International Journal of Anatomy and Research,
Int J Anat Res 2016, Vol 4(3):2637-42. ISSN 2321-4287
DOI: http://dx.doi.org/10.16965/ijar.2016.272

Original Research Article

CRANIAL MEASUREMENT INDICES IN THE STATE OF PARAIBA, NORTHEAST OF BRAZIL

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ABSTRACT

Introduction: The population of the Brazilian Northeast is known for the tendency towards a different head format in relation to the ones of the other regions, characterized by brachycephaly. Various studies correlate this phenotype to craniocervical malformations, especially the basilar impression and the Chiari malformation. The objective was to determine the Cranial Index (CI) in specimens from the State of Paraiba and, compare our values to those of the studies found in literature.

Materials and Methods: The CI of 166 articulated adult skulls, 101 male and 65 female, over 18 years of age, belonging to the Anatomy Laboratory of the Federal University of Paraiba (UFPB) were analyzed.

Results: The CI in the male skulls presented an average of 82.3cm ± 4.3, and in the female skulls 82.9cm ± 3.2, significant difference ($p < 0.0456216$). As for the cranial type: 2.41 % were dolichocephalic (narrow skull), 17.47 % mesocephalic (skull with median proportion), and 80.12 % brachycephalic (wide skull).

Discussion and Conclusion: The present study proves the bradycephalic profile in the population from Paraiba, which presented higher indices than the Northern and Southern regions of Brazil, as well as those of other brachycephalic ethnicities. We highlight the need to extend similar studies to the other states of the Brazilian Northeast for a typification of the skulls of this region, with a deepening of its relations with the basilar impression and the Chiari malformation.

KEY WORDS: Craniometry. Cranial Index. Craniocervical Malformations.

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Access this Article online

Quick Response code

DOI: 10.16965/ijar.2016.272

Web site: International Journal of Anatomy and Research
ISSN 2321-4287
www.ijmhr.org/ijar.htm

Received: 21 Jun 2016 Accepted: 15 Jul 2016
Peer Review: 21 Jun 2016 Published (O): 31 Aug 2016
Revised: None Published (P): 31 Aug 2016

INTRODUCTION

The State of Paraiba (PB) is one of the 27 Brazilian Federations and is localized at latitude of 07º 09' S and longitude of 36º 49' W. It is part of the Northeast Region (NE), whose population is known for the head format which tends to be different from the other regions of the country, characterized by brachycephaly, popularly called "*cabeça-chata*" (flat head) [1-4].

The term '*cabeça-chata*' (flat head) is cited in various literary works of the region, such as Macunaíma' - *"barely six months had passed and the Mother of the woods gave birth to a red son (...) The little one had a flat head (...)"* and Iracema - *"we identified Macunaíma and Ci's son, who had a flat head"* [5,6].

Vidal et al. [7] claim that the brachycephalic phenotype is a consequence of the genetic heritage of the natives who inhabited the region before the arrival of the Europeans. In general, the cranial morphology of the native Americans is divided into two standards, one characterized by a narrow and long neurocranium, and another characterized by a short and wide neurocranium [8].

The growth of the cranial base is what will define the cranial length [9-12], except in the cases of neurological pathologies where there is cerebral atrophy associated to microcrania [9]. The growth of this base is obtained by means of a complex balance between the sutural growth, lengthening of the synchondrosis, cortical sliding and remodeling [13,14].

In the post-birth, the calvaria is more extense than the baseand presents an unequal development. Its growth in width occurs at the sutures: sagittal, esfenofrontal, esfenotemporal, occipitomastoid and in thepetro-occipital cartilaginous articulations, and the growth in height occurs in the frontozygomatic, scamous, in the pterium and in the asterium articulations [15].

The premature consolidation of these sutures may determine phenotypical characteristics in the cranial format. According to González [16], the causes of cranial malformation resulting from the premature ossification of the sutures are called craniosynostosis, where according to Virchow's law there is a compensation of the cranial growth in relation to the compromised suture.

In the NE, there is a high rate of surgeries resulting from the malformation of the craniocervical transition [17]. These dysfunctions are associated to the compression of structures of the central nervous system, which may require surgical intervention [7,17], and they are correlated to brachycephaly [3-5,17,18]. In the State of Paraiba, between 1971 and 1992, Silva et al. [18] made 260 surgeries to treat occipitocervical malformations, being 29 (11.1 %) cases of pure basilar impression 18 (6.9 %) Arnold-Chiari malformation, and 213 (81.9 %) cases of association between basilar impression and Arnold-Chiari.

Even though there are reports in literature about brachycephaly among the Northeastern people, none of these works brought statistical data which proved the population's brachiocephalic profile in samples of the NE, including the State of Paraiba. They only cite the correlation of the craniocervical malformations with brachiocephaly [3-5,17,18]. The ethnic condition, fundamentally characterized by crossbreeding, induces that this population may present a morphological variability with its own characteristics.

The objective was to determine the Cranial Index (CI) in specimens from Paraiba, and prepare a systematization of the cranial types, comparing them to the measurements of the diameters and the indices presented in some other studies.

MATERIALS AND METHODS

The CI of 166 articulated adult skulls were analyzed, being 101 of them male and 65 female, over 18 years of age, belonging to the anatomy laboratory of the Federal University of Paraiba (UFPB). The research was approved by the Ethics and Research Committee of the same institution under the number CAAE:32265714.0.0000.51880 CEP2014.

During their analysis, the skulls were photographed and the data was registered in Microsoft Excel 2010 spreadsheet, composing a database with all the variables of the study, which allowed for a posterior statistical analysis. For the comparison of means between the genders, the T-Test with a confidence interval of $p<0,05$ was used.

To measure the CI a digital pachymeter for external measuring, adapted and properly calibrated. The cranial index was obtained by the maximum laterolateral diameter, divided by the maximum anteroposterior diameter, being this coefficient multiplied by 100, thus allowing to classify the cranial types in: dolichocephalic ($CI \leq 74.9$), mesocephalic ($75.0 \leq IC \leq 79.9$) and brachycephalic ($IC \leq 80.0$) [19].

As an additional study, the sample was also categorized regarding the width. The following parameters are in millimeters: very narrow (male: 125-133; female: 120-128), narrow (male.: 134-138; female.: 129-133), average (male.: 139-

144; female.:134-139), wide (male: 145-149; female: 140-144), very wide (male.: 150-158; female.: 145-153) [20].

With regard to the gender estimate the following were used: frontal bone, glabella, superciliary arch, supraorbital margin, mastoid processes, styloid processes, zygomatic arch, occipital condyles and the robustness of the protrusions [21].

RESULTS

The statistical analyses of the variables of the study were shown in the Tables 1 to 6. The male skulls represented 60.8% (101 skulls) of the sample while the female 39.2% (65 skulls).

The average maximum width of the analyzed skulls is of 14.5 cm ± 0.7 for the male gender and 14.19 cm ± 0.6 for the female gender (Table 1), while the average maximum length is of 17.67cm ± 0.9 and 17.1 cm± 0.7 for the respective genders (Table 2). It is noticeable that the averages of the linear segments presented a significant difference between the genders, when compared by paired averages by the t-Student test., with $p<0.05$.

The CI in the male skulls obtained an average of 82.3 cm ± 4.3, and in the female skulls 82.9 cm ± 3.2, a significant difference ($p<0.05$) (Table 3). As for the cranial type: 2.41% are dolichocephalics (narrow skull), 17.47% mesocephalic (skull with a medium proportion) and 80.12% brachycephalic (wide skull) (Fig. 1 and Table 4). The brachycephalic proportion was not different between the genders, with 80.19 % for the male gender and about and 80.0 % for the male gender.

The qualifying analysis of the sample regarding the width (Table 6), showed a small incidence of narrow skulls, with about 13.8% considering the narrow and very narrow ones. In relation to the wide skulls the study presented a percentage of 57.8 %, adding the wide to the very wide ones, in other words, more than half of the sample was of wide skulls. Among the medium width skulls (47 specimens), 66% were skulls of high width (31 skulls), with values very close to the values of the wide skulls.

Table 1: Mean and Standard Deviation of the maximum width of the sample (n=166).

Statistical Analysis	N	Male	N	Female
Means	101	14,55	65	14,19
Standard Deviation	101	± 0,7	65	± 0,6

Student T-test for the comparison of the means, n, total sample; *p < 0.05=0.000666

Table 2: Mean and Standard Deviation of the maximum length of the sample (n=166).

Statistical Analysis	N	Male	N	Female
Mean	101	17.67	65	17.11
Standard Deviation	101	± 0.9	65	± 0.7

Student T-test for the comparison ofthe means, n, total sample; *p < 0.05=0.000666

Table 3: Mean and standard deviation of the cranial indexof the sample (n=166).

Statistical Analysis	N	Male	N	Female
Mean	101	82.3	65	82.9
Standard Deviation	101	± 4.3	65	± 3.2

Student T-test for the comparison of the means, n, total sample; *p < 0.05=p <0.0456216

Table 4: Percentage distribution of the cranial type according to the cranial index.

Typesofskulls	N	Male	N	Female
Brachycephalic	81	48.80%	52	31.32%
Mesocephalic	16	9.64%	13	7.83%
Dolichocephalic	4	2.41%	-	-

Table 5: Means of the measures and linear indices of Northeastern skulls and other ethnic groups.

Skulls	Male.	Max. Width.	Max. Leng.	CI	Female.	Max. Width	Max. Leng.	CI
Present Study	101	14.55	17.67	82.3	65	14.19	17.11	82.9
Brazilian North	54	-	-	80.9	-	-	-	-
Brazilian South	56	-	-	79.1	-	-	-	-
Aleu1	82	14.71	18.21	80.8	57	14.26	17.58	81.1
South ofAustralia	147	13	18.3	71.1	71	12.6	18.09	69.7
Peru	223	13.91	17.62	78.9	143	13.47	16.95	79.5
EastAsia- Togoku	107	13.93	18.22	76.5	68	13.43	17,32	77.5
Eskimo – Alaska 1	135	14.15	18.21	77.7	130	13.65	17.34	78.7
Eskimo – Greenland	107	13.68	19	72	57	13.07	18.13	72.1
NortheastAsia - Mongols	151	14.9	18.24	81.7	65	14.32	17.34	82.6
Polynesia – Maori New Zealand	120	13.86	18.69	74.2	23	13.33	17.96	74.2
South EastAsia– Philippines	122	13.98	17.84	78.4	38	13.47	16.83	80
Sub-SaharanAfrica– Kenya	95	13.21	18.49	71.4	29	13.01	17.64	73.8
USA – California 2	163	13.86	18.13	76.4	156	13.79	17.36	79.4
USA- Florida	96	14.51	18.2	79.7	62	13.32	18.05	73.8

Table 6: Classification of the skulls according to the maximum width of theneurocranium.

Width	N	Male	N	Female
Verynarrow	7	4.20%	0	-
Narrow	11	6.60%	5	3%
Average	26	15.70%	21	12.70%
Wide	37	22.30%	17	10.20%
Verywide	20	12%	22	13.30%

Fig. 1: Showing; a: brachycephalic, b: mesocephalic, c: dolichocephalic.

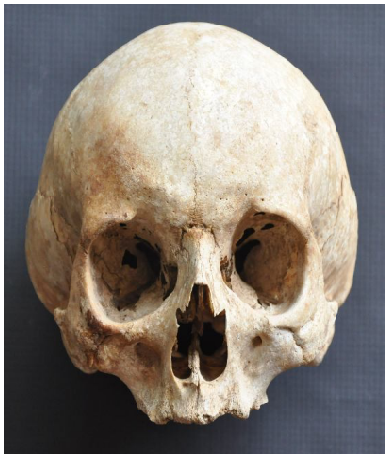

Fig. 2: Brachycephalic skull with lateralization of the temporal bones.

Fig. 3: Brachycephalic skull with alteration in the morphology of the base of the skull.

DISCUSSION

Neves & Hubbe [8] defend that the first cranial morphology regarding the originof the American man is generalized (Paleoamerican), similar to the sub-Saharan African people, and that the second is very specific, similar to the Asian people and some native Americans, known as mongoloid morphology.

Using craniometric data extracted from Hanihara's study [22], Table 5 was arranged which envisaged to compare our data to the data of other geographically distinct samples. The parameters of our study were similar to the ones of the Asian Northeast , both of brachycephalic averages, where our CI appeared with an average of 82.3 and 82.9 and Mongolian index with 81.7 and 82.6 for the male and female genders, respectively. The Aleuts also had parameters approximate to our sample, being 80.8 and 81.1, for the respective genders.

The genesis of mongolian morphology, originated from the Northeast of Asia, is one of the theoretical principles to justify the morphology of the American skulls [8]. Our study reveals higher CI means than those presented in Hanihara's [22] sample, which is numerically expressive and with a widespread distribution around the world.

We found that the brachycephalia is characterized by the flattening of the skull in the transverse plane, evidenced by the increase in its laterolateral diameter (Table 6) (Fig. 2), due to the lateralization of the temporal bones which, many times, makes the neurocranium rounded in shape.

About 21 skulls presented a noticeable levelling of the base's anterior and posterior fossa and the height of the sphenoid, in different levels, which possibly is related to platibasya and basilar impression. Although it is generally without pathological significance, the platibasya is frequently associated to the malformations of the craniocervical junction, in particular the basilar impression, Chiari malformation and syringomyelia (Fig. 3). This justifies the high rate of surgeries in the Northeast, carried out in order to decompress neural structures adjacent to the craniocervical transition, such as the medulla, brainstem, cerebellum [7,17,18].

Furthermore, a study carried out with Magnetic Resonances of the population of the 'Sertão' region of the State of Paraiba [23] revealed a strong inverse correlation between the increase in the Welcker basal angle (WBA) and the decrease of the clivus-canal angle (CCA), as well as a statistically significant correlation between the WBA and the distance between the tooth of the second cervical vertebra (C-2) and Chamberlain's line. This proves that the increase of the base of the skull is closely related to the basilar impression by C-2.

In this study, the averages of the cranial indices for the male gender (82.30) and for the female gender (82.90) were higher than those of the study for the Northern (80.93) and Southern (79.06) regions of Brazil [24], a research which used only male individuals. In his research, Alves et al. [24] concluded that Mesocephaly is predominant in the Northern and Southern regions; in contrast, the present study establishes the predominance of brachycephaly in the population of the State of Paraiba.

We conclude stating the evident peculiarity of brachycephaly in the studied population of the State of Paraiba (Brazilian Northeast), which evidences people with wide and flattened skulls, and the majority of the sample had brachycephalic skulls (80.12%) and a very small part of them had dolicocephalic skulls (2.41%). We highlight the need to extend similar studies in the other states of the Northeast for a typification of the skulls of this region, with a deepening in understanding of their relation with the basilar impression and Chiari malformation.

ACKNOWLEDGEMENTS

I thank the authors of this researching for their dedication and commitment to do it. I'm grateful to Eulâmpio José da Silva Neto, for his support and encouragement that he has given to me through all these years. I dedicate this research to my family, specially to my beloved mother, for her unconditionally support.

Conflicts of Interests: **None**

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How to cite this article:

Nascimento JJC, Ribeiro ECO, Silva-Neto EJ, Araújo-Neto SA, Holanda MMA, França CCNL. CRANIAL MEASUREMENT INDICES IN THE STATE OF PARAIBA, NORTHEAST OF BRAZIL. Int J Anat Res 2016;4(3):2637-2642. **DOI:** 10.16965/ijar.2016.272