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REFERENCING ORBITAL MEASURES FOR SURGICAL AND COSMETIC PROCEDURES

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SUMMARY

Orbital morphometry is an important consideration during surgical procedures such as reconstruction of the face and cranium. These are done to restore lost functional capacity or to improve cosmetic appearance. Periorbital and intraorbital neurovascular structures risk relative damage during these maneuvers. A thorough understanding of orbital anatomy is therefore essential in avoiding surgical complications. The aim of this study was to describe the average orbital distances and depths from known identifiable anatomical landmarks. One hundred and thirteen adult crania obtained from National Museum of Kenya, Nairobi were examined. Measurements of superior and inferior orbital depths and the biorbital and marginofissural distances were taken using a sliding vernier caliper and their mean measurements documented. The superior orbital depth was 53.38mm in males and 52.03mm in females. The inferior orbital depth was 55.17mm in males and 53.76mm in females. The marginofissural distance was 23.79mm and 22.30mm in males and females respectively. The biorbital breadth was 99.49mm in males and 96.43mm in females while the interorbital distance was 18.91mm in males and 18.26mm in females. This study proposes that orbital measures be given special consideration during orbital reconstruction. A depth of 53mm is recommended as a safe superior orbital depth during operations involving the deep orbit. Similarly, on the orbital floor 55mm into the orbital cavity should be considered safe from the optic nerve.

Key words: orbital measurements, facial cosmetic surgery, facial plastic surgery, orbital reconstruction, orbital anesthesia

INTRODUCTION

Periorbital and facial injuries are mainly caused by assaults and falls and at times may involve the forehead (Folkestad et al., 2003). Such injuries necessitate cranial and orbital reconstructions to correct both aesthetic and functional deficits (Freihofer, 1995; Masayuki et al., 2005; Chacon-Moya et al., 2009). Care must be taken to prevent damage to the neurovascular structures contained in the orbit or within its walls. In order to achieve this, the surgeon needs to have a proper understanding of the human orbital structure, its relationship with both intra- and extracranial structures, and associated key surgical/anatomical landmarks. Principal factors to consider include inferior and superior orbital depths, interorbital and biorbital distances and the marginofisural distance. However, these measures have been known to vary with age and sex (Igbigbi et al., 2008) and with race (Parsons et al., 1919).

The inferior orbital fissure serves as a communication between the orbit and the infratemporal and pterygopalatine fossae. Although its contents can be safely manipulated, care must be taken in order not to damage the infraorbital nerve or branches of the inferior ophthalmic vein that pass through the fissure into the pterygoid venous plexus (Tripathi et al., 2007). As a result, the surgeon must bear in mind the distance of the anterior extent of the inferior orbital fissure from the inferior orbital margin during inferior orbital wall reconstruction. Moreover, the practice of safe regional orbital anesthesia is largely dependent on a proper understanding of orbit anatomy and contents (Grizzard et al., 1989; Khaleeq et al.,

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2008). This helps in preventing detrimental effects following injuries of structures like the optic nerve. It is therefore important to consider the lengths of the superior and inferior orbital depths during deep orbit surgical operations in order not to damage the optic nerve. However, these orbital depths not only show a racial variation but also vary with sex within a given population (Hwang et al., 1999; Karakas et al., 2002; Huanmanop et al., 2007).The biorbital distance is a measure of how wide the face is and would be a key factor to consider in the design of spectacle frames. The interorbital width sets the right and left orbits apart from each other and when small may give an impression of squinting (Patnaik et al., 2001). Both distances are usually higher in males than among females (Igbigbi and Ebite, 2008) and should be borne in mind for the effective restoration of aesthetic deficits.

MATERIALS AND METHODS

Adult crania of known sex were obtained from the archives of the osteology department, National Museum of Kenya, Nairobi. Measurements from eighty male crania (71%) and thirty three female crania (29%) were analyzed. Non-sexed crania and those which had gross defects were excluded from the study. Measurements were taken using a sliding vernier caliper Franchois™, 2000 with an accuracy of 0.01cm. Measurements for all crania were taken by the same person twice but at different sittings in order to control for intra-observer errors. The superior orbital depth was measured from the supraorbital notch to the superior aspect of the orbital opening of the optic canal. The infraorbital foramen was used as the landmark for the inferior orbital depth. This depth was measured from the point on the inferior orbital margin directly above the infraorbital foramen to the inferior aspect of the orbital opening of the optic canal. The distance from the inferior orbital margin to the anterior extent of the inferior orbital fissure, here referred to as the marginofissural distance (MFD), was measured from the point directly above the infraorbital foramen on the inferior orbital margin to the most anterior point of the inferior orbital fissure. These depths were measured for both the right and left orbits. The ectochion, which is the intersection of the most anterior surface of the lateral border of the orbit and a line bisecting the orbit along its long axis, was used as a landmark for the most lateral point of the orbit. Together with its opposite counterpart, they were used to measure the biorbital breadth (Kelly et al., 1999). The sloping distance between the dacryon (the point on the medial border of the orbit at which the frontal, lacrimal, and maxilla bones intersect) and the ectochion was taken to be the orbital breadth. To get the interorbital distance, the sum of the right and left orbital widths were deducted from the biorbital distance. All distances were expressed in millimeters.

RESULTS

The right superior orbital depth (RSOD) ranged from 43mm to 62mm with a mean depth of 52.9 +/- 2.86mm. There were 62.5% skulls with a RSOD which was lower than the average depth. On the other hand, the left superior orbital depth (LSOD) ranged between 48mm and 61mm with a mean depth of 53.1 +/- 2.60mm, and only 59.4% of the orbits with a depth lower than 55mm. The right inferior orbital depth (RIOD) ranged from 48mm to 64mm, with a mean depth of 54.7 +/-2.88mm. The left inferior orbital depth (LIOD) ranged from 51mm to 63mm with a mean depth of 54.8 +/- 2.74mm. The difference between the right and left orbital measurements for a particular sex gave a p-value of 0.927 which was not statistically significant ($p<0.05$).

In the males, the biorbital distance ranged between 87.10mm and 111.20mm (mean 99.49mm +/- 4.31) while in the females the range was between 80.70mm and 104.00mm (mean 96.43 +/- 4.86mm). The difference between the biorbital distances of the two sexes gave a p-value of ($p = 0.001$) which was statistically significant.

Among the males, the interorbital distance ranged between 9.52mm and 27.80mm, with a mean distance of 18.91 +/- 3.18 mm, while in the females it was between 11.20mm and 25.40mm with a mean distance of 18.26 +/- 3.32 mm. The difference between the interorbital distances of the two sexes gave a p-value of 0.331, which was not statistically significant. When the sum of the orbital width of the right and left orbits was expressed as a percentage of the biorbital distance, it ranged between 71.78% and 90.31% (mean 81.03% +/- 3.0604) in the males and between 72.81% and 87.87% (mean 81.10% +/ 3.15) in the females. This difference gave a p value of 0.915 which was not statistically significant.

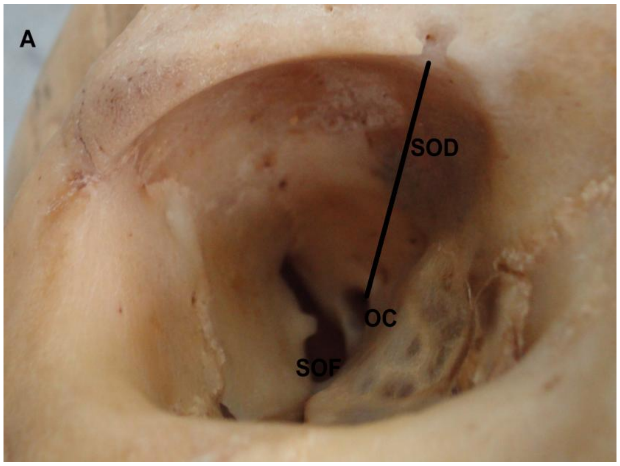


Figure 1.0 Diagram showing Superior orbital depth OD, superior orbital width; OC, optic canal; SOF, superior orbital fissure

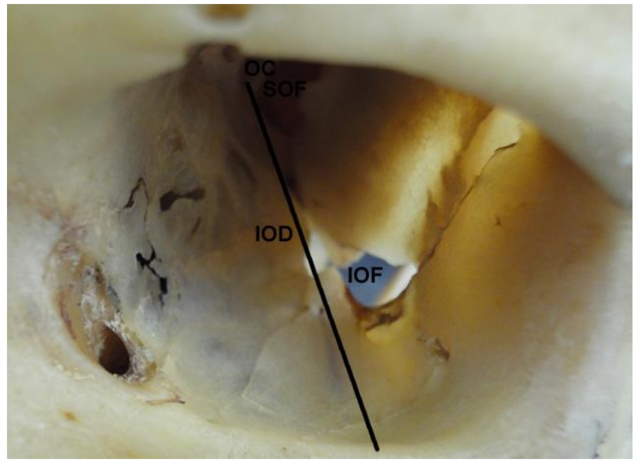
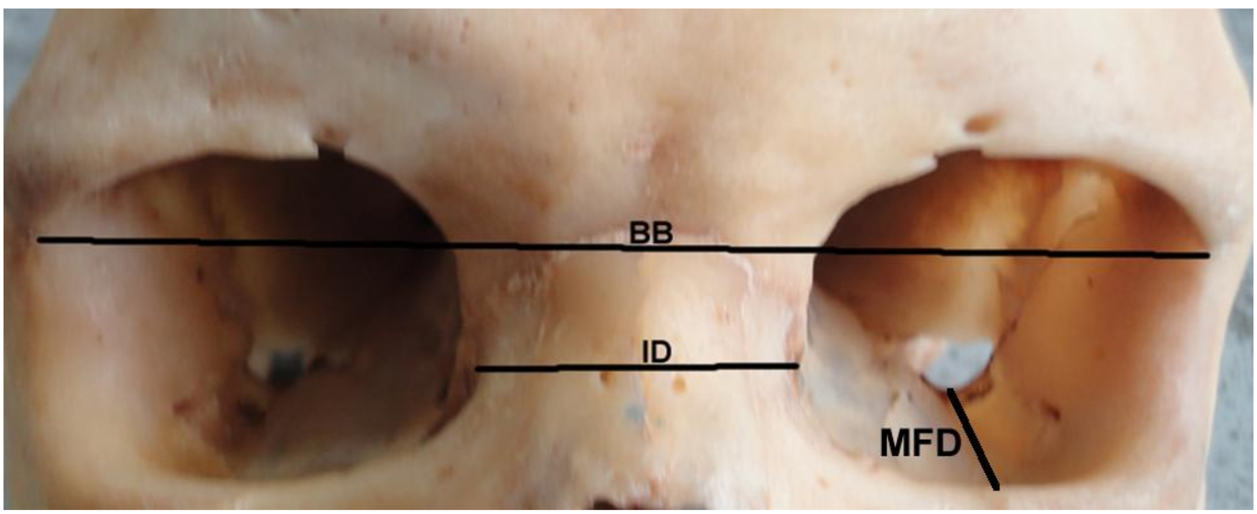


Figure 1.1Diagram showing inferior orbital depth

OC, optic canal; SOF, superior orbital fissure; IOD,

Figure 1. 2. Diagram showing biorbital breadth(BB), interorbital distance(ID) and marginofissural distance(MFD).



The Marginofissural Distance (MFD) on both sides was longer among the male subjects than among the female ones (Table 1).

Table 1: Marginofissural Distance in a Kenyan population

Side	Sex	Range (mm)	Mean (mm)	P value
Right*	Male	19 – 30	23.825	0.0034
	Female	19 – 26	22.364	
Left *	Male	19 – 28	23.738	0.0031
	Female	17 – 28	22.242	

Table 2: Comparisons of Orbital Depths

Author	Year of Study	Location	SOD (mm)	IOD(mm)
Munguti .	Present	Kenya (male)	53.250	55.188
Munguti	Present	Kenya(female)	51.939	53.636
Huanmanop	2007	Thailand	40.00	46.2
Karakas	2002	Turkey	45.3	50.3

Table 3: Comparisons of the Marginofssural Distance

Author	Year of Study	Location	Mean Values (mm)
Munguti	Present	Kenya (male)	23.825 (right orbit); 23.378 (left orbit)
Munguti	Present	Kenya (female)	22.364 (right orbit); 22.242 (left orbit)
Huanmanop	2007	Thailand	21.7

DISCUSSION

Orbital measures are important considerations not only during orbit reconstructive operations but also during administration of periorbital anesthesia. Important among these measures are the superior and inferior orbital depths and the MFD which are crucial for the safety of intra orbital neurovascular structures during surgical procedures deep into the orbit, and the interorbital distance and biorbital breadth for the maintenance of facial symmetry during both reconstructive and cosmetic operations. All these measures have been known to vary with sex and race. The observed differences in the male and female orbital depths may be due to the longer glabellomaximal length of the male cranium relative to that of females as previously evidenced by lower cranial index values of the male compared to those of females among Africans (Oladipo et al., 2009). Although this difference in the orbital depths gave a statistically significant p-value, it may not be clinically significant since the actual difference is quite small (less than 13mm). As a result, the surgical probes used for the SOD or IOD in male patients may safely be used for the female patients over the same depths.

Since the SODs are shorter than the IODs by over 1.7mm for both sexes, it is expected that the floor of the orbit will be longer anteroposteriorly than the roof. This difference is caused by the superior orbital fissure and the anterior opening of the optic canal which results in a defect on the orbital roof as these two extend more anteriorly in the superior orbital wall than in the inferior wall. The surgeon should therefore allow for this difference when working with the floor and roof of the orbit in order to avoid damage to the optic nerve during deep orbit surgical maneuvers. Since the male subjects also had a wider range of the superior and inferior orbital depths for the right and left orbits, care should be taken when doing deep orbit surgical procedures in the male patients some of who could have more shallow orbits. The results of our study support previous findings by other researchers who found the anatomy of the orbit to vary not only with race but also with sex and between sides (Table 2). The Kenyan population is shown to have deeper orbits compared to both Thais and Turks by up to 13mm and 9mm respectively. This could be attributed to the lower cranial index recorded among Africans due to their longer glabellomaximal lengths relative to the cranial vault height (Oladipo et al., 2006). The Kenyan patient might thus be at a lower risk of having injuries to the optic nerve and contents of the superior orbital fissure during deep orbit surgical operations compared to Thais and Turkish. However, relatively longer surgical probes will be required for the Kenyan patient compared to those required for the Caucasian and Asian patients.

The three studies evidently show that the IOD is longer than the SOD. However, the Kenyan study gave the difference between the two measures to be within 2mm while the difference in the other studies was over 5mm. This could be attributed to the shorter face of Kenyans which give them a smaller orbital index. Since the orbital roof and floor are not greatly separated from each other, it therefore follows that the difference between the superior and inferior depths is expected to be lower in the Kenyan population than in the Asian and European populations. When repairing or working around the floor of the orbit, the infraorbital nerve is always at relative risk. A safety measure taken to avoid injury to this nerve and its associated vasculature is to locate the anterior extent of the inferior orbital fissure. Consequently, the MFD is of critical value. The inferior orbital fissure in the orbit of the male which lies about 1.2 mm deeper into the orbit compared to that of a female may be due to the longer orbital floor of the orbit of a Kenyan male. Although the difference between the MFD of the two sexes was found to be statistically significant, it can clinically be overlooked when working on the orbits of Kenyan patients because the actual difference is negligible (< 1.5mm). The MFD was longer in the findings of the present study compared to what was reported by Huanmanop in 2007 (Table 3). This data seems to suggest that Thais have their inferior orbital fissure located much shallower to that of the Kenyans. This difference may however not be clinically significant because the shorter MFD of the Thais could be a reflection of their shorter IOD relative to that of Kenyans.

The interorbital breadth was found to be longer among the male subjects than among the female subjects by 0.7mm although this difference did not give a statistically significant-value. This longer interorbital distance of the male subjects could be due to a wider nasal ridge compared to that of female subjects. Among the French, interorbital distance was 19.81mm (Schmittbhul et al., 1998) while it was 25.71mm among the Turks (Yasan et al., 2006). As such, the interorbital distance was slightly lower in the Kenyan population compared to the French with a difference of 1.23mm, yet much lower than that of the Turkish study (7.13mm). This implies that the European populations have a wider nasal ridge compared to the African populations. It could also mean that the interorbital breadth tentatively shows interpopulation variation since the values of the interorbital distance for the three populations studied are different. The interorbital breadth is therefore a significant factor that needs to be considered during nasal bridge reconstruction during facial cosmetic surgeries and in the design of spectacle bridges. Since the width of the upper face is determined by the biorbital breadth, the Kenyan study population seems to suggest that Kenyan men have a wider upper face (99.49mm) compared to the females (96.43mm). This difference should be taken into account when designing nasal plates in the reconstruction of the nasal bridge and when designing frames for spectacles. The difference between the interorbital distances of the two sexes is very small compared to that of the biorbital breadth difference, but the percentage of the orbital widths to the biorbital distance for the two sexes is virtually the same. This means that the female orbit is more elongated and proportionately larger relative to the male orbit. Such knowledge can be useful when considering the design of the shape of spectacle lenses. The biorbital breadth in the French study was 98.97mm (Schmittbuhl et al., 1998). This is slightly smaller than the Kenyan male value but larger than that of the females. Since the Kenyan study gave a shorter interorbital breadth than the French, it follows that the difference in the biorbital distance between the Kenyan males and the French could possibly be due to wider orbits. This observation is reflected in the lower OI recorded among African populations (Igbigbi and Ebite, 2008) in comparison to Caucasian populations (Tripathi et al., 1997).

In conclusion, although the orbital depths for a Kenyan male are longer than those of the Kenyan female, the same surgical instruments and prosthesis can be applied for both sexes during orbital wall reconstruction and orbital regional anesthesia. A depth of 53mm is recommended as a safe superior orbital depth during operations involving the deep orbit. Similarly, on the orbital floor 55mm into the orbital cavity should be considered safe from the optic nerve. A distance of 22mm along the orbital floor would most likely be within the anterior extent of the inferior orbital fissure. For any procedures done beyond these distances, caution is advised.

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