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IMPORTANCE OF CRANIOMETRIC POINTS FOR FORENSIC ANTHROPOLOGY

[1]Vicente Bruno de Freitas Guimarães, [2]Kirley Kethellen Batista Mesquita,*[3]Francisco Mayron Morais Soares, [4]Aluízio Rodrigues Guimarães Júnior,[5]Eryka Maria Rodrigues Pereira, [5]Glaucirene Siebra Moura Ferreira, [6]Tatyane Oliveira Rebouças, [2]Patrícia Giselle Freitas Marques, [2]Vicente Paulo Silva Lopes, [2]Francisco Ivanildo Sales Ferreira,[2]Naiane Oliveira MendonçaMaria Roberta Freitas de Melo Lima, [2]Ana Leticia Guedes de Lima, [2]Karine de Almeida Silva,[2]Beatriz Avelino Cavalcante, [2]Nairliana Kelly Lima Mendes,

[1]Master in Biotechnology in Human Health UECE. Professor of the UECE Medicine course; [2]Nurse at the University of Fortaleza, postgraduate in organ transplantation / Obstetrics, Nurse. [3]Master in Nursing – Professor of Nursing Graduation at College UNINTA Itapipoca, [4]Nursing student. Regional University of Cariri (URCA), [5]Nurse. Master in Nursing – Professor of Nursing Graduation at College UNINTA Itapipoca; [6]Nurse. Master in Nursing - Hematology and Hemotherapy Center of Ceará = HEMOCE

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Corresponding author: Francisco Mayron Morais Soares,

ABSTRACT

Objective: Analyze the evidence in the literature about the importance of craniometric points for forensic anthropology, as well as synthesize anatomical knowledge about craniometric points. **Method:** This is a descriptive, qualitative, literature review study. **Results:** When analyzing the publications, it was noted that the main tasks of the forensic anthropologist or criminal expert for human identification, through examination of skull pieces of unknown origin, is to establish what is called a biological profile, which would be a list of four fundamental characteristics, which include: sex, age, ancestry and probable stature of that specimen. **Conclusion:** It was found that such a procedure plays a fundamental role in human identification in many situations.

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INTRODUCTION

Anthropology, as a science that analyzes the individual from a physical-cultural perspective, has within the scope of forensic expertise the intention of enabling the understanding of direct identity under the physical criterion, enabling the identification of sex and ancestry, so that, the estimate age and other characteristics can be assessed (Kiran, 2015). Craniometry is a technique used to measure the skull, in which it assists the cranioscopy technique, a visual inspection of the skull, where it allows the observation of morphological variability. Craniometric points are used when measuring the skull to better identify variability (Drake, 2015). The variations present in the skull of the human species can be verified and measured by analyzing a set of reference points called craniometric points. They are of interest in anthropology, as an anatomical use, since the study of various measurements of various skulls allows their classification, as well as their distinction between different races. They are also used in forensic practice, given the presence of some variations in the shape and measurements of the skull between man and woman (Drake, 2015) .The use of craniometric points, in view of the anatomical position itself, occurs throughout the anatomical study. By virtue of the head orientation plane in which it complies with an orbitomematic head orientation convention. This comprises the line of union from the lowest point of the lower margin of the left orbit to the most external point of the roof of the external auditory canal (Freitas, 2004). There are, on average, about 50 craniometric points. Most of them are unique, as they are in

the median sagittal plane. Others are in the lateral planes of the skull, existing in pairs (Bontrager, 2015). These measures, in general, are carefully applied in anthropology to identify sex and sexual dimorphism. Through the skull and jaw it is possible to obtain the necessary information in this exam, making it easy to distinguish a male skull from a female skull in its precise measurements; in imprecise measures, it assumes a difficult and uncertain function (Jobim, 2006). Distinctions are noted between adult male and female skulls. The female bones in most cases are smaller in size and lighter, the joints also have smaller dimensions. In contrast, male bones tend to be larger and heavier, structures are more robust.7 The analysis of the skull according to forensic anthropology refers to a methodology that seeks to complement the DNA examination, such a method provides the delimitation of the sample, provides important information to detect conditions that caused death, age, individual signs, pathologies and possible traumas related to death (Carvalho, 2013). Skull analysis in the face of forensic anthropology is a complementary methodology to DNA examination. The evidence obtained by this method allows the delimitation of the sample, even when there is no subject for comparison, before leaving for genetic analysis. In addition, it can provide useful information to measure the conditions involved at the time of death, age, individual signs, pathologies, and possible traumas related to death (Carvalho, 2013). Thus, it is important to add studies that reflect on the theme, aiming at a greater understanding and discussions about the process of identifying people, from the analysis of the skull or parts of it. The task requires more precise techniques and methods that will assist medical experts to efficiently carry out their work of scientifically assisting justice in both civil and criminal labor law. Given the above, the study is justified by the importance of deepening knowledge about the subject, correlating applications of craniometry to other sciences, as in the case, anthropology. In this context, this study aimed to analyze the evidence in the literature about the importance of craniometric points for forensic anthropology, as well as synthesize anatomical knowledge about craniometric points.

MATERIALS AND METHODS

This is a descriptive, qualitative, literature review study to show the importance of craniometric points in forensic anthropology. This method includes the analysis of studies consisting of a method used to identify knowledge gaps, define research agendas and identify implications for decision making (Tricco, 2016). An exploratory descriptive study are exploratory studies that aim to completely describe a certain phenomenon, such as, for example, the study of a case for which empirical and theoretical analyzes are carried out (Marconi, 2010). The purpose of descriptive studies is to observe, describe and document aspects of the situation. The cross-sectional designs are specially approved to describe the situation, the status of the phenomenon or the relationships between the phenomena at a fixed point in time (Polit, 2011). The bibliographic survey was carried out between August and September 2019, concurrently in the following databases: Medical Literature Analysis and Retrieval System Online (MEDLINE), Cumulative Index to Nursing and Allied Health Literature (CINAHL) and Latin American and Caribbean in Health Sciences (Lilacs); by combining the following descriptors: using the following descriptors: “Forensic anthropology”; "Skull"; "Legal Medicine". The study has as its guiding question the following question: “What is the evidence in published literature about the importance of craniometric points for forensic anthropology?”

The criteria used for the selection of the sample were: complete articles available electronically in the cited databases, in Portuguese, English or Spanish, with full text available, in the last ten years, whose adopted methodology would allow obtaining evidence on the subject in question. As exclusion criteria, articles in duplicates and those that were not reliable were not included in the study analysis. Of the 428 articles selected for screening, 383 publications were excluded. Of these, 45 studies remained, after analyzing the articles, 37 were excluded because they did not answer the research question. Thus, 8 articles remained eligible for full reading.

RESULTS

To facilitate the analysis and presentation of the results, Tables 1 and 2 were elaborated.

DISCUSSION

When analyzing the publications, it was noted that the main tasks of the forensic anthropologist or criminal expert for human identification, through examination of skull pieces of unknown origin, is to establish what is called a biological profile, which would be a cataloging of four fundamental characteristics, which include: sex, age, ancestry and probable stature of the specimen (Lima, 2016). Forensic human identification is commonly obtained through digital analysis. However, in some cases this method cannot be used due to tissue destruction, carbonization or decomposition of the corpse. In this way, forensic anthropology proves to be a reliable practice for human identification, it is from there that information related to sex, age, height, ancestry, as well as the individual characteristics of the individual is collected. Most of the studies carried out in the area bring a qualitative methodology, in which detailed characteristics about the skull are exposed, being these structures: the frontal sinuses, teeth, glabella, superciliary arches, ment, bone surface in which the muscles are fixed, mastoid processes , parietal eminences, canine fossa, alveolar arches, coronoid processes, frontonasal joint, among others.07,14 The skull has specific structures that can support elements for the identification of the sex of an individual, whether alive, recent cadaver, rotting, skeletonized or carbonized corpse (Lima, 2016). Almeida junior[13] conducted a study whose objective was to verify sexual dimorphism and age estimation using facial bones, showed satisfactory results in which it was possible to establish methodologies for the identification of sex through the means, confidence interval and Student's t test, demonstrating that the averages differ at the 5% significance level. In addition, there was a strong linear association between the PZOD-ENA and PZOE-ENA measures (coefficient of determination = 80.90%), showing that the male measures are significantly higher than those of the sex feminine. Souza and Soares19 developed a study in which they sought to understand the importance of studying the skull, from a biological perspective, in the process of investigation of its identification, determining its probable ancestry and sex, in which 30 skulls of adult individuals were examined. Such a study demonstrated numerous limitations for their identification, highlighting the difficulty, first in obtaining a representative sample group and also in relating the phenotype to ancestry in

Table 1. Identification of articles

No.	TITLE	METHOD	PERIODIC	YEAR
1	Determination of Golden Age Proportions for Reconstruction with Medical Identification Fines12	Exploratory study	Int. J. Morphol	2008
2	Investigation of sex through a triangular facial area formed by the intersection of the points: right, left infraorbital foramen and the prostate, in dry adult skulls.13	Exploratory study	Journal of Medical and Biological Sciences	2010
3	Gender Investigation and Age by Face Measurements in Dry Adult Skulls.14	Exploratory study	Brazilian Journal of Forensic Sciences	2013
4	Evaluation of the efficiency and effectiveness of the anthropometry of the mastoid process triangle in the estimation of sex in Brazilian skulls.15	Exploratory study	Brazilian Journal of Forensic Sciences	2016
5	16Analysis between the orbital zygomatic points and anterior nasal spine in the investigation of sex and age in dry adult skulls.16	Cross-sectional, quantitative study	J Health Sci Inst.	2016
6	Evaluating causes of error in landmark-based data collection using scanners.17	Exploratory study	PLOS ONE	2017
7	Anthropometric analysis of mandible: an important step for sex determination.18	Exploratory study	Clin Ter	2018
8	Sexual and ethnic-racial distinction through craniometry: evaluation of the skulls of a collection of maringá-PR.19	Cross-sectional, quantitative study	MUDI Archives	2019

Source: Elaborated by the researcher, 2019.

Table 2. Objectives and Summary of Results

ARTICLE	GOAL	SUMMARY OF RESULTS
1	Determine the presence of craniofacial auric proportions between straight lines formed by the union of reproducible anatomical and anthropometric points.	42 auric relationships were found between lines formed by the union of specific points of the craniofacial massif, which are repeated or constant in the studied skulls. It can be said that proportional relations are found in the architecture of the bone head, whose knowledge can serve as a basis for reconstructions for the purposes of medico-legal identification.
2	To verify the sexual dimorphism using the linear distances Infraorbital Interforam (DI), Infraorbital-Prostium Interforam (DIP) and the Lower Facial Triangle Area (ATFI)	The results found allowed the establishment of methodologies for the identification of sex through mean and confidence interval (59%) and Student's t test, demonstrating that the means differ from each other at the 5% alpha significance level. It was concluded that the analysis of the variables under study showed sexual dimorphism, and the measures corresponding to males were significantly higher than those of females.
3	To verify sexual dimorphism and age estimation through facial measurements. The authors studied a sample of 153 dry skulls.	According to the statistical analysis, there was a success rate of 73.3% by logistic regression and 68.05% by the discriminant analysis. The mean and confidence interval were also verified using the t-test and the multiple linear regression method was used to predict age. The results allowed the development of statistical methodology for the diagnosis of sex and age in future observations.
4	Evaluation of efficiency and effectiveness of the anthropometric method of the process triangle mastoid for sex estimation	The results showed that, in addition to the high number of exclusions due to impossibility of execution and the need for technical refinement to avoid intraobserver errors, the areas obtained contrasted with the values found. It is concluded that, with the passage of time and technical refinement, the anthropometric method becomes more efficient in terms of reducing observer errors.
5	Check sexual dimorphism and age estimation using the following measures: Right Orbital Zygomatic Point, Left Orbital Zygomatic Point, Anterior Nasal Spine and the area of the triangle formed by these 3 points.	The results found allowed to establish methodologies for the identification of sex through the means, confidence interval and Student's t test, demonstrating that the means differ from each other at the 5% significance level. It was concluded that the analysis of the variables identified a difference between the sexes, with the measures of the male sex being significantly larger than those of the female sex.
6	Assess the precision, accuracy and repeatability of the reference points on a single macaque skull digitally reconstructed with three different surface scanners and a microCT scanner.	The type of scan does not affect the intra or interobserver error rate. The interobserver error is much greater than the intraobserver error in all individuals and presents a variation similar to that found between different species of monkeys. In addition, the experience with osteology and morphometry contributes positively to the accuracy in several sessions of marking points of reference, even where less experienced researchers were trained in the acquisition of points.
7	Determine the sex of the human jaw from morphology, morphometric measurements and analysis of the discriminating function of computed tomography	All parameter measurements showed values significantly higher in men than in women by the independent t test ($p < 0.01$). Through the discriminant analysis, the classification accuracy was 78.5%, the sensitivity was 79.2% and the specificity was 77.4%. The discriminant function equation was formulated based on bigonial respiration and condylar height, which were the best predictors.
8	Understand the importance of studying the skull, from a biological and clinical-pathological perspective, in the process of investigating its identification, determining its probable ancestry and sex	The condyle index and foramen magnum diameters were analyzed for sexual diagnosis. The Horizontal, Sagittal, Transversal, Upper Nasospinhal Facial and Gnatic Flower indices were analyzed for ancestry (ethnic-racial affinity). It was found that 70% of the skulls were male and 30% female. Based on the metric and morphological methods of assessing population affinities, of the total analyzed, 60% of the skulls had Caucasian ancestry.

Source: Elaborated by the researcher, 2019.

a population with a certain degree of miscegenation, not providing accurate results and may lead to dubious conclusions. Regarding the physical characteristics of an individual. Still according to Souza and Soares19 another condition that hindered a good result of the study was the absence of the mandible in some skulls, a form that could contribute considerably to these results, but in the analyzed collection most of the mandibles were disjointed. According to Alias18 & Silva23, the mandible directly assists in an analysis with a degree of precision, estimating the gender of an individual. The canine mandibular index, for example, is obtained with an accuracy of around 76%, for women about 82% and for men approximately 70%. Moretto et al15 also showed in their study a similar result when evaluating the efficiency and effectiveness of the anthropometric method of the triangle of the mastoid process to estimate sex, in it, it was seen that anthropometry can present execution errors, demanding greater precision in data collection.

Heterogeneous samples, for example, in situations of intense miscegenation, can provide heterogeneous results. According to Almeida Júnior13 the major obstacle that pervades forensic anthropology is the morphological and metric variability that occurs in different populations, modified by climatic and socioeconomic factors, having to carry out further studies in the population. Di Dio24 & Gray25 list the cranial measurements based on measurements including the craniometric points. One of them is the cranial index or cephalic index. This is measured through the maximum skull width ratio by the maximum skull length, multiplied by 100. All these measures and indices allow comparisons to be made between the skull varieties. For example, when you define that a given breed has dolichocranium, it is not a subjective analysis, but a statistical series of several of these measurements. Sexual dimorphism, as highlighted by France26 can also be established between these various points and measures. In women, in general, the skull is lighter and smaller when compared to that of men. The surface is smoother and has softer bumps on the female skull. When supported on a table, a woman's skull is usually supported by the occipital bone, while a man's is supported by mastoid processes. Such differences are of great value, especially in bone findings, when one wants to establish whether such a skull would likely belong to a male or female bone. According to Alias et al18 & Lima, Silva and Júnior22, the identification of sex from an adult bone becomes a strategy of reliability if the anatomical pieces were fully available for analysis. After the pelvis, the skull is the second-choice structure for identifying sex, this differentiation becomes impaired when you have a skull before the puberty period, because the human body tends to undergo changes due to hormones and environmental factors. The use of anthropometric methods has been shown to be effective in the last twenty years and especially in the last decade. Those who use this modality affirm the involvement of less subjectivity and lower error rate within and between observers, comparing themselves with decision-making methods.27

Conclusion

The study in question responded to the proposed objective, so that it made it possible to analyze the literature evidence about the importance of craniometric points for forensic anthropology. Through the analysis, it was possible to make an explanation of the craniometric points. It was found that such a procedure plays a fundamental role in human identification in many situations, especially with regard to the definition of sex, age and ancestry. The identification, based on the characteristics of an individual's skull, is an effective, reliable, inexpensive process and supported by scientific quality criteria. On the other hand, some studies under analysis showed some limitations, regarding their identification, highlighting the difficulty, first in obtaining a representative sample group and also in relating the phenotype to ancestry in a population with a certain degree of miscegenation, not providing accurate results and may lead to dubious conclusions regarding an individual's physical characteristics.

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