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Ethnic Comparison of Inner and Outer Intercanthal Distance among Adult Sudanese

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Abstract

Background: Anthropometric pattern of the inner and outer intercanthal distance varies with no universal normative values. This study was conducted on three Sudanese ethnic groups, namely blacks, Arabs, and Hamites to identify normative values and the ethnic and gender influence in the anthropometric pattern of the inner and outer intercanthal distance. **Methods:** This is a cross sectional study among Sudanese subjects selected randomly from Khartoum Teaching Dental Hospital and Port Sudan Dental Hospital, using a stratified sampling technique. The inner intercanthal distance (IICD) and outer intercanthal distance (OICD) were measured directly using a digital caliber. **Result:** A total of 280 subjects included with a mean age of 35.76 ± 12.23 years, 122 males and 158 females. The distribution of groups was as follow: 92 (33%) Arabs, 62 (22%) blacks, and 126 (45%) Hamites. The mean IICD of males and females are 31.50 mm ± 2.89 and 32.22 mm ± 3.17, respectively. The mean OICD are 95.09 mm ± 5.78 and 93.95 mm ± 4.27 for males and females, respectively, with a statistically significant relationship. Regarding the ethnic group differences, the mean of IICD was wider among the blacks, followed by the Arabs and Hamites. However, the mean of OICD was wider among the Hamites, followed by the blacks and the Arabs. **Conclusion:** Intercanthal distance differs across ethnic groups. Gender and ethnicity are two of the main parameters that affect the variation as this study showed in the current study. These findings would be applicable in clinical setup as reference values during surgical planning.

Keywords

Sudanese Anthropometry, Intercanthal, Craniofacial

1. Background

Intercanthal distance is one of the interorbital craniofacial anthropometric measures. Anthropometry is defined as the science of human body measurements [1].

The inner intercanthal distance IICD is the distance between the medial angles of the horizontal palpebral fissures of both eyes, while the outer intercanthal distance OICD is the distance between the lateral angles of the horizontal palpebral fissures of both eyes [2].

The clinical importance of the intercanthal dimensions is in the evaluation of many craniofacial malformations and syndromes and the management of post-traumatic telecanthus [3]. Increased intercanthal distance is considered to be one of the somatometric traits by which craniofacial anomalies can be diagnosed [4].

People with an African background tend to have false hypertelorism due to flattening of the nasal bridge [5]. In order to define hyperbolism, Feingold and Bossert formulated a regression equation to measure the interpupillary distance based on inner and outer IC distance measurement [6]. The use of Caucasian values of intercanthal dimensions with Africans in craniofacial reconstructive surgery could result in inappropriate postsurgical outcomes [5]. In the assessment of aesthetic facial proportions of certain races, the intercanthal distance showed racial polymorphism, which influences the facial reconstructive surgery to restore the natural facial ethnic appearance [7] [8].

Sudanese people are a mixture of many ethnic groups distributed throughout the country [9]. Arabs, Hamites and Blacks are the major ethnic groups or races that form the population in Sudan [10]. According to A. C. Haddon, the race is defined as "a group of people who have certain well-marked physical characteristics in common." These physical characteristics are skin color, hair form, stature, head shape, face shape, and nose shape [8]. The linguistic distribution among these ethnic groups, aside from the physical characteristics, plays an important role in racial classification and identification [10].

Normal values for canthal dimensions to be used as a guide in medical practice are available for Mexicans, Japanese, North American whites, North American blacks, Indians, and Turkish [5]. The use of non-African standard canthal values in clinical practice arose because of the non-availability of African standard values [5]. These variations in the craniofacial morphology of different ethnic backgrounds may be the result of different genetic components and environmental conditions [5] [11].

This study was conducted among the Sudanese population, specifically among Arabs, Blacks, and Hamites, to investigate IICD and OICD. These ethnic groups are considered as among the most consistent components in the Sudanese population, with great diversity in their craniofacial anthropometry.

The investigation of intercanthal distance among these ethnic groups is establishing local data for this particular percentage of the population for the benefit of clinical practice.

2. Methods

The objective of this study was to investigate normal values for the inner and outer intercanthal distances among Black, Arabs, and Hamites to determine the anthropometric variation in the intercanthal distance among the three different

ethnic groups and the gender influence on the anthropometric pattern of the intercanthal distance.

It was a cross-sectional hospital-based study, conducted in Khartoum Teaching Dental Hospital and Port Sudan Dental Hospital from October 2013 to January 2014. KTDH is the biggest dental hospital in the country, and the cases were referred from different states of the country, representing different ethnic groups. The population was stratified into groups based on the ethnic background. The criterion of classification of races was established as described by Seligman [10].

The sample size was calculated for each ethnic group using different values of the standard deviation (SD) from the following studies: For the Arabs, a Saudi study done by Khalid *et al.* [2] in 2001 was used. For the Blacks, the calculations were based on the pilot study. For the Hamites, the estimation of the sample size was done by using the average of the sample sizes of Africans and Arabs.

The sample size was calculated for each ethnic group by the following equation: $n = \left(4z_\infty^2 S^2\right)/W^2$, where n = sample size, α = 0.05, W = marginal error (1), S = standard deviation and z_∞ = critical value (1.645).

An inclusion criterion was Sudanese from Arabs, blacks, or Hamites with ages between 18 - 60 years old. Any patient with a history of maxillofacial trauma, surgical operation in the maxillofacial region, Craniofacial malformation, or patient who refused participation in the study was excluded. The Stratified random sampling was the method of sampling.

An electronic digital caliber was used in the measurement of the intercanthal distance (Figure 1). The device was calibrated in millimeters and inches. The inner and outer intercanthal distance was measured as shown in Figure 2(A) & Figure 2(B).

The data were collected by two investigators; the primary investigator was in KTDH and the second, at Port Sudan Hospital. Data were entered in a computer master sheet using SPSS version 16. All statistical analyses were set at 95% confidence level, level of significance (alpha) 0.05. Descriptive statistics were obtained, and the means, standard deviation, and frequency distribution were calculated. Group comparisons were analyzed using independent sample t-test, ANOVA, and Post Hoc.

Figure 1. The digital caliber is calibrated in millimeters and inches. It is 150 mm in length. The peripheral end is fixed, while the other one is sliding used to adjust the measurement. Made in China.

Figure 2. The technique of measurement of the inner intercanthal distance (A) and outer intercanthal distance (B).

3. Results

The total sample size of 280 subjects included. Among them, 122 males and 158 females. The distribution was as follow: 92 (33%) Arabs, 62 (22%) blacks, and 126 (45%) Hamites, with median age of 36 years.

The inner intercanthal distance was measured by the digital caliber, and the mean value was calculated; the results of males and females are 31.50 mm ± 2.89 and 32.22 mm ± 3.17, respectively. For the outer intercanthal distance, the mean was also calculated, and the results are 95.09 mm ± 5.78 and 93.95 mm ± 4.27 for males and females, respectively. For testing the significant difference in the IICD and OICD of males and females, an independent-sample t-test was used, and the results show a significant difference (P-value = 0.025) in the IICD between males and females and an insignificant difference (P-value = 0.06) in the OICD between males and females (Figure 3).

For the ethnic groups, the results of the IICD are 33.16 mm ± 2.88, 34.02 mm ± 2.56 and 30.08 mm ± 2.27 for Arabs, Blacks and Hamites, respectively (Figure 4). The significant difference in the IICD between the three ethnic groups was tested by ANOVA and Post Hoc. The test of significance by ANOVA shows a significant difference in the IICD of the three ethnic groups. Then the Post Hoc was performed for multiple comparisons and revealed the presence of a significant difference when comparing the IICD of Arabs and Hamites and of Hamites and Blacks (Table 1).

The results of the OICD are 93.44 mm ± 5.09, 94.11 mm ± 4.97 and 95.35 mm ± 4.88 for Arabs, Blacks and Hamites, respectively (Figure 4). The significant difference in the OICD between the three ethnic groups was also evaluated by ANOVA and Post Hoc. The test by ANOVA shows a significant difference in the OICD between the three ethnic groups. Then the Post Hoc was performed, and a significant difference is found in the comparison of Hamites and Arabs (Table 1).

The IICD and the OICD were evaluated in both genders for each ethnic group to identify gender influence on these facial anthropometric measures (Figure 5). The significant difference in the IICD and OICD for males and females within each ethnic group was tested by the independent sample t-test, and a significant difference in the form of gender dimorphism was shown in the OICD of Hamites (Table 2).
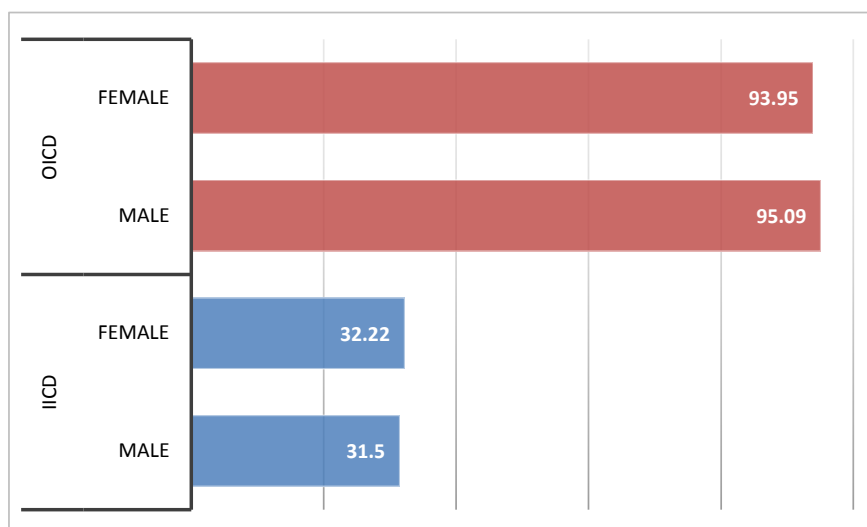
Figure 3. The mean (in millimeter) of the inner intercanthal distance (IICD) and outer intercanthal distance (OICD) for female and male.
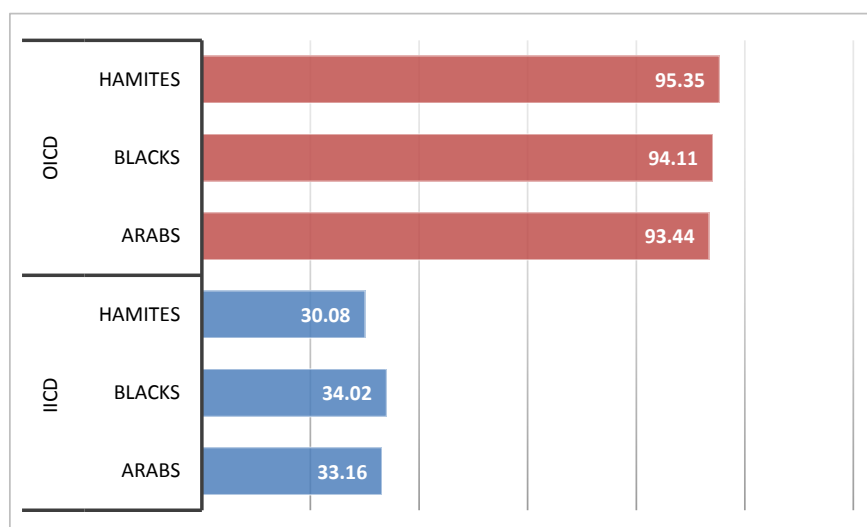

Figure 4. The mean (millimeter) of the inner intercanthal distance (IICD) and outer intercanthal distance (OICD) for the three ethnic groups.

Table 1. Comparison of inner intercanthal distance (IICD) and outer intercanthal distance (OICD) between the three ethnic groups by Post Hoc.

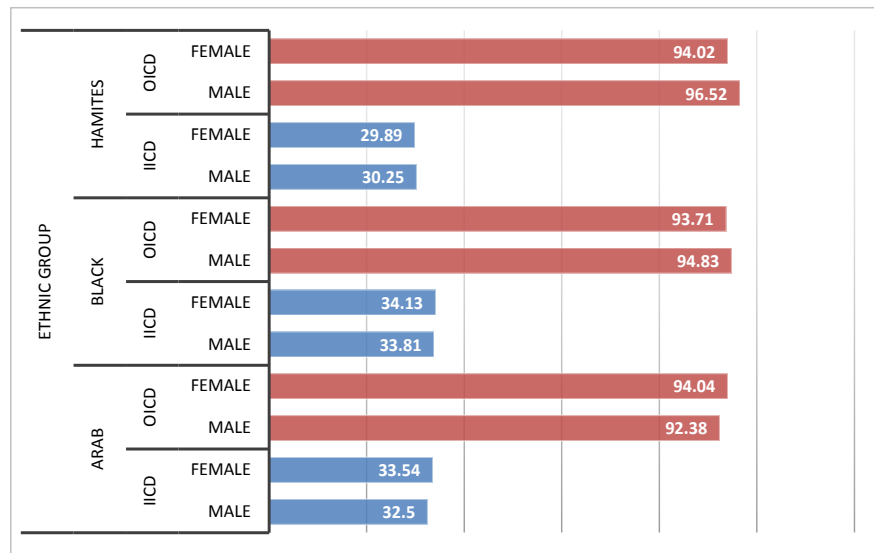| Ethnic group		OICD		IICD	
		Std. Error	P-value	Std. Error	P-value
Arab	Black	0.81475	0.693	0.41926	0.106
	Hamites	0.67999	0.015	0.34992	0.001
Black	Arab	0.81475	0.693	0.41926	0.106
	Hamites	0.76922	0.243	0.39583	0.001
Hamites	Arab	0.67999	0.015	0.34992	0.001
	Black	0.76922	0.243	0.39583	0.001

Figure 5. The mean (millimeter) of the inner intercanthal distance (IICD) and outer intercanthal distance (OICD) in both genders for each ethnic group.

Table 2. The mean (millimeter) of inner intercanthal distance (IICD) and outer intercanthal distance (OICD) in males and females for the three ethnic groups by the independent sample t-test.

Ethnic group		Gender	Number of subjects	Mean	Std. Deviation	P-value
Arab	IICD	male	33	32.5	2.95	0.09
		female	59	33.54	2.79	
	OICD	male	33	92.38	6.17	0.17
		female	59	94.04	4.21	
Black	IICD	male	22	33.81	2.48	0.64
		female	40	34.13	2.62	
	OICD	male	22	94.83	5.8	0.14
		female	40	93.71	4.49	
Hamites	IICD	male	67	30.25	2.3	0.38
		female	59	29.89	2.24	
	OICD	male	67	96.52	5.14	0.001
		female	59	94.02	4.24	

For the intra-examiner calibration, an independent sample t-test was used. The IICD of randomly selected ten subjects was measured twice, with a ten days' interval between the two measures. The mean of the IICD of the ten subjects measured the first time was compared to the mean of the IICD measured the second time by the independent sample t-test, with no statistically significant difference (P-value = 0.9).

4. Discussion

In recent years, there has been an increased demand for local data of craniofacial anthropometry in developing countries, including Sudan. The new advances in craniofacial reconstruction and increase in the awareness of the clinicians and patients toward this specialty give the great importance of craniofacial anthropometry in clinical practice.

The inner and outer intercanthal measurements are the simplest to use for standard clinical workups, and patients' parameters should be referred to their own norms [12]. Moreover, the evaluation of patients with developmental anomalies should include the evaluation of the orbital region, as well as other parts of the face and body [12].

Sudan is positioned geographically between Arabic and African countries, creating its characteristic population variation. The distribution of the population in Africa, in general, is influenced mainly by geographic and lifestyle related factors [10]. The Hamitic people inhabit the east and north of Africa while the blacks mainly inhabit the middle of the continent and around the Nile Valley [5]. The traditional Arabs are long headed in nature with fine oval faces and are mainly classified by their mode of life criterion. The other Sudanese ethnic components are a mixture of these groups [10].

The major parameters that influence the anthropometric difference in the inner and outer intercanthal distances are age, gender, and ethnic background [3]. In this study, the consideration of the blacks, Arabs, and Hamites is due to their consistent background [10]. These ethnic groups represent a different anthropologic pattern that is reflected in their craniofacial anthropometry. The facial appearance of some people from an African background is described as pseudo-hypertelorism. This is due to the flattening of the nasal bridge rather than the increase in interorbital distance [10].

The IICD for Arabs, Blacks, and Hamites shows different results described as ethnic polymorphism; the Hamites have the lowest value (30.08 mm ± 2.27), while the Blacks have the maximum value (34.02 mm ± 2.56). The OICD is 93.44 mm ± 5.09, 94.11 mm ± 4.97, and 95.35 mm ± 4.88 for Arabs, Blacks, and Hamites, respectively.

The Arabs have the least OICD, while the Hamites have the maximum one. The ethnic polymorphism is also obvious in the results of the OICD, with a significant difference when comparing the OICD between Hamites and Arabs. These different outcomes reveal the importance of the consideration of ethnic background in the evaluation of the IICD and OICD to identify the specific differences that influence clinical practice.

The influence of gender should be evaluated in the investigation of the IICD and OICD because of the differences in the physical background of males and females. The IICD and OICD were investigated in males and females within the three ethnic groups. For Arabs, the IICD for males and females are 32.50 mm ± 2.92 and 33.54 mm ± 2.79, respectively, while the OICD for males and females

are 92.38 mm ± 6.17 and 94.04 mm ± 4.21, respectively. The comparison of the IICD and OICD for Arab males and females reveals an insignificant difference. The IICD of blacks among males and females are 33.81 mm ± 2.48 and 34.13 mm ± 2.62 while the OICD for males and females is 94.83 mm ± 5.80 and 93.71 mm ± 4.49, respectively. An insignificant difference in the mean of the IICD and OICD for males and females among blacks is shown in this study. For the Hamites, the IICD for males and females is 30.25 mm ± 2.30 and 29.89 mm ± 2.24, respectively while the OICD for males and females is 96.52 mm ± 5.14 and 94.02 mm ± 4.24, respectively. A significant difference is shown in the comparison of the OICD of Hamites between males and females.

A Sudanese study was done by Salah *et al.* [13] among females and it revealed that the IICD minimum value is 24.15 mm and the maximum value is 37.46 mm. The other Sudanese study, done by Nasr *et al.* revealed that the mean width of the IICD is 32.80 mm [14]. In both studies, the ethnic background was not considered in the calculation of the IICD mean. The comparison of the results of the IICD and OICD of the Sudanese to the Nigerians in this study results in a study done by Oladipo *et al.* in Urhobo, and the Itsikiri ethnic groups revealed that the values of the IICD are comparable to each other, but the OICD shows higher values among Nigerians (129 mm) [3]. Furthermore, the gender shows significant influence on the anthropometric pattern of the IICD and OICD, with higher values in males. A Turkish study done by Cem *et al.* [15] for the investigation of the IICD and OICD in males and females revealed significantly lower values when compared to the Sudanese in the current study. These previous non-Sudanese studies revealed the racial polymorphism in the mean values of the IICD and OICD. The comparison of the patients' values with the normal standard measurement specific for their race, age, and gender would lead to a precise analysis of these abnormal features for diagnostic purposes and, finally, for the choice of the appropriate clinical interventions [12].

This study has generated normative values for IICD and OICD of the Arab, Hamite, and Black ethnic groups in Sudan, which can be used in clinical work for patients from the same ethnic background when these anthropometric parameters are necessary for diagnosis and treatment planning. An investigation of the other components of craniofacial anthropometry in lines, angles, and indices for the Sudanese population is needed. Also, the evaluation of the age influence on the IICD and OICD in a wide age range, from childhood up to adulthood, and studying the relationship between the interorbital growth and cranial base should be considered in the near future.

5. Conclusion

The IICD of the three ethnic groups reveals ethnic polymorphism, with the maximum mean value in Blacks and minimum mean value in Hamites. Furthermore, for the OICD there was a significant difference in the mean values, with the maximum value in Hamites and the minimum value in Arabs. The gender influence

was evaluated for each ethnic group separately, and significant gender dimorphism is shown only in the comparison of the OICD in males and females in Hamites.

Acknowledgements

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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