ORIGINAL ARTICLE

A cephalometric study of skulls from the Bahriyah oasis

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Abstract

Objectives: To determine the craniofacial characteristics of crania from the Bahariyah oasis dating from the Greco-Roman period and to compare their cephalometric traits with other ancient Egyptian samples from various time periods and to evaluate sexual dimorphism. **Materials and Methods:** The sample comprised 149 skulls (90 males and 59 females), belonging to the Greco-Roman (332 B.C. – 395 A.D.). Lateral and postero-anterior cephalograms were taken. Sixteen linear measurements were analyzed and six indices were calculated. **Results:** Significant differences were found between males and females almost in all measurements. All male measurements were greater than those of the females. The study shows notable differences in the craniofacial parameters of the present sample as compared to other ancient Egyptians from various periods and from various geographical areas. **Conclusion:** The present study suggests that the studied crania from Bahriyah oasis had a specific craniometric phenotype, which is distinguished from other Egyptian samples from different periods, suggesting some migration could have occurred along the Egyptian Nile Valley over various times.

Key words: Ancient, cephalometry, crania, Greco-Roman period, sexual dimorphism

Introduction

A number of investigators noticed the variation of the craniofacial morphology in different populations. Cephalometric studies have revealed craniofacial differences between different populations, ages, and sexes.[1,2] In various populations it is possible to observe many variations of cephalometric patterns within homogeneous groups.[3-5] Hanihara applied distance analysis and factor analysis to 23 craniofacial measurements in 1802. Recent and prehistoric crania from major geographical areas of the Old World revealed that craniofacial variations are not necessarily consistent with the geographical distribution pattern of the human populations.[6]

Due to the lack of reports on the cephalometric characteristics of crania of the Bahariyah oasis dating from the Greco-Roman period, the aim of this study was to determine the craniofacial characteristics of these crania, and to compare their cephalometric traits with other ancient Egyptian samples from different time periods as well as to evaluate sexual dimorphism.

Materials and Methods

The material for the present study consisted of 149 skulls (some were without mandibles) of adult non-senile individuals (90 males and 59 females), with no obvious pathological deformity that might affect the skull shape and/or size. These skulls were collected from the Bahriyah oasis, belonging to the Greco-Roman period that dated back 332 B.C. – 395 A.D.[7] They were recovered during the excavation seasons between 1991 and 1994 by the Supreme Council of Antiquities "SCA".

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DOI: 10.4103/0975-1475.109895	

Sexing was carried out using cranial morphological characteristics.[8] This material was excavated from large rocky tombs in the Bahriyah Oasis which is located in the Libyan Desert 180 Km west of the Nile Valley and 350 Km south west of Cairo. Archaeological literatures indicated that ancient individuals living in the Bahriyah Oasis in the Greco-Roman period were engaged in many activities like agriculture, wine, and textile production.[9] With the beginning of the Roman period which extended for more than two centuries, all the oases witnessed a period of prosperity, where governmental and agricultural efficiency increased producing accelerated economic development. It is worth noting that during the Roman rule, the Roman citizens of Greek cities, metropolitans, and Egyptians were kept clearly distinct. Many tombs dating from this period are found all over the Bahriyah oasis in the form of cut in the rocks. Ancient Egyptian texts and steles indicate that the oasis was far from the Nile Valley.

Estimation of age at death was carried out using suture closure procedures.[10] The cephalometric roentgenography was taken, according to recommendation by Krogman and Sassouni.[11] The crania were radiographed in the median sagittal plane with each skull held in place, using General Electric Cephalostat, where the skull was fixed in the cephalostat by inserting the two ear rods in the external auditory meati. The distance between the X-ray tube and the cassette was 150 cm. Two numerically labeled cephalograms: a lateral and a postero-anterior using Kodak X-ray films (24 cm × 30 cm) were taken for every skull. The dose used was 75 Kvolt, 10 mA and exposure time of 0.2 s. Film development and fixation were carried out manually. The processed films were then left to dry. The scanned X-ray films were then exported to the Dental tracer program version 1,00,02 (Nile Delta Software). Fifteen points and sixteen lines were defined. Then the landmarks for every exported image were plotted with great accuracy.

Linear measurements derived from lateral cephalograms were:
- Sella-Nasion (S-N): Anterior cranial base length
- Sella-Basion (S-Ba): Posterior cranial base length
- Nasion-Basion (N-Ba): Total crania base length
- Nasion-Palatal plane (NPP): Upper anterior face height (UFH)
- Palatal plane-Menton (MPP): Lower anterior face height (LFH)
- Nasion-Menton (N-M): Total anterior face height (TFH)
- Menton-Gonion (M-Go): Length of the body of the mandible
- Gonion-Articular (Go-Art): Height of the ascending ramus of the mandible
- Articular-Gnathion (Art-Gn): Oblique length of the mandible
- Anterior Nasal Spine-Posterior Nasal Spine (ANS-PNS): Length of the palate (Maxillary or palatal plane) (MxP): the line connecting ANS to PNS
- Glabella-Opisthocranium (Gl-Opis): Maximum cranial length
- Bregma-Basion (Br-Ba): Cranial height

Linear measurements derived from postero-anterior cephalograms were:
- Gonion-Gonion (Go-Go): Bigonial breadth
- Zygon-Zygon (Zy-Zy): Bizygomatic breadth
- Euryon-Euryon (Eu-Eu): Maximum cranial breadth
- Vertex-Menton (V-M): Maximum cranial height

Derived indices were:
- Cranial index (CI) = (max. cranial width × max. cranial length) /100
- Upper anterior facial index (UFI) = (Upper Ant. Facial Ht. × Bizygomatic breadth) /100
- Total anterior facial index (TFI) = (Total Ant. Facial Ht. × Bizygomatic breadth)/100
- Vault size and face size (VS) = (Cranial length × Cranial height × Cranial breadth) ⅓.[12]
- Face size (FS) = (Upper facial height × bizygomatic breadth) ½.

Statistical analysis

Normal distribution was verified by the Kolmogorov–Smirnov test, results showed no significance for all variables. Mean values and standard deviations were computed for all variables. Unpaired t -tests were used to compare the mean differences of each cephalometric measurement between the groups after F-tests for equal and unequal variances. The minimum level of statistical significance was set at $P < 0.05$.

Results

Table 1 shows the means and the standard deviations of the linear measurements of males and females and the pooled sexes for crania with mandibles. Significant differences were found between males and females almost in all measurements. All male measurements are greater than those of the females. Table 2 shows means and standard deviations of linear measurements and derived index of males and females and of the pooled sexes for crania without mandibles. All male measurements are greater than those of the females. The differences are significant except for Go-Go, Go-Art, and TFI index.

Table 3 shows the means and the standard deviations of indices of males and females and in the pooled sexes for crania with mandibles. The statistical analysis showed a significant decrease in CI and VS of males compared to females. The results also revealed that all the crania are brachycranic, with a mean cranial index "CI" of 82.404.

Table 1: Means and standard deviations of linear measurements of males and females and of the pooled sexes for crania with mandibles

Parameters	Males			Females			*P* value	Pooled sexes		
	N	Mean	S.D.	N	Mean	S.D.		N	Mean	S.D.
Gl-Opis	90	21.205	0.878	59	19.996	1.251	0.001**	149	20.726	1.196
Eu-Eu	90	17.239	0.727	59	16.718	0.903	0.001**	149	17.033	0.838
Zy-Zy	90	16.434	0.706	59	15.745	0.774	0.001**	149	16.161	0.806
N-Ba	90	11.103	0.710	59	10.523	0.832	0.001**	149	10.874	0.809
Br-Ba	90	15.230	0.624	59	14.693	0.890	0.001**	149	15.016	0.784
NPP	90	5.790	0.469	59	5.558	0.478	0.004**	149	5.698	0.485
S-N	90	7.766	0.361	59	7.312	0.450	0.001**	149	7.586	0.455
S-Ba	90	4.527	0.616	59	4.253	0.697	0.013*	149	4.419	0.066
ANS-PNS	90	5.047	0.384	59	4.824	0.471	0.002**	149	4.959	0.433

*$P<.05$; **$P<.001$

Table 2: Means and standard deviations of linear measurements and derived index of males and females and of the pooled sexes for crania without mandibles

Parameter	Males			Females			*P* value	Pooled sexes		
	N	Mean	S.D.	N	Mean	S.D.		N	Mean	S.D.
VS	90	81.407	4.350	59	83.925	6.807	0.007**	149	82.404	5.574
FS	90	35.272	2.953	59	35.385	3.450	0.831	149	35.317	3.148
CI	90	81.492	4.390	59	83.838	6.844	0.012*	149	82.404	5.573
UFI	90	35.303	2.880	59	35.263	3.542	0.940	149	35.317	3.148

**$P<.001$

Table 3: Means and standard deviations of derived indices of males and females and of the pooled sexes for crania with mandibles

Parameters	Males			Females			*P* value	Pooled sexes		
	N	Mean	S.D.	N	Mean	S.D.		N	Mean	S.D.
Go-Go	30	10.725	1.145	32	10.188	0.963	0.071	62	10.502	1.097
MPP	30	7.181	0.845	32	6.464	0.707	0.002**	62	6.878	0.860
N-M	30	12.833	0.881	32	11.825	1.038	0.001**	62	12.407	1.067
Go-Art	30	4.719	0.681	32	4.456	0.506	0.112	62	4.610	0.623
Art-Gn	30	11.493	0.609	32	10.781	0.880	0.001**	62	11.191	0.810
M-Go	30	7.342	0.732	32	6.669	0.716	0.002**	62	7.057	0.793
V-M	30	19.730	1.018	32	19.016	0.881	0.009**	62	19.433	1.018
TFI	30	77.467	5.311	32	75.529	7.593	0.284	62	76.647	6.380

*$P<.05$; **$P<.001$

Discussion

The comparison of the mean values of both Eu-Eu and Zy-Zy with the other ancient Egyptian samples from various periods revealed that these parameters vary among Egyptians from various periods.[13] Facial width measurements vary among Egyptians more than the other groups.[14] Variations in cephalic indices between and within populations have been attributed to a complex interaction between genetic and environmental factors.

Former studies reported that the breadth and length dimensions of the vault, interorbital breadth, biorbital breadth, palate length, and upper facial height were among the most important discriminators that distinguish between different populations.[15] Strouhal[13] studied ancient Egyptians from different sites and different periods (from 1st Dynasty up to Ptolemaic). The means of Gl-Ops, Eu-Eu, Br-Ba, and Zy- Zy were greater in the male samples of the present study than that of Strouhal's. These differences may be due to pooling sexes together, in the samples studied by Strouhal, and because of the heterogeneity of sample regarding the extended time period.

Hanihara studied different ancient Egyptian samples from different sites and belonging to different periods (Badari: Ancient Egyptians (ca. 5000-4000 years B.P., N = 40), Naqada: Predynastic Egyptians (ca. 5000-4000 years B.P., N = 80) and Gizeh: Egyptians (26th–30th Dynasty, 664-343 B.C., N = 100).[16] The mean values of Gl-Ops and N-Ba for Hanihara's samples were slightly smaller than those of our sample and almost lie within the same range of values. The variability in the craniofacial morphology of Egyptians can be attributed to differences in masticatory force production.[17] However, the Northern Egyptians are influenced more by the Caucasian features; also, the craniofacial skeleton was not significantly different between the Nubian and American samples.[18] The Egyptian Nubians represent a very ancient gene pool extending back to predynastic Egypt and the beginning of civilization.[19,20]

Differences in craniofacial morphology between human populations have been established on dry skulls as well as in the living. There is evidence that this variation results from both epigenetic and phylogenetic factors. Some studies proposed that differences in craniofacial morphology among populations might be due to variation in the orientation of the cranial base and the facial cranium as a whole.[21]

Concerning sexual dimorphism in the linear measurements, all linear measurements were greater in males than females except Ans-Pns, but not all the differences were significant. El-Hadary *et al*.[22] studied Nubian cephalometry and concluded that craniofacial dimensions in Nubian females were smaller than in Nubian males. Our results revealed that both Eu-Eu and Zy-Zy differ significantly between sexes. Our results agree with previous studies reported that most human craniofacial measurements, in particular the linear ones, show statistically significant sex differences and male skulls are 8.5 % larger than female skulls.[23,24] CI and VS in our males were significantly smaller than in females. Sex is a major factor in craniofacial differentiation and it can be stronger in one population and weaker in another.[25] Sexual dimorphism in the craniofacial robustness and craniofacial width was attributed to the large masticatory stress that differs from males to females.[17,26] It is reported that the anterior cranial base length "S-N" shows both significant sexual dimorphism and racial variation.[27,28] However, sexually dimorphic traits are usually assumed to result from the effect of gonadal hormones, sex-specific gene actions, or both.[29]

Strouhal[13] reported that the cranial index "CI" in ancient Egyptians from different periods (from 1st Dynasty up to Ptolemaic) and from different sites ranged between 71.80 and 76.10. The mean value of the "CI" in Bahriyah was 82.404 ± 5.573, which means that crania are brachycranic. Other previous studies reported that ancient Egyptian crania were most similar to that of Mediterranean.[30] Archaeological evidence suggests that the ancient Egyptian Nile Valley was occupied in large part by immigrants from the Sahara and more southern areas, who brought Neolithic traits there.[31] High levels of genetic heterogeneity over the Predynastic and early Dynastic periods, was reported.[32]

In conclusion, the present study suggests that these crania of the Bahariyah oasis dating from the Greco-Roman period had a specific craniometric phenotype, which is distinguished from other Egyptian samples from different periods, suggesting that some migration might have occurred along the Egyptian Nile Valley over various periods.

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How to cite this article: Zaki ME, Soliman MA, El-Bassyouni HT. A cephalometric study of skulls from the Bahriyah oasis. J Forensic Dent Sci 2012;4:88-92.

Source of Support: Nil, **Conflict of Interest:** None declared