e.g. eye implants, eye motion, etc.) that may cause errors in orbital measurements and patients with ferromagnetic prosthesis were excluded from the study. MRI Scan was performed on 1.5T MRI scanner (Siemens Magnetom Amira). For the measurement of the normal globe position, T2-weighted axial images of brain at the level of lens (mid-globe section) is used. The IZL is drawn between the most anterior part of Zygomatic bone with electronic caliper and length is measured. It is used as a reference line. Distance between the Anterior margin of the globe & IZL is measured by drawing the perpendicular line from IZL to the corneal apex. Distance between the posterior margin of the globe & IZL is measured by drawing the perpendicular line from IZL to the posterior border. (Figure1).

Statistical analysis was carried out with the help of SPSS version 20 (IBM, Version: 20.0, Window OS) and Microsoft Excel 2013 (64 bit OS). The quantitative value of IZL, RAM, RPM, LAM and LPM is analyzed using Shapiro-Wilk test for normal distri-

bution. For normally distributed data, Paired samples t-test, Independent samples t-test and Karl Pearson's Correlation Coefficient were used for statistical analysis and for data not normally distributed, Mann Whitney U test and Spearman Correlation Coefficient were used for analysis. A 95% confidence interval was taken and p-value less than 0.05 ($p < 0.05$) was taken as statistically significant.

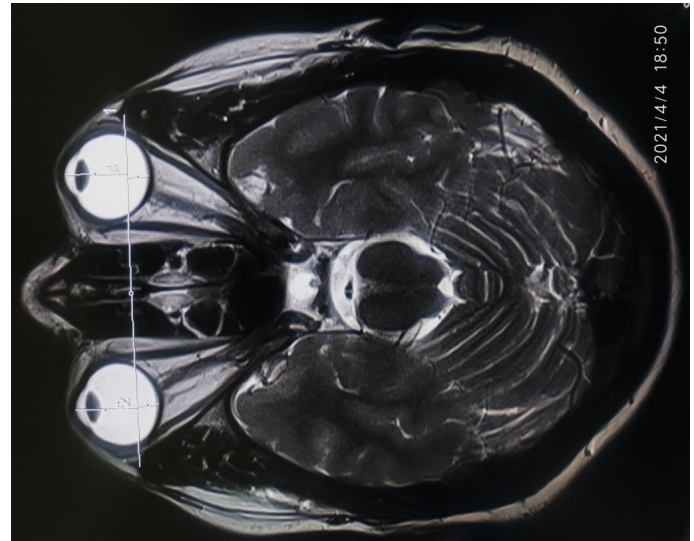


Figure 1: Measurement of ocular globe position on T2 weighted axial image of brain.

Result

A total of 150 patients were enrolled in the study. As per gender wise distribution, 81 (54.0%) patients comprised of female and 69 (46.0%) patients were male. The mean age of the patients was 41.65 ± 17.46 years with the minimum age being 18 years and the maximum age being 85 years. The mean value of IZL, RAM, RPM, LAM and LPM was found to be 97.74 ± 3.74 mm, 16.95 ± 1.48 mm, 5.68 ± 1.31 mm, 16.86 ± 1.38 mm, 5.78 ± 1.24 mm respectively (Table1).

Table 1: Mean values, standard deviation and range of all the measurements in the study.

Parameter	Mean \pm SD	Range (Minimum Maximum)
IZL	97.74 ± 3.74 mm	88.2-106.9 mm
RAM	16.95 ± 1.48 mm	14.2-20.5 mm
RPM	5.68 ± 1.31 mm	2.7-8.7 mm
LAM	16.86 ± 1.38 mm	14.2-20.3 mm
LPM	5.78 ± 1.24 mm	3.0-8.9 mm

There were statistically significant differences found between data for the right and left orbits for all the measurements. ($p < 0.05$). All the measurements showed higher values in males than in female (Table 2). Statistically, there was no significant differences between male and female patients in all measurements ($p > 0.05$) with the notable exception in the IZL which showed the statistically significant differences between males and females ($p < 0.05$). There was statistical significant correlation between age and right and left orbital parameters. ($p < 0.05$).

Table 2: Gender-wise stratification of mean values and standard deviation of all the measurements in the study.

Parameters	Mean \pm SD		Mean Difference	p-value
	Male(n=69)	Female(n=81)		
AGE	42.91 \pm 18.42	40.57 \pm 16.63	2.34	
IzL(mm)	98.82 \pm 3.81	96.82 \pm 3.44	2.00	0.001
RAM(mm)	17.14 \pm 1.52	16.79 \pm 1.43	0.35	0.130
RPM(mm)	5.71 \pm 1.38	5.65 \pm 1.26	0.06	0.782
LAM(mm)	16.99 \pm 1.37	16.74 \pm 1.39	0.25	0.192
LPM(mm)	5.88 \pm 1.28	5.69 \pm 1.22	0.19	0.347

Discussion

Proptosis and enophthalmos are symptoms of numerous orbito-ocular and systemic illnesses, and assessment of their etiology with CT and MRI may be necessary. The necessity for an imaging parameter that will facilitate its early detection is necessary since visual compromise is a serious consequence if they are not identified and treated promptly. CT, MRI and USG are the key diagnostic tools and the imaging modalities of choice for ocular examination of eye, peri-orbital and bony tissues. Ultrasound offers a quick, cheap, non-invasive image of the eye without the need of sedation or anesthesia; however, multiplanar capability is not possible. Although the CT offers rapid image acquisition and appears to be currently more widely available, CT exposes the patient to the ionizing radiation which may limit its routine utilization. In comparison, MRI offers very good contrast resolution of the soft tissues without exposing the patients to ionizing radiation and has multiplanar imaging capability. Although MRI is less available and needs longer image acquisition time as compared to CT, MRI is considered as the key imaging modalities of choice for the soft tissue demonstration.

The mean length of the IZL, which is a reflection of the size of the face was 97.74 \pm 3.74 mm for the entire research participants. It was, however, found to be significantly higher in males than in females. The mean value in males was 98.82 \pm 3.81 mm while that of female participants was 96.82 \pm 3.44 mm. This observation is in tandem with the larger head size usually found in males¹⁶ and it concurs with the finding of other authors. IZL length was significantly higher among male participants [7]. IZL length was significantly higher among male participants [8, 9, 14]. Performed a similar study using MRI scan and found IZL was higher in males than in females [13]. Performed using CT scan in 2019 in India and found IZL was higher in males than in females[15].

Our study revealed a significant difference in the position of the right and left ocular globes within the orbits. The similar findings but this finding is not consonance with the outcome of similar studies done by other authors in other parts of the world [7,8,9,14]. Ozgen and Aydingoz [8] did not find any significant statistical difference between data for the right and left orbits. There was also no significant difference in parameters for right and left orbits in the studies. The discordance observed in the outcome of this study and earlier research works enumerated above may be due to differences in technique and possibility of asymmetrical extraocular muscles contraction that could occur during the scan and the parameters that normally results in prolonged scan time as against MRI systems used by earlier authors. Furthermore, some of the authors used CT for their studies [9,10,17]. Image acquisition is faster with CT and asym-

metrical extraocular muscles contraction may not occur with this modality.

In our study, the posterior margin of the right ocular globe was 5.68 \pm 1.31 mm (ranged 2.7-8.7mm) behind the IZL while the left was 5.78 \pm 1.24 mm (ranged 3.0-8.9mm) from the IZL. Aiyekomogbon et al. [7] found that the posterior margin of the right ocular globe was 6.34 \pm 0.99 mm (ranged 5.4-7.3 mm) behind the IZL while the left was 6.56 \pm 0.93 mm (ranged 5.6-7.5 mm) from the IZL in Nigerian Population. Ozgen and Aydingoz [8] determined the normal position of the ocular globes with the aid of MRI in Turkey and discovered that the normal position of the posterior margin of the globe was 8.9 mm behind the IZL (ranged 5-12.7 mm). Ozgen and Ariyurek [14] used CT for similar study in Turkey and found a mean value of 9.4 mm (ranged 5.9-12.8 mm) as the distance between the IZL and posterior margin of the globes. Carried out similar study among Koreans and found normal position of the ocular globe to be 11.2 mm (ranged 6.4–15.3 mm) behind the IZL [9]. A similar study in Canada revealed that 95% of the cases had the posterior margins of their globes lying 6.5 mm or more behind the IZL [11]. The normal position of the posterior pole from IZL was 7.9 mm and 7.8 mm for left and right sides, respectively among the Indian subjects using CT scan [15].

In our study, the distance between the anterior margin and IZL of the right ocular globe was 16.95 \pm 1.48mm (ranged 14.2-20.5mm) and that of left was 16.86 \pm 1.38mm (ranged 14.2-20.3mm). The distance between the right anterior margin and IZL was 17.01 \pm 1.56 mm while that of left anterior margin was 16.72 \pm 1.43 mm in Nigerian populations [7]. The distance between the anterior margin of globe and IZL to be 16.5 \pm 2.2 mm in men and that of women to be 15.3 \pm 2.1 mm among the Northeast German adult population [10].

The differences that existed between the findings regarding the position of the ocular globes in the present study among Nepalese and findings among Nigerian, Turkish Koreans and others Populations as stated above might be due to racial variation and environmental influence. Benjamin and Borish¹⁸ published an epidemiological study concerning ethnic differences, which suggested a general pattern of the highest prevalence of myopia in Asian, intermediate in Caucasian, and lowest in African-American. There is a paucity of data regarding this in Nepal, making comparison difficult.

In our study, the statistically significant differences in all right and left orbital parameters were found among the studied ages. These findings do not concur with that of where no statistically significant differences in orbital measurements were found among the studied age groups [7, 9]. The position of the globes showed no statistically significant differences among gender groups in our study which is similar to findings among other authors [8,9,11,12,14,17] where the gender differences were not statistically significant.

Conclusion

The position of the globes showed higher values in males than in female. There was no significant difference between male and female patients in orbital measurements. However, a statistically significant difference in globe position was observed between right and left orbits. The distance between the posterior margin of the globe and the IZL was found to be lower among the Nepalese population compared with Caucasians, Koreans, Nigerian and Canadian. This further affirms that race

and environmental influence have significant effects on the position of the ocular globes. The results obtained from this study may help ophthalmologists, radiologists, and other clinicians to objectively evaluate patients with proptosis, enophthalmos or other changes in orbital morphology.

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