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-
nology, the study of the orbit at present could be
done more accurately with the aid of various radi-
ological 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 vari-
ous populations (Forbes et al., 1985; Karam-
patakis, 1998; Mercandetti and Cohen, 2004). For
instance, megasemse type of orbital index is typical
of Asiatic populations except the Eskimos;
mesoforme type of orbital index is typical of Cauca-
sian populations, while microseme type of orbital
index is typical of black African population. Orbital
dimensions had been found to vary among differ-
ent populations (Dilmen et al., 2002; Merz et al.,
1995; Haas et al., 1993; Denis et al., 1998). Popu-
lation-based variations were recognized as the
result of evolutionary processes, that is, mutations
that are inheritable are acted upon by natural se-
lection. Population-based differences, thus, reflect
current environmental pressure, genetic drift, past
and present hybridization between geographically
distinct populations and the present selective adap-
tation 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 dimen-
sions 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 megasemse type, the
orbital index is 89 and above; in mesoforme type, the
orbital index is between 83 and 89 (i.e. 83.1 to
88.9) while in microseme type of orbital
index is typical of black African population. Orbital
dimensions had been found to vary among differ-
ent populations (Dilmen et al., 2002; Merz et al.,
1995; Haas et al., 1993; Denis et al., 1998). Popu-
lation-based variations were recognized as the
result of evolutionary processes, that is, mutations
that are inheritable are acted upon by natural se-
lection. Population-based differences, thus, reflect
current environmental pressure, genetic drift, past
and present hybridization between geographically
distinct populations and the present selective adap-
tation of human varieties to their environment
(Catalina-Herrera, 1988).

Researches aiming to find the normative dimen-
sions of the bony orbit among the Igbo Ethnic
group of Nigeria are not very common. Studies
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 megasemse type, the
orbital index is 89 and above; in mesoforme 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 dimen-
sions 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 es-
ential 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 rec-
ords, 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 mag-
nification factor of X-ray machines. Hence, in ob-
taining 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 accom-
plished by placing the nose of the patient approxi-
ately 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. Meas-
urements were only taken on skulls that were evi-
dently healthy or, if pathology was present, from
those that did not affect the dimensions of the or-
it. 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-Igbo
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

<p>| Table 1. Frequency of age and sex distributions among the study population |
|-----------------|-------|-------|-------|</p>
<table>
<thead>
<tr>
<th>Age group (years)</th>
<th>Males</th>
<th>Females</th>
<th>COMBINED</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-9</td>
<td>13</td>
<td>20</td>
<td>33</td>
</tr>
<tr>
<td>10-19</td>
<td>29</td>
<td>12</td>
<td>41</td>
</tr>
<tr>
<td>20-29</td>
<td>66</td>
<td>35</td>
<td>101</td>
</tr>
<tr>
<td>30-39</td>
<td>47</td>
<td>20</td>
<td>67</td>
</tr>
<tr>
<td>40-49</td>
<td>24</td>
<td>13</td>
<td>36</td>
</tr>
<tr>
<td>50-59</td>
<td>16</td>
<td>13</td>
<td>30</td>
</tr>
<tr>
<td>60-69</td>
<td>12</td>
<td>13</td>
<td>25</td>
</tr>
<tr>
<td>70-79</td>
<td>10</td>
<td>7</td>
<td>17</td>
</tr>
<tr>
<td>TOTAL</td>
<td>217</td>
<td>133</td>
<td>350</td>
</tr>
</tbody>
</table>
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:

\[ \text{Orbital index} = \frac{\text{height of orbit}}{\text{width of orbit}} \times 100 \]

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

<table>
<thead>
<tr>
<th>Sex</th>
<th>Combined</th>
<th>Males</th>
<th>Females</th>
<th>Probability</th>
</tr>
</thead>
<tbody>
<tr>
<td>count</td>
<td>350</td>
<td>217</td>
<td>133</td>
<td></td>
</tr>
<tr>
<td>Age(mean ± SD) years</td>
<td>33.12±18.74</td>
<td>33.02±17.50</td>
<td>33.29±20.70</td>
<td></td>
</tr>
<tr>
<td>Orbital index</td>
<td>73.09±13.47</td>
<td>73.54±13.14</td>
<td>69.74±13.16</td>
<td>0.000*</td>
</tr>
</tbody>
</table>

*significant

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

<table>
<thead>
<tr>
<th>Sex</th>
<th>Combined</th>
<th>Males</th>
<th>Females</th>
<th>Probability</th>
</tr>
</thead>
<tbody>
<tr>
<td>count</td>
<td>350</td>
<td>217</td>
<td>133</td>
<td></td>
</tr>
<tr>
<td>Right Orbital index</td>
<td>72.2±13.5</td>
<td>73.6±13.3</td>
<td>69.9±13.5</td>
<td>0.014*</td>
</tr>
<tr>
<td>Left orbital index</td>
<td>72.0±13.1</td>
<td>73.5±13.0</td>
<td>69.6±12.8</td>
<td>0.006*</td>
</tr>
<tr>
<td>PROBABILITY</td>
<td>0.88</td>
<td>0.97</td>
<td>0.84</td>
<td></td>
</tr>
</tbody>
</table>

*significant
Table 4. Mean Orbital Index among the different age groups

<table>
<thead>
<tr>
<th>Age group (years)</th>
<th>Combined (n)</th>
<th>Males (n)</th>
<th>Females (n)</th>
<th>Probability</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-9</td>
<td>65.24±11.60 (33)</td>
<td>69.07±10.59 (13)</td>
<td>62.76±11.68 (20)</td>
<td>0.030*</td>
</tr>
<tr>
<td>10-19</td>
<td>68.23±10.12 (41)</td>
<td>66.77±9.33 (23)</td>
<td>71.75±11.25 (12)</td>
<td>0.042*</td>
</tr>
<tr>
<td>20-29</td>
<td>73.26±13.26 (101)</td>
<td>73.82±13.08 (66)</td>
<td>72.21±13.60 (35)</td>
<td>0.413</td>
</tr>
<tr>
<td>30-39</td>
<td>75.28±13.88 (67)</td>
<td>77.02±14.33 (47)</td>
<td>71.18±11.97 (20)</td>
<td>0.025*</td>
</tr>
<tr>
<td>40-49</td>
<td>74.98±13.25 (36)</td>
<td>74.28±14.21 (24)</td>
<td>76.29±11.43 (13)</td>
<td>0.537</td>
</tr>
<tr>
<td>50-59</td>
<td>74.69±16.52 (30)</td>
<td>75.58±16.95 (16)</td>
<td>73.61±16.24 (13)</td>
<td>0.655</td>
</tr>
<tr>
<td>60-69</td>
<td>68.56±10.89 (25)</td>
<td>74.63±8.74 (12)</td>
<td>62.95±9.70 (13)</td>
<td>0.000*</td>
</tr>
<tr>
<td>70-79</td>
<td>69.72±9.63 (17)</td>
<td>74.37±6.55 (10)</td>
<td>63.09±9.59 (7)</td>
<td>0.000*</td>
</tr>
</tbody>
</table>

*significant

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

<table>
<thead>
<tr>
<th>Age group (years)</th>
<th>Combined right</th>
<th>left</th>
<th>probability right</th>
<th>left</th>
<th>probability right</th>
<th>left</th>
<th>probability right</th>
<th>left</th>
<th>probability right</th>
<th>left</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 – 9</td>
<td>65.24±12.53</td>
<td>65.25±10.79</td>
<td>1</td>
<td>69.21±11.19</td>
<td>68.93±10.41</td>
<td>0.95</td>
<td>62.66±12.94</td>
<td>62.96±10.61</td>
<td>0.86</td>
<td></td>
</tr>
<tr>
<td>10 – 19</td>
<td>68.01±10.51</td>
<td>68.44±9.84</td>
<td>0.85</td>
<td>66.55±9.72</td>
<td>66.99±9.09</td>
<td>0.86</td>
<td>71.55±11.91</td>
<td>71.95±11.07</td>
<td>0.93</td>
<td></td>
</tr>
<tr>
<td>20 – 29</td>
<td>73.27±13.17</td>
<td>73.25±13.41</td>
<td>0.99</td>
<td>73.76±12.92</td>
<td>73.88±13.35</td>
<td>0.96</td>
<td>72.35±13.76</td>
<td>72.07±13.64</td>
<td>0.93</td>
<td></td>
</tr>
<tr>
<td>30 – 39</td>
<td>75.23±14.12</td>
<td>75.33±13.74</td>
<td>0.97</td>
<td>76.93±14.47</td>
<td>77.11±14.34</td>
<td>0.95</td>
<td>71.22±12.73</td>
<td>71.15±11.48</td>
<td>0.98</td>
<td></td>
</tr>
<tr>
<td>40 – 49</td>
<td>75.29±13.66</td>
<td>74.68±13.01</td>
<td>0.85</td>
<td>74.53±14.75</td>
<td>74.03±13.95</td>
<td>0.9</td>
<td>76.69±11.82</td>
<td>75.88±11.50</td>
<td>0.86</td>
<td></td>
</tr>
<tr>
<td>50 – 59</td>
<td>75.15±16.94</td>
<td>74.24±16.37</td>
<td>0.84</td>
<td>75.85±17.60</td>
<td>75.31±16.85</td>
<td>0.93</td>
<td>74.28±16.76</td>
<td>72.93±16.35</td>
<td>0.84</td>
<td></td>
</tr>
<tr>
<td>60 – 69</td>
<td>68.95±11.18</td>
<td>68.17±10.81</td>
<td>0.8</td>
<td>75.08±9.22</td>
<td>74.19±8.62</td>
<td>0.81</td>
<td>63.29±10.00</td>
<td>62.62±9.78</td>
<td>0.86</td>
<td></td>
</tr>
<tr>
<td>70 – 79</td>
<td>69.91±10.09</td>
<td>69.54±9.45</td>
<td>0.91</td>
<td>74.49±7.45</td>
<td>74.25±5.92</td>
<td>0.94</td>
<td>63.37±9.01</td>
<td>62.80±8.76</td>
<td>0.92</td>
<td></td>
</tr>
</tbody>
</table>

*significant

Table 6. Comparison between male and female right Orbital Index

<table>
<thead>
<tr>
<th>Age group (years)</th>
<th>Males right</th>
<th>Females right</th>
<th>probability Males right</th>
<th>Females right</th>
<th>probability Males right</th>
<th>Females right</th>
<th>probability</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 – 9</td>
<td>69.21±11.19</td>
<td>62.66±12.94</td>
<td>0.145</td>
<td>68.93±10.41</td>
<td>62.86±10.61</td>
<td>0.115</td>
<td></td>
</tr>
<tr>
<td>10 – 19</td>
<td>66.55±9.72</td>
<td>71.55±11.91</td>
<td>0.169</td>
<td>66.99±9.09</td>
<td>71.95±11.07</td>
<td>0.144</td>
<td></td>
</tr>
<tr>
<td>20 – 29</td>
<td>73.76±12.92</td>
<td>72.35±13.76</td>
<td>0.61</td>
<td>73.88±13.35</td>
<td>72.07±13.64</td>
<td>0.522</td>
<td></td>
</tr>
<tr>
<td>30 – 39</td>
<td>76.93±14.47</td>
<td>71.22±12.73</td>
<td>0.131</td>
<td>77.11±14.34</td>
<td>71.15±11.48</td>
<td>0.105</td>
<td></td>
</tr>
<tr>
<td>40 – 49</td>
<td>74.53±14.75</td>
<td>76.99±11.82</td>
<td>0.652</td>
<td>74.03±13.95</td>
<td>75.88±11.50</td>
<td>0.684</td>
<td></td>
</tr>
<tr>
<td>50 – 59</td>
<td>75.85±17.60</td>
<td>74.28±16.76</td>
<td>0.81</td>
<td>75.31±16.85</td>
<td>72.93±16.35</td>
<td>0.705</td>
<td></td>
</tr>
<tr>
<td>60 – 69</td>
<td>75.08±9.22</td>
<td>63.29±10.00</td>
<td>0.006*</td>
<td>74.19±8.62</td>
<td>62.62±9.78</td>
<td>0.005*</td>
<td></td>
</tr>
<tr>
<td>70 – 79</td>
<td>74.49±7.45</td>
<td>63.37±10.17</td>
<td>0.020*</td>
<td>74.25±5.92</td>
<td>62.80±9.78</td>
<td>0.009*</td>
<td></td>
</tr>
</tbody>
</table>

*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 Igbughi 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 Igboos 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.

REFERENCES


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