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Research Article

Anatomical evaluation of the craniometric points and dimensions among adult's populations of the South-Eastern Nigerians and its implication for intracranial surgical procedures

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Abstract

Background: The understanding of Craniometry with its associated craniometric points and dimensions have found immense applicable relevance in anthropology and neuroscience, ranging from growth determination, estimation of cranial deformities, personal biological profile identification and facial reconstructive surgeries, analysis of evolution of the human species in archeology as well as age variations.

Objective: The aim of this study was to evaluate the craniometric dimensions among adults' subjects in Eastern Nigerian State.

Methods: Research data was collected from Computed Tomography scans in the Radiological Department of Federal Medical Centre, Umuahia, Nigeria with strict adherence to inclusive and exclusive factors. A total number of 150 human CT scans were used in the findings. Craniometric parameters were calculated - derived from the two and three coordinate points for linear and angular measurements respectively.

Results: Results revealed that age group 36-45 had the lowest cranial parameters and age group 56-65 had the highest cranial parameters.

Conclusion: It was concluded that cranial parameters does not increase as age increases throughout life. The study findings will be useful to the anatomists, anthropologists and neuroscientists.

Introduction

Cranial index variations between and within population have been attributed to a complex interaction between genetic and environmental factors. Knowledge of the cranium of either a dry human skull or of a living being through morphometric and non-morphometric studies are very helpful for the study and comparison of populations with various fundamental differences such as in personal identification of individuals from basic biological profile of sex, age, ethnicity or geographic.

According to Kanchan, et al. [1] crania are also the most commonly used skeletal elements in population studies because they are known to be more genetically driven and less affected by environmental factors. Craniometry evaluated by computed tomography and other radio-imaging and radiographic techniques are now a useful and modern tool to anatomists, anthropologists and neuroscientists accepted as a standard protocol for clinical diagnosis and surgical procedures or medico-legal examinations as identified by Christensen and Crowder [2]. However, anatomical landmarks of skulls can be established by using other various methods such as direct physical measurement, x-ray and 2D or 3D (third dimension) imaging technology. When investigating craniometric variations, two main types of data in either two or three-dimensional views are collected. Both data requires locating a suite of craniometric points and dimensions [3,4].

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Three dimensional data is specifically useful because it allows for the x and y coordinates from the traditional inter-landmark distances to be analyzed spatially with respect to the z coordinates.

Cranial volume as an aspect of dimension equally expresses several degrees of growth and development and permits critical evaluation of unusually large, small or misshapen crania as noted by Haack and Meihoff [5]. The application of craniometric data from cranial morphology in mainstream science today is used to analyze the evolution of the human species in archeology as population differentiation has been explored showing that various cranial characteristics are responsible for both inter and intra-regional differences within a geographical region [6]. Measurements of craniofacial complex are useful in comparison of the patient with a normal reference group, so that the differences between the patient's actual craniofacial and dento-facial relationships and those expected for his/her racial or ethnic group are revealed [7]. The need to produce and update the various craniofacial dimensional standards among a unique populations is central to this study, hence the aim of this study is to evaluate the craniometric dimensions among adults' subjects in Eastern Nigerian State, with the objective of determining the variations of craniometric points among adult age groups using the radio-imaging tool of computed tomography.

Materials and methods

Study design

This is a prospective study that was carried in a multi specialist government tertiary health facility using computed tomography data taken from May 2020 to July 2021.

Sample inclusion

Individuals between the age of 25 to 60 years with no incidence of head trauma or abnormality, loss of teeth from the maxilla or chronic illness that might affect the cranium were used for the study while individuals with anatomical deformities and children were avoided in the collection of data.

The data for this research included one hundred (150) Computed Tomography scan results collected from a Computed Tomography SCAN's diagnostic centers in Umuahia, Nigeria.

Computed Tomography (CT) was used due to its accuracy of verification of surface landmark placement relative to bony landmark as well as easy measurability and reproducibility of paired dimensions. CT scan also has the advantage of sectioning images in the same section and archiving them in DICOM (Digital Imaging and Communications in Medicine) format.

Computed tomography data acquisition

During CT scan, the individual lie on a table structure known as gantry. The gantry slowly passes through the center of a large x-ray machine. During some test the individual receives dye for contrast. Patients were scanned and the CT data were processed in a computer workstation at the department. A spiral computed tomography scanner (SIEMEN) was used to obtain data from 150 crania. The CT scan acquisition was performed with 1.5mm slice thickness and reconstruction was done with 1.0m 2m slice thickness. All the CT data was recorded using DICOM 3.0 as a medical image file format into CD-ROM and subsequently imported to the medical imaging software (MIMICKS) - materialized N.V Belgium. The segmentation techniques was used to identify the region of interest of the computed tomography image based on Hounsfield unit. The selected regions were calculated into 3D modem which enabled the determination of the 3D Craniometric data. During each scanning, each subject was placed in a supine position. Axial scanogram was obtained from the setting such that the tube voltage was 120KVP and tube current was 52 mA, with 0.58 rotation time and 1mm slice thickness.

Measurement of 3d craniometric data

Craniometric data was determined by defining the anatomical landmarks which can be classified as median and bilateral types [8,9]. The mean landmarks are approximately located on sagittal plane. All dimensions/landmarks used were based on traditional definitions with modification into 3D model. The most prominent anatomy in 2D/3D views were selected to state the proper position of each anatomical landmark. However, craniometric parameters were calculated - derived from the two and three coordinate points for linear and angular measurements respectively.

The craniometric points includes

Glabella (GL): The most anterior point of frontal bone between supraorbital in the sagittal plane. Bregma (BR) - the crossing of the coronal and sagittal sutures on the top of the skull. Opisthocranium (OPC) - the most posterior point in midline of inion bone which length of the skull is maximum when measure from Glabella point.

Nasion (NA): The intersection point of the internasal and frontonasal sutures in the sagittal plane.

Basion (BA): The most anterior point of the great foramen magnum in the sagittal plane.

Craniometric dimensions/landmarks includes: Occipal Length (GOL), Basion Nasion Length (BNL), Basion Bregma Height (BBN), Nasion Bregma Cord (NBC), Bregma Lambda Cord (BLC), Lambda Opisthion Length (LOL), Basion Prosthion Length (BPL).

Only one investigator located the entire dimensions in the skulls to avoid uncertainty and wide variations if any of intra-observer. The anatomical landmarks were used to obtain 150 Craniometric parameters. There were considerations limited to only complete union of the glabella occipal length, basion nasion length, basion bregma height, nasion bregma cord, bregma lambda cord, lambda opisthion length, basion prosthion length sutures instead of taking into account other scoring system of suture closure and compared with standard data mentioned in different texts and previous studies.

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Statistical analysis

The measurement data were expressed in Microsoft Excel and then exported to SPSS version 20.0 for the statistical analysis and interpretation by descriptive statistics reported in form of comparism of the mean values and mean difference, standard deviation and confidence interval in respect to the various landmarks. In order to distinguish Craniometric parameters of each age, analysis of variance was utilized for analysis. The investigation of different Craniometric data between the cranium values was analyzed with their degree of freedom (df), confidence interval (CI). A p-value < 0.05 was considered to be statistical significant difference.

Results and discussion

The table describes the confidence interval for the mean (lower and upper bound), minimum value and maximum value of the length for each group with the confidence interval for each group in each column following an alpha (α) level of significance of 0.05 Table 1.

From the distribution of means among the various group dimensions it is observed that the difference between each group is not large but rather a difference with a few number which ranges from 1 to at least 50 as seen in Tables 2,3 which is similar to work done by Vidona, *et al.* [10].

This research work of significance value of 0.00 means that the research is 90% confident indicating the results are accurate. Therefore, the test is statistically significant which means that the cranium results have an acceptable amount of error. This also agrees with research of Craniometry patterns of Nigerians and its correlation with chronological age [10].

Table 1: Descriptive Analysis showing Length for Upper and Lower bound.

Length (Lower Bound)	G0L	BNL	BBH	NBC	BLC	LOL	BPL	TOTAL
N	150	150	150	150	150	150	150	1050
Mean	173.46	115.26	123.25	128.14	117.34	99.89	124.53	125.98
SD	13.860	8.404	13.317	9.313	10.987	12.535	9.215	23.982
Standard Error	1.132	.686	1.087	.760	.897	1.023	.752	.740
95% Confidence Interval for Mean	171.22	113.90	121.10	126.64	115.57	97.87	123.05	124.53
Length (Upper Bound)	G0L	BNL	BBH	NBC	BLC	LOL	BPL	TOTAL
95% Confidence Interval for Mean	175.70	116.62	125.40	129.64	119.11	101.92	126.02	127.44
Minimum	144	94	98	102	90	80	99	80
Maximum	199	139	171	149	142	169	150	199

Table 2: Comparing groups mean.

Parameters in age	G0L	BNL	BBH	NBC	BLC	LOL	BPL
25-35	31.2228	20.7468	22.185	23.0652	21.1212	17.9802	21.6864
36-45	20.8152	13.8312	14.78	15.3768	14.0808	11.9868	14.4576
46-55	52.038	34.578	36.578	38.442	35.202	29.967	36.144
56-65	69.384	46.104	46.104	51.256	46.936	39.956	48.192

Table 3: Anova Test showing length values between and within groups.

Anova Test	Between groups	Within groups
S/N	150	150
DF	6	1043
SS	470793.851	132541.840
MS		127.078
F-RATION	617.464	
Significant value	0.00	

Key

SD: Standard Deviation

SS: Sum of Squares

MS: Mean Sum of Squares

F-ratio: Mean sum of squares of treatment / mean sum of square of error

N: Number of sample

DF: Degree of Freedom.

Most of the data from the length of the dimensions differ from values of work done in India [11] which be probably be due to genetic, racial, developmental factors, geographical location and dietary habits. The study has demonstrated an advanced technique based on computed tomographic and medical imaging methods, which is very useful to analyze the craniometric study digitally without physical measurement and destruction to the specimen as was done in the stone centuries back as noted in a material by Leaky [12]. Age of the cranium skulls suture of the dimensions were matching with standard data given in the table that was analyzed.

Comparing group mean values of GOL, BNL, BBH, NBC, BLC, LOL and BPL parameters, the ages between 56-65 revealed the highest values across groups whereas the ages between 36-45 had the lowest values amongst the groups. On the other hand, the ages between 46-55 years had a mean values greater than the ages between 25-35 years.

Conclusion

Cranial Parameters decreases between ages 36-45 among South-Eastern Nigerians. This could be as result of the assertion that cranial length or maximum cranial reaches its size in adults around the age of 10 for females and about 14 years for males according to Farkas, *et al.* [13,14]. The implication of this outcome is therefore for clinicians to understand the cranial dimensions and its growth length corresponding to adults' population within the age brackets investigated to help guide diagnosis and interpretations for cranial related cases. Recommendation would be for more such studies to understand the effect of genetics on the cranial shapes in

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different population groups and its geometric morphometric analysis as well as that comparing data with different nationalities will be important in determining the structural craniometric properties for social diversity. Therefore the localization of these cranial dimensions will help in identifying vital intracranial structures lying within such dimensions and hence the implication in what is referred to as surgical tailoring as well as in correlating these normal structural dimensions with pathological or cranial abnormalities subcortically.

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