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Radiologic Evaluation of the Orbital Index among the Igbo Ethnic Group of Nigeria

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SUMMARY

The two orbits in the human face serve as sockets for the eyeball and other visual apparatus. It is pyramidal in shape with the apex directed posteriorly and the base which forms the orbital margin located anteriorly. The purpose of this study was to radiologically evaluate the orbital index of the Igbo ethnic group of Nigeria. Three hundred and fifty frontal plain radiological films of the skull were obtained from the National Orthopaedic Hospital, Enugu, Nigeria. The films comprised of 217 males and 133 females aged between zero and seventy nine years (0-79 years). The maximal orbital height was measured from the frontal film as the maximum vertical distance between the superior and inferior orbital rims while the maximal orbital width was determined as the maximum horizontal distance between the medial and lateral orbital rims. The orbital indices were estimated from the data gathered using the formula: Orbital index= [maximal orbital height/maximal orbital width]*100. The analyses were done using Statistical Package for Social Sciences (SPSS) version 16.0. The results are reported as mean ± standard deviation. The orbital indices of both sides as well as both sexes were compared using the Student t-test. The differences were considered statistically significant when probability was less than 0.05 ($P<0.05$). The results showed that the mean orbital index was 73.09±13.47. This study also revealed that the orbital index was significantly higher ($P<0.05$) in males than in females. There were no statistically significant differences ($P>0.05$) between the right and left orbital indices in both sexes. It is recommended that further population-based studies be carried out in different geographical locations.

Key words: Orbital height – Orbital width – Orbital index – Igbo ethnic group – Radiology

INTRODUCTION

The two orbital cavities are situated on either side of the sagittal plane of the skull between the cranium and the skeleton of the face. Thus situated, they encroach about equally on these two regions (Last, 1968). Each orbital cavity essentially is intended as a socket for the eyeball, but it also contains associated muscles, vessels, nerves, lacrimal apparatus, fascial strata and a soft pad of fat. In a nutshell, it lodges the visual apparatus (Soames, 1999). Due to the fact that it is made up of many bones and that it has fissures, foramina and canals, the orbit is said to have a very complex structure. However, the orbit is roughly pyramidal in shape with the apex located posteriorly forming the optic canal and the base located anteriorly forming the orbital margin.

The studies of the orbit, its dimensions and volume have long been done by many researchers in various parts of the world. The use of vernier calipers to study the dimensions of the orbital rims is a common process even to the present day (Giles and Elliot, 1962; Catalina-Herrera, 1988; Nitek et al., 2009). However, with the advancement in tech-

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nology, the study of the orbit at present could be done more accurately with the aid of various radiological techniques (Dilmen et al., 2002; Merz et al., 1995; Haas et al., 1993; Denis et al., 1998).

Many anthropologists had given various values to the dimensions and volumes of the orbit in various populations (Forbes et al., 1985; Karampatakis, 1998; Mercandetti and Cohen, 2004). For instance, megaseme type of orbital index is typical of Asiatic populations except the Eskimos; mesoseme type of orbital index is typical of Caucasian populations, while microseme type of orbital index is typical of black African population. Orbital dimensions had been found to vary among different populations (Dilmen et al., 2002; Merz et al., 1995; Haas et al., 1993; Denis et al., 1998). Population-based variations were recognized as the result of evolutionary processes, that is, mutations that are inheritable are acted upon by natural selection. Population-based differences, thus, reflect current environmental pressure, genetic drift, past and present hybridization between geographically distinct populations and the present selective adaptation of human varieties to their environment (Catalina-Herrera, 1988).

Bentley et al. (2002) and Haas et al. (1993) all agreed that there were no significant differences between the right and the left orbits. Orbital dimensions had also been correlated with sex and age. Ferrario et al. (2001), Bentley et al. (2002) and Denis et al. (1998) all agreed that there were no significant differences between males and females in orbital morphometries, including orbital heights and widths. They further went ahead to propose that there could be a correlation between orbital width and height analyzed by the orbital index [orbital index = (orbital height/orbital width)*100]

According to Patnaik et al. (2001), taking the orbital index as the standard, three classes of orbit could be recognized: in megaseme type, the orbital index is 89 and above; in mesoseme type, the orbital index is between 83 and 89 (i.e. 83.1 to 88.9) while in microseme (small) type, the orbital index is 83 or less.

Researches aiming to find the normative dimensions of the bony orbit among the Igbo Ethnic group of Nigeria are not very common. Studies such as this are of paramount importance, as a thorough understanding of orbital anatomy is essential to fully appreciate the effects of disease on the orbit, and therefore useful for performing safe orbital surgery (René, 2006). This study would also be of help to surgeons especially when performing reconstructive surgery in and around the orbit.

The knowledge of this index will be important in various aspects such as interpretation of fossil records, skull classification in forensic medicine, and in exploring the trends in evolutionary and ethnic differences. Furthermore, documented ranges of this index in different ethnic groups will assist in skull identification (Giles and Elliot, 1962; Steward, 1954). The main objective of the present study was to evaluate radiologically the orbital index of the Igbo ethnic group of Nigeria.

MATERIALS AND METHODS

The study was carried out retrospectively in the National Orthopedic Hospital, Enugu, using Plain X -rays of the Water's (frontal) view of the skull. The orbital parameters obtained from roentgenographs have been shown to be slightly different from those obtained from direct measurement of human skulls and this difference had been attributed to the magnification factor of X-ray machines. Hence, in obtaining a roentgenograph, the angle of emission of radiation, the distance from source of radiation and the positioning of the patient were all standardized to give valid reproducible results (Lusted and Keats, 1977). This was achieved by placing the chin of the patient on the X-ray cassette with the canthomeatal line (the line that connects the lateral canthus and the external auditory meatus) at 37 degrees to 45 degrees. This orientation is accomplished by placing the nose of the patient approximately 0.5 to 1.5 cm above the X-ray plate.

Radiographic films (Water's view) of patients aged between less than one year and seventy nine years (<1year – 79years) were collected. Measurements were only taken on skulls that were evidently healthy or, if pathology was present, from those that did not affect the dimensions of the orbit. All cases of raised intracranial or intraorbital pressures as reported by the radiologists were also discarded. Information on the age and sex were also gathered from the hospital cards. The films that were selected for the study were strictly those of the Igbos based on the information given by the subjects and filled in their cards. Non-Igbos were not included in the study. Moreso, all forms of deformed or distorted plain films were excluded from the study. A total of 350 individuals (217 males and 133 females) were analyzed. Therefore, a total of 700 orbital margins were measured (350 from each side). Frequencies of distribution of age and sexes are shown in Table 1.

Measurements were taken as shown in figure 1 below. The orbital height was measured from the

Table 1. Frequency of age and sex distributions among the study population

Age group (years)	Males	Females	COMBINED
0-9	13	20	33
10-19	29	12	41
20-29	66	35	101
30-39	47	20	67
40-49	24	13	36
50-59	16	13	30
60-69	12	13	25
70-79	10	7	17
TOTAL	217	133	350

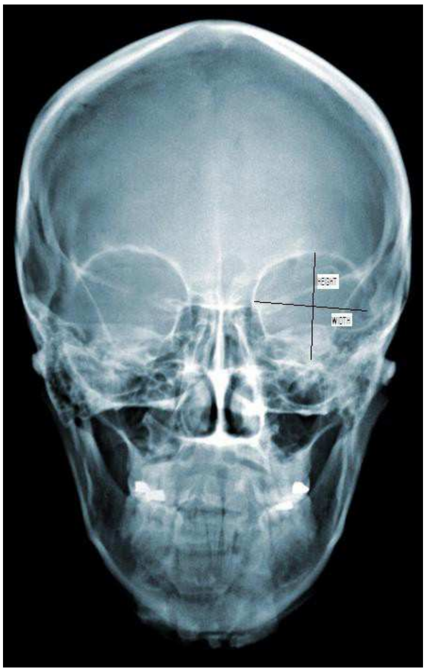

Fig. 1. Plain film showing the orbital margin and measurement of orbital width and height.

frontal film as the maximal distance between the superior and inferior orbital margins. The orbital width was also measured from the same frontal film as the maximal distance between the medial and lateral orbital margins.

The orbital indices were calculated from the data gathered using the formula:

Orbital index = (height of orbit/width of orbit)*100

The results were reported as mean ± standard deviation. The orbital indices of both sides were compared using the students' t-test (2 samples and paired) taking into account the age and sex of the individuals. The results were also compared in both sexes using the students' t-test (2 samples, unpaired, assuming equal variance) taking into account the laterality and age of the individuals. The differences were considered statistically significant at 95% confidence level, i.e., when probability is less than 0.05 ($P<0.05$). The analyses were done using computer software known as statistical package for social sciences (SPSS) version 16.0.

RESULTS

Results indicate that the male orbital index was significantly higher ($P<0.05$) than the females orbital index (Table 2).

When the sexes were combined, there was no statistically significant difference between right and left orbital indices ($P>0.05$). In males (Table 3), there was no statistically significant difference between right and left orbital indices ($P>0.05$). In females (Table 3), there was no statistically significant difference between right and left orbital indices ($P>0.05$). The right and left orbital indices were significantly higher ($P<0.05$) in males than in females, see Table 3.

There were statistically significant differences ($P>0.05$) in orbital index between males and females in all age groups with the exception of groups 20-29, 40-49 and 50-59 years, probably due to the size of the sample in these age intervals. Male orbital index was significantly higher ($P<0.05$) than female orbital index in age groups 0-9, 30-39, 60-69 and 70-79 years while female orbital index was significantly higher ($P<0.05$) than male orbital index in age group 10-19 years (Table 4).

There was no statistically significant difference ($P>0.05$) between right and left orbital indices in all the age groups in males, females and sexes combined.

There was no statistically significant difference ($P>0.05$) between male and female orbital indices on both sides in age groups 0-9, 20-29, 30-39, 40-49 and 50-59 years while male orbital indices were significantly higher ($P<0.05$) than female orbital indices on both sides in age groups 60-69 and 70-79 years.

Table 2. Mean ± standard deviation of all the parameters studied irrespective of the side

Sex	Combined	Males	Females	Probability
count	350	217	133	
Age(mean ± SD) years	33.12±18.74	33.02±17.50	33.29±20.70	
Orbital index	73.09±13.47	73.54±13.14	69.74±13.16	0.000*

*significant

Table 3. Comparison of the Orbital Index with respect to sexes and sides

Sex	Combined	Males	Females	Probability
count	350	217	133	
Right Orbital index	72.2±13.5	73.6±13.3	69.9±13.5	0.014*
Left orbital index	72.0±13.1	73.5±13.0	69.6±12.8	0.006*
PROBABILITY	0.88	0.97	0.84	

*significant

Table 4. Mean Orbital Index among the different age groups

Age group (years)	COMBINED (n)	Males (n)	Females (n)	Probability
0-9	65.24±11.60 (33)	69.07±10.59 (13)	62.76±11.68 (20)	0.030*
10-19	68.23±10.12 (41)	66.77±9.33 (29)	71.75±11.25 (12)	0.042*
20-29	73.26±13.26 (101)	73.82±13.09 (66)	72.21±13.60 (35)	0.413
30-39	75.28±13.88 (67)	77.02±14.33 (47)	71.18±11.97 (20)	0.025*
40-49	74.98±13.25 (36)	74.28±14.21 (24)	76.29±11.43 (13)	0.537
50-59	74.69±16.52 (30)	75.58±16.95 (16)	73.61±16.24 (13)	0.655
60-69	68.56±10.89 (25)	74.63±8.74 (12)	62.95±9.70 (13)	0.000*
70-79	69.72±9.63 (17)	74.37±6.55 (10)	63.09±9.59 (7)	0.000*

*significant

Table 5. Comparison between right and left Orbital Index among the different age groups

	Combined			MALES			FEMALES		
Age group (years)	right	left	proba-bility	right	left	proba-bility	right	left	proba-bility
0 – 9	65.24± 12.53	65.25± 10.79	1	69.21±11.19	68.93± 10.41	0.95	62.66± 12.94	62.86± 10.61	0.86
10 – 19	68.01± 10.51	68.44± 9.84	0.85	66.55±9.72	66.99 ± 9.09	0.86	71.55± 11.91	71.95± 11.07	0.93
20 – 29	73.27± 13.17	73.25± 13.41	0.99	73.76±12.92	73.88± 13.35	0.96	72.35± 13.76	72.07± 13.64	0.93
30 – 39	75.23± 14.12	75.33± 13.74	0.97	76.93±14.47	77.11± 14.34	0.95	71.22± 12.73	71.15± 11.48	0.98
40 – 49	75.29± 13.66	74.68± 13.01	0.85	74.53±14.75	74.03± 13.95	0.9	76.69± 11.82	75.88± 11.50	0.86
50 – 59	75.15± 16.94	74.24± 16.37	0.84	75.85±17.60	75.31± 16.85	0.93	74.28± 16.76	72.93± 16.35	0.84
60 – 69	68.95± 11.18	68.17± 10.81	0.8	75.08±9.22	74.19± 8.62	0.81	63.29± 10.00	62.62± 9.78	0.86
70 – 79	69.91± 10.09	69.54± 9.45	0.91	74.49±7.45	74.25± 5.92	0.94	63.37± 10.17	62.80± 9.78	0.92

Table 6. Comparison between male and female right Orbital Index

	Right			Left		
Age group (years)	Males	Females	probability	Males	Females	probability
0 – 9	69.21±11.19	62.66±12.94	0.145	68.93±10.41	62.86±10.61	0.115
10 – 19	66.55±9.72	71.55±11.91	0.169	66.99±9.09	71.95±11.07	0.144
20 – 29	73.76±12.92	72.35±13.76	0.61	73.88±13.35	72.07±13.64	0.522
30 – 39	76.93±14.47	71.22±12.73	0.131	77.11±14.34	71.15±11.48	0.105
40 – 49	74.53±14.75	76.69±11.82	0.652	74.03±13.95	75.88±11.50	0.684
50 – 59	75.85±17.60	74.28±16.76	0.81	75.31±16.85	72.93±16.35	0.705
60 – 69	75.08±9.22	63.29±10.00	0.006*	74.19±8.62	62.62±9.78	0.005*
70 – 79	74.49±7.45	63.37±10.17	0.020*	74.25±5.92	62.80±9.78	0.009*

*significant

DISCUSSION

This radiologic study presented the values for orbital index from a sample of Igbos of Nigeria. The study showed that there was no statistically significant difference between the right and left orbits in all the parameters studied and in both sexes which agreed with Bentley et al. (2002), Haas et al. (1993), Sforza et al. (2009) and Ji et al. (2010). These results allowed us to combine both sexes during the analysis.

This study showed that the orbital index was significantly higher in males (73.54±13.14) than in females (69.74±13.16). This is in agreement with Adebisi (2003), Ji et al. (2010) and Weaver et al. (2010). Male Hausas/Fulanis of Nigeria had higher orbital index (93.7) than the males in this study, while the female Hausas/Fulanis Nigeria had similar orbital index (69.3) as the females in this study (Adebisi, 2003). This work was at variance with the works of Igbigbi and Ebite (2010) in adult Malawians and Catalina-Herrera (1988) in Europeans, which showed that female orbital index were generally higher than males. Furthermore, this work is at variance with those of Ferrario et al. (2001), Bentley et al. (2002) and Denis et al. (1998), which conclude that there was no significant difference in orbital parameters between males and females on both sides.

This study established the mean values of the orbital index taken into account the sex and laterality, showing that men always have higher orbital indexes than females. However, the results of this study do not indicate differences between right and left orbital indexes.

This study also established the mean values of the orbital index for various age groups in both sexes. There was an increase in the orbital index with age up to age group 30-39 when a peak was attained. Then there was a decline with further increase in age. The variation of the orbital index with age supports the works of (Igbigbi and Ebite, 2010). This suggests either a genetically determined continuous variable like height, or might be due to continuous bone resorption and remodelling which according to Parfitt (1983 and 1993), occurred at cortical bone surface every 2-5 years while bone turnover for the whole skeleton occurred about 10% per year.

When sexes were combined, the smallest orbital index of 65.24±11.60 occurred in age group 0-9 years. In males, the smallest orbital index of 69.07±10.59 occurred in age group 0-9 years. In females, the smallest orbital index of 62.76±11.68 also occurred in age group 0-9 years. This was in contrast with smallest parameters occur in later ages (Igbigbi and Ebite, 2010). This could be attributed to a more chronic bone resorption and remodeling as a result of aging among adult Malawians. This is however subject to further studies.

When sexes were combined, the orbital index attained a peak of 75.28±13.88 at age group 30-39 years. In males also, the orbital index attained a peak of 77.02±14.33 at age group 30-39. However, in females, the orbital index attained a peak of 76.29±11.43 at a later age group (40-49 years).

Earlier study by Igbigbi and Ebite on adult Malawians showed that orbital index attained peak in age group 48-57 in both sexes. This earlier peak among the Igbos could be an indication of early metamorphic changes in the bones of the orbit. This is however subject to further studies.

When right and left orbits were combined, there were no statistically significant differences in orbital index between males and females of age groups 20-29, 40-49 and 50-59 while male orbital index was significantly higher than female orbital index in age groups 0-9, 10-19, 30-39, 60-69 and 70-79. However, when sides are put into consideration, there was no statistically significant difference between male and female right orbital index in age groups 0-9, 20-29, 30-39, 40-49 and 50-59 while male left orbital index was significantly higher than female left orbital index in age groups 60-69 and 70-79 on both sides.

In conclusion, this study presents the orbital indices among the Igbo ethnic group of Nigeria thus providing a useful baseline and an anthropometric data that will be of clinical and surgical interest in ophthalmology, oral and maxillofacial surgery and indeed neurosurgery in this part of the world. Further studies are recommended to evaluate and characterize orbital parameters among different populations.

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