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MORPHOMETRIC ANALYSIS OF POSTERIOR CRANIAL FOSSA AND SUPRATENTORIAL CRANIAL CAVITY IN SUDANESE: A COMPUTERIZED TOMOGRAPHY STUDY

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ABSTRACT

Characterization of the posterior cranial fossa (PCF) and supratentorial cranial cavity (SCC) plays an important role in the diagnosis of many disorders. Quantitative assessment of any morphological changes requires normative data for these anatomical areas. This study was obtained in order to achieve local reference morphometric analysis data for Sudanese (PCF) and (SCC). This is a descriptive study of 200 consecutive normal computerized tomography (CT) scans of (PCF) and (SCC) without any bony abnormality. All of the patients were Sudanese and Khartoum residents, of North Sudan origin, 97 were males and 103 were females. The sample mean age was 49.76±17.2 years old, ranged between (20-80) years old. The (PCF) and (SCC) height, anteroposterior, and transverse dimensions were calculated in advanced work station of (CT) scan. The data were analyzed as mean and standard deviation according to age and gender. Results showed that the males have larger measurements than females; these differences were statistically significant for all variables except (SCC) height. There was no difference in dimensions of the (SCC) in various age groups, but significant differences were detected in transverse dimension and height of the (PCF). The measurements of Sudanese were greater than other populations in the literature .Normal values of (PCF) and (SCC) dimensions could serve as a normative local reference for Sudanese. More studies are needed as there could be variations in dimensions in different regions in Sudan.

INTRODUCTION

Human cranial variations have been described worldwide for a long time in human anatomy (Poirier, 1896). Akabori (1933) reported many cranial variations in Japanese. Hauser and De Stefano (1989) reviewed the gross anatomy, function, development, of cranial variations on the basis of vast previous anatomical studies. Anthropologists have long studied cranial data in order to characterize population affinities (Howells, 1973). Ossenberg (1986) has undertaken advanced studies of cranial traits, which proved effective for reconstructing the Pan-Pacific population history. Dodo and his collaborators have intensively studied cranial character from the viewpoint of their stability within populations and diversity among populations (Dodo and Kawakubo, 2002). On the basis of these series of studies, the cranial variations of populations worldwide have been investigated (Dodo and Sawada, 2010; Nakashima *et al*., 2010).

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The most recent and advanced computer tomography (CT) and magnetic resonance imaging (MRI) methods can evaluate anatomical variations of living human subjects, (Oshiro *et al*., 2009; Morita *et al*., 2010). On the other hand, a wide spectrum of central nervous system diseases have been associated with alterations in the size of the cranium and posterior cranial fossa (PCF) or its contents, such as the Chiari and Dandy-Walker malformations and Down's syndrome (Hashimoto 1991, Barkovich, 1990, Schaefer, 1991)

Quantitative assessment of these morphological changes requires normative data for cranium as well as the posterior cranial fossa and supratentorial cranial cavity. Here, we preliminarily applied the computerized tomography (CT) imaging methods to study the normative cranial characteristics in order to obtain basic local reference data for Sudanese (PCF) and (SCC) morphometric analysis. To the best of our knowledge, no anatomical study was achieved regarding this area for the Sudanese population.

MATERIALS AND METHODS

Sample

The sample for this descriptive study which was ethically approved by Research Council (College of Medical Radiological Science, Sudan University of Science and Technology), were obtained from patients attending the Radiology department at Ebn Elhaitham hospital, during the period from 2012 up to2014 in a consecutive series. All of the patients were Sudanese and Khartoum residents, of North Sudan origin, and healthy with no evidence or history of medical complications, craniofacial malformation, or syndromes. Any subject with a cranial abnormality was excluded from the study. The study comprised of 200 brain CT examinations, 97 were males and 103 were females. The sample mean age was 49.76±17.2 ranged between (20-80) years old.

Posterior Cranial Fossa (PCF) and Supratentorial Cranial Cavity (SCC) Morphometic Analyses

All patients were examined supine with sections parallel to the supraorbital meatal line employing a 256 x 256 matrix, 5 mm slice thickness in the PF and 10 mm in the rest of the skull, 120 kV, 150 mA and 2.9 s scan time. In all CT examinations, linear measurements were performed.

Window settings were adjusted (window width 2500 HU and window level 600 HU). The inner margins of the posterior cranial fossa (PCF) and supratentorial cranial cavity (SCC) were measured; measurements were done by taking into consideration the maximal anteroposterior (AP) and transverse diameters (TRV). The anteroposterior (AP) diameter of the (SCC) was calculated from the number of sections above the sella turcica and the (PCF) from the number of sections between the foramen magnum and the tentorial apex. Height /Cephalocaudal (CC) was calculated by multiplying the number of slices containing the (PCF) and (SCC) by the slice interval.

Statistical analysis

The means and standard deviations were calculated for each variable in the sample. A One-way

Analysis of Variance (ANOVA) was carried out to compare the characteristics of (PCF) and (SCC) between the two genders and in different age group. A Pearson Correlation Coefficient was calculated. Significance for the tests was noted at $P < 0.001$. All of the statistical analyses were performed using Statistical Package for Social Sciences software package (SPSS for Windows, Version 16 Chicago, IL, USA).

RESULTS

Table 1. The Posterior Cranial Fossa (PCF) and Supratentorial Cranial Cavity (SCC) Morphometic Analyses

		Variables mean, standard deviation and standard error				P -value
		N	Mean (mm)	Std. Deviation	Std. Error Mean	
AP(mm)**	PCF	200	72.82	±7.70	0.54	0.000*
	SCC	200	158.69	±6.53	0.46	
TRV(mm)**	PCF	200	106.21	±8.75	0.61	0.000*
	SCC	200	125.06	±5.05	0.35	
CC(mm)**	PCF	200	65.22	17.81	1.25	0.000*
	SCC	200	401.82	44.52	3.14	

**Correlation is significant at* $P < 0.001$. ***AP stands for antero-posterior dimension, TRV for transverse dimention, CC for cranio-caudal dimensions (height).*

Table 2. The Posterior Cranial Fossa (PCF) and Supratentorial Cranial Cavity (SCC) Morphometic Analyses According to Gender

		Gender/variables means and standard deviation			
Variables	Gender	N	Mean (mm)	Std. Deviation	P -value
(PCF)AP	Male	97	74.63	±6.848	0.001*
	Female	103	71.11	±8.094	
(PCF)TRV	Male	97	108.07	±5.42	0.003*
	Female	103	104.44	±10.74	
(PCF) CC	Male	97	71.29	±20.14	0.000*
	Female	103	59.49	±12.99	
(SCC)AP	Male	97	160.60	±7.04	0.000*
	Female	103	156.88	±5.47	
(SCC)TRV	Male	97	126.43	±5.41	0.000*
	Female	103	123.77	±4.33	
(SCC)CC	Male	97	403.25	±44.85	0.659
	Female	103	400.46	±44.39	

** Correlation is significant at* $P < 0.001$. *(PCF) AP stands for Posterior Cranial Fossa antero-posterior dimension, (PCF) TRV for Posterior Cranial Fossa transverse dimension, (PCF)CC for cranio-caudal dimensions (height).(SCC) AP stands for Supratentorial Cranial Cavity antero-posterior dimension, (SCC)TRV for Supratentorial Cranial Cavity transverse dimension , (SCC)CC for Supratentorial Cranial Cavity cranio-caudal dimensions (height).*

Table 3. Posterior Cranial Fossa (PCF) Dimensions According To Various Age Groups in Sudanese Population

		Descriptive Quantitative Data Of (PCF)					P -value
		N	Mean	Std. Deviation	Minimum	Maximum	
(PCF)AP	20-30	42	71.90	8.59	27.63	85.39	.192
	31-40	20	70.42	6.55	59.26	82.28	
	41-50	38	72.82	7.89	61.08	98.62	
	51-60	41	72.28	8.15	36.90	91.57	
	>61	59	74.66	6.73	60.48	92.61	
	Total	200	72.82	7.70	27.63	98.62	
(PCF)TRV	20-30	42	105.91	5.19	93.90	114.69	.016*
	31-40	20	100.97	22.0	11.81	115.78	
	41-50	38	108.73	5.66	94.82	120.65	
	51-60	41	105.08	5.42	94.21	118.49	
	>61	59	107.33	5.37	95.75	123.79	
	Total	200	106.20	8.75	11.81	123.79	
(PCF)CC	20-30	42	58.47	10.85	48.00	100.00	.002*
	31-40	20	61.60	14.00	48.00	100.00	
	41-50	38	61.47	16.14	48.00	100.00	
	51-60	41	69.07	20.68	48.00	100.00	
	>61	59	70.98	19.71	48.00	100.00	
	Total	200	65.22	17.81	48.00	100.00	

**Correlation is significant at P < 0.001. (PCF) AP stands for Posterior Cranial Fossa antero-posterior dimension, (PCF) TRV for Posterior Cranial Fossa transverse dimension, (PCF) CC for cranio-caudal dimension (height).*

Table 4. Supratentorial Cranial Cavity (SCC) Dimensions According To Various Age Groups in Sudanese Population

		Descriptive Quantitative Data Of (SCC)					P –value*
		N	Mean	Std. Deviation	Minimum	Maximum	
(SCC)AP	20-30	42	159.34	7.36	145.60	182.95	0.659
	31-40	20	157.11	6.26	143.44	167.69	
	41-50	38	159.29	5.42	146.55	169.89	
	51-60	41	157.97	5.68	146.42	170.22	
	>61	59	158.87	7.25	144.20	182.67	
	Total	200	158.69	6.53	143.44	182.95	
(SCC)TRV	20-30	42	124.17	5.16	113.02	135.79	0.344
	31-40	20	126.06	5.63	117.43	136.60	
	41-50	38	126.02	5.38	117.00	140.90	
	51-60	41	124.28	4.80	110.90	137.71	
	>61	59	125.28	4.68	114.90	140.70	
	Total	200	125.06	5.05	110.90	140.90	
(SCC)CC	20-30	42	398.00	44.41	360.00	450.00	0.713
	31-40	20	391.10	43.48	360.00	450.00	
	41-50	38	402.05	44.92	360.00	450.00	
	51-60	41	405.60	45.06	360.00	450.00	
	>61	59	405.38	44.20	360.00	450.00	

**Correlation is significant at* P < 0.001 *.(SCC) AP stands for Supratentorial Cranial Cavity antero-posterior dimension, (SCC)TRV for Supratentorial Cranial Cavity transverse dimension , (SCC)CC for Supratentorial Cranial Cavity cranio-caudal dimensions (height).*

DISCUSSION

Pathologies of the (PCF) are very common. Knowledge of anatomy of this region and the normal range is important in the proper planning of the management. There are normal variations amongst various races, body, habitus, and gender, geographical, and genetic factors (Gautama Kanodia *et al*., 2012). Although there are studies on normal dimensions of the (PCF) and (SCC), there is no study in the Sudanese population. Table (1) presented the measurements done for the 200 patients. The (AP), (TRV) and height (CC)dimensions for (PCF) and (SCC) were found to be 72.82±7.70 (mm), 158.69±6.53(mm) and 106.21±8.75(mm) for the (PCF) and, 125.06±5.05(mm), 65.22±17.81(mm), 401.82± 44.52(mm)for (SCC) respectively with significant difference between the variables at p=0.000.Sudanese height (CC)of the (PCF) and (SCC) were greater than the study done by Gautama Kanodia *et al*. (2012).

The (AP), (TRV) and height (CC) measurements reflects the volume of the cavity Prassopoulos *et al*., 1996).

The presentation with hypoplasia of the bony structures could be more in congenital anomalies like Chiari Malformation 1. Short craniocaudal height of (PCF) and underdeveloped bony structures could lead to downward herniation of the contents in adult (Nishikawa, 1997; Vega, 1990). The congestion of posterior cranial fossa (PCF) can be determined if the normal range of the dimensions and height is available (Gautama Kanodia *et al*., 2012). Grant *et al.* (2011) reported that the myelomeningocele was associated with smaller (PCF). The (PCF) and (SCC) morphometic analyses according to gender was done, this was presented in Table (2). It is useful, when assessing (PCF), (SCC), and height (CC) dimensions, to use standards for males and females and to relate (PCF) to (SCC) to eliminate sex differences. We found the (PCF) develop in parallel with the (SCC); its (AP) and (TRV) dimensions showed a strong correlation with the (SCC) measurements.

Dimensions and the height (CC) of the (PCF) and the (SCC) were recorded in 200 Sudanese patients. There were 97 male and 103female patients, males have larger measurements than females, these differences were statistically significant in all

variables except the (SCC) height (CC). No significant difference was detected between the males and females, similar study was done by Prassopoulos *et al*. (1996). There was no difference in dimensions of the (PCF) and (SCC) in various age groups, as shown in tables (3) and (4) except (TRV) and height (CC) of the(PCF) as noted in table(3) it increases by advanced age . Abnormal changes in the measurements of the (PCF) associated with malformations are usually assessed qualitatively as mentioned by Schaefer GB (1991) and recent reports have stressed the necessity for quantitative morphometric analysis in the study of diseases of the (PCF) (Schaefer *et al*., 1990; Edward 1991). Therefore normative quantitative values will reflect any presence of morphometric changes occurs at that area. This is why we need to establish a local reference for Sudanese. The study concluded that normal ranges of various dimensions of (PCF) and (SCC) for Sudanese population were established and could serve as Local reference.

Strengths and limitations of study

The strength of our study is the large sample size of adult Sudanese population, and it included both genders. We did the morphometric analysis in CT scan of head without any bony abnormality. This limitation of our study is that the Sudanese tribes have not been considered.

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