Original Article

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Comparative Analysis of Determination of the Human Genealogy Based on the Base of the Head in Jurisdictional Criminalism

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Abstract

Background: Scientific works on the determination of somatic sex on the basis of the skull, conducted and published in our country and abroad, are analyzed and presented. In the process of cranioscopic research, craniometric and cranioscopic approaches and the existing traditional and modern methods used for their implementation were considered. In the process of studying the head, work is carried out to determine the somatic sex. This is one of the most important issues in forensic science, anthropological and archaeological research, the scientific study of general problems of human variability. **Subjects and Methods:** The study was conducted on the basis of MSKT imaging of the skull of 27 male and 20 female volunteers who had no congenital or acquired defects in the skull of an adult (over 18 years of age). The resulting images were examined by cranioscopic and craniometric methods using the IMA program. In cranioscopic studies, W.M. Krogman, G.Acsadi, J. Nemeskeri, and V.N. The advantages and disadvantages of Zvyagin methods are revealed. A. I. According to R. Martin and H. Welcker, who performed the craniometric method on the craniometric method of Bogdanov and a number of English craniologists, a comparative comparative analysis of the study was given in the modification. **Results and Discussion:** The authors note that the Center for Forensic Medicine has developed a craniological blank containing 79 types of head sizes. With this, it is possible to determine not only the sexual orientation of the head, but also the estimated age of the person. **Conclusion:** In conducting craniometric examinations in forensic practice. N. Zvyagin's modification, which included 40 registered diagnostic signs described and registered, was further informative. Its efficiency was 93.5%.

Keywords: Craniometry, Cranioscopy, IMA Program.

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Introduction

Determining sexual orientation by looking at the head of an unknown person is one of the main tasks of craniological research. In recent years, the concept of "human gender" has gained many meanings. The following concepts can be distinguished from this:

- Gender (English gender, Latin genus - "species") - determines a person's behavior in society and is called "social gender";

- Genetic sex occurs depending on the combination of sex chromosomes (X and Y) and is diagnosed by the molecular genetic method;

- Somatic sex is determined by the morphological structure of the primary, secondary sexual organs during human development, as well as the features of the body structure associated with them.[1,2]

In the process of studying the head, work is carried out to determine the somatic sex. This is one of the most important issues in forensic science, anthropological and archaeological research, the scientific study of general problems of human variability.[3] The resolution of the issue of human sexuality is of great practical importance in the forensic examination of skeletal, unrecognized corpses. Gender allows for the halving of the range of individuals sought in the identification of a person's race, age, oral portraiture, and facial reconstruction (reconstruction), as well as in the identification process. In some cases, pieces of clothing, jewelry, and other material evidence found at the crime scene may partially determine the sexuality of an unknown person, but they may also lead to the wrong conclusion. It is important to keep in mind that long hair and jewelry today cannot be said to belong to any particular gender.

Sexual differences in healthy individuals are primarily determined by the effects of the XX and XY genotypes, which affect the development and growth of the organism from the time of

conception in the human womb. These differences (e.g., external genitalia) are noticeable as soon as a person is born. The sexual dimorphism of the musculoskeletal system, including the skeleton, is less noticeable and begins to take shape during adolescence. Depending on the bone marrow, for example, the diagnosis of gender on the head can be complicated by many factors: environmental, occupational, nutritional characteristics, pathological changes, and disease.

At this point, a logical question arises - if it is possible to conduct genetic research, why is it necessary to determine the sex on bone remains? The answer is obvious: molecular-genetic testing reveals genetic gender, not somatic, that they may not be compatible with each other. On the other hand, in cases of extreme changes after death, and especially from old, for example, archaeological finds, it is not always possible to identify and find material suitable for genetic research.

The purpose of the study: to determine the effectiveness of the existing modifications used in the practice of examination to determine the somatic sex in the practice of examination using the IMA-Computer program developed by the authors.

Materials and Methods

The study was conducted on the basis of MSKT imaging of the skull of 27 male and 20 female volunteers who had no congenital or acquired defects in the skull of an adult (over 18 years of age).

The resulting images were examined by cranioscopic and craniometric methods using the IMA program. In the morphological study of the head, two main methodological approaches are distinguished: cranioscopic (visual, qualitative) and craniometric (measurable, quantitative).

The cranioscopic approach identifies the signs that are visible and their characteristics. These include the shape of the bones, their configuration, the nature of the joints and the location of the muscle joints, i.e., macroscopically visible symptoms that differ in men and women. There is a drawback to this type of research: to "approximate" a sign, you need to have a clear idea of the anatomical features and relative dimensions of the object, which will be achieved as a result of regular work and experience with specialist bone remains.

An expert in this field will have to constantly develop the ability to evaluate the different shapes of the head, i.e., relatively "large" or "small", "rough" or "smooth", and so on. It is important to keep in mind that some characters may have developed differently in different ethnic groups. Cultural factors that alter head structure and affect sexual differentiation are presented. A classic example is the shape of the lower jaw of Eskimo women. Because the Eskimo woman actively used the chewing muscles to process and prepare the skin for clothing, the muscular junction of the lower jaw may have been highly developed, a separate lower jaw of a woman belonging to this ethnic group, this exact definition, may correspond to the lower jaw of a man from another country.

The craniometric approach consisted of a method of determining the size of the head as a whole and its individual areas recorded in numerical values using instruments. Craniometry is performed using anthropological craniometric equipment. The advantage of this approach is the reduction in the subjectivity of the assessment. However, the degree of variation in size characteristics between males and females in human populations may not be significant. Within each gender, a wide range of sizes is set, with only the most slender women and the most physically fit men being outside the closed (limit) range of the opposite sex. It is also necessary to take into account the racial and ethnic characteristics of the population (for example, the characteristics associated with size, intended for the group of Europeans do not correspond to the people of Japan, Vietnam, etc.).

Given these conditions, two complementary but non-repetitive approaches to the assessment of sexual dimorphism are considered: cranioscopic and craniometric [Figure 1].

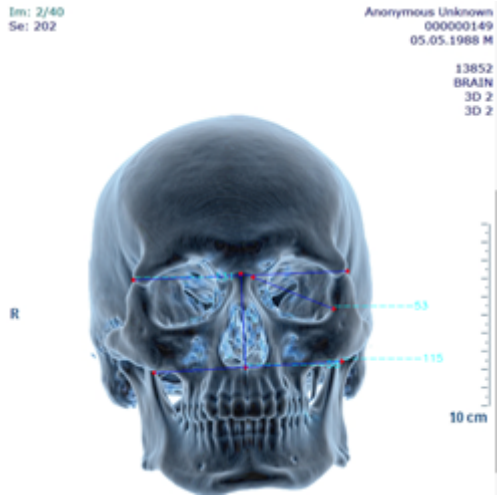

Figure 1: Appearance of craniometric analysis of the head using the IMA program.

Results and Discussion

Cranioscopic approach. Visually, that is, when viewed visually, the sex difference is observed in the fact that most of the male heads are large, especially the joints of the muscles are more rough, and the ridges are more developed. This is due to the strong development of the male musculature. The heads of women are similar to the heads of teenagers. They are usually

smaller in size, have a smoother surface, and have slightly thinner and "thinner" bones. In 1962, W. M. Krogman tabulated morphological features that diagnose the main sex [Table 1].[4]

As can be seen from [Table 1], it is much more difficult to assess some departmental symptoms if the research specialist does not have long-term experience in craniology. In order to objectify some of the assessment of quality marks, in 1970 anthropologists G. Acsadi, J. Nemeskeri carried out the gradation of the following five morphological features of the head: the size of the convex edge of the cervical bone, the size of the sucker-like tumor, the slight triangulation of the upper edges of the eye, the bulge of the glabella, and the degree of elevation of the jaw [Figure 1].[5,6] In all cases, the five-point scale ranges from subtle traits specific to women to increments specific to males.

The authors point out that the best results can be obtained when the skull (or lower jaw) is held a few cm (5-10) higher than the desired part of [Figure 1], at arm's length, so that the features studied are directly comparable to the image. The skull is moved from one diagram to the next until a high resemblance is obtained to this diagram. Each character is evaluated separately without taking into account other features.

V. N. Zvyagin's method, which takes into account 40 descriptive diagnostic features, is considered to be the most complete morphological method of determining a person's sexuality by the skull [Table 2].[7,8] The method was developed for an adult population belonging to different local races of the Europeoid and Mongoliod race species.

Cranioscopic signs are assessed visually or tactilely. Diagnostic signs are of an alternative nature, i.e., the presence (+) or absence (-) of each specific sign is assessed. Then the positive results of men and women are added separately, their total sum should not exceed 40.

The diagnostic value of the signs is not the same: at the highest № 3, 4, 25, 28, 35 signs, and the lowest (45-50% error) - at the signs № 5, 26, 29.

The data obtained are evaluated according to the following formula:

$DK = 100 \cdot \log E / A,$

DK - diagnostic coefficient; E is the number of male characters; A is the number of female characters.

If the value of DK is +25,553, then the head is male, if DK = - 20,681, the head is female. If DK is in the range of 20,682 to +26,552, then it is not possible to determine sexuality by this method ("the problem is not solved"). According to the authors, this method allows almost reliable diagnosis of sexuality in 93.53% of cases, and in 6.47% of cases it is concluded that it is impossible to solve the problem. The method is convenient to use, does not even require identification of previous racial affiliation and restoration of lost parts of fragmented skull.

Craniometric approach. To begin direct measurement, it is first necessary to determine the anatomical landmarks, called craniometric points. These allow you to unify the illumination of the head measurement technique, to do the same.

There are many methods and techniques of craniometry. Often, the same size is given different names by different authors. In general, two main approaches to recording dimensional characteristics are distinguished: numeric and alphabetic. For digital coding - R. Martin's list and for letter coding - A. P. By Bogdanov, and later by a number of English craniologists. We can safely say that the Welcker program can be a classic example.[9,10] Each system has its own advantages: a digital list allows you to easily and quickly find the size you want, but if you add an extra size when needed, the layout of the system can be disrupted. In a letter system, you can easily add new letters or numbers next to existing letters. But you have to work through the list and browse the whole list to find the size you want, which can be quite inconvenient.

At present, there is no single craniometric system: different scientists use both numeric and alphanumeric systems. Scientists of our country V. P., G. F. Debits make more use of the R. Martin system supplemented by.[11] However, research developed abroad, when working with published scientific literature, will need to focus on literal characters, focusing on.[12]

Pair measurements are traditionally performed on the left side. However, if it is not possible to start from the left side (e.g., when the head is partially damaged), the use of measurements on the right side is permitted. All dimensions are recorded with an accuracy of up to millimeters, it is recommended to record small dimensions (less than 50, especially less than 25 mm) with an accuracy of 0.1 mm. This can be done completely using sliding or coordinate compasses. The size of the angles is recorded in degrees. Most of the angular dimensions are determined relative to the Frankfurt horizon (ear-eye) passing through the lower edges of the porion and eyeballs.

According to world scientists, the sexual orientation of the head is determined by the presence of a large number of possible traits specific to this sex. If there is at least one credible sign, then the skull being examined is the sex to which that credible sign belongs. If many signs are in an unknown range, with only one probable sign and no reliable signs, then the author recommends switching to the cranioscopic method.

This method involves deformed, fragmented heads; it is not recommended for use in the examination of the remains of heads and heads of children exposed to high temperatures (temperatures). One of the craniometric methods of determining the sex of a human head is the method of E. Giles,[13] which is widely used abroad. It was obtained as a basis for constructing equations in determining sex on discriminant functions for

Table 1: Gender diagnostic features of the head (according to W.M. Krogman, 1962)

Mark	Men	Women
Overall size	Big	Small
External relief of bones	Rough	Smooth
Joint bows	Medium to large	From small to medium
Sucker-like tumors	Medium to large	From small to medium
Occipital bone	The lines of attachment of the muscles and the bulge of the neck are well developed	The roughness of the lines and the bulge of the neck are not well developed
Forehead ridges	Small	Big
The ridges of the top bone of the head	Small	Big
Orbits	Square (angular) with the upper edge of the eye, below	Round, high, with slightly sharpened upper eyelids
Forehead	It's crooked, a little round	Round and high, sometimes bulging
Cheeks	Large and lateral bulge	Light, slightly bulging (except Mongoloids)
Mandible	Large, high symphysis, angles of mandible are rough	Small, angles f mandible are polished and do not bulge into the chin
Palate	Large, wide, usually U-shaped	Smaller, more paraboloid
Temporal bone	Big	Small

representatives of an entire Eurasian race - Europoids [Table 3]. At the same time, equations were calculated for members of a large equatorial race - African Americans, as well as for representatives of the entire Asian - American race – Japanese. [14]

J. E. Buikstra, D. Y. Uberlaker, K. R. Burns, S. N. Byers used the following craniometric parameters in the equations (the English abbreviation of craniometric points was decoded according to the R. Martin system):

- g-op (glabella – opistocranion) - longitudinal diameter;
- eu-eu (eurion– eurion) - transverse diameter;
- ba-b (bazion - bregma) - diameter of height;
- po-b (projection distance from the breg to the line passing through both porions);
- ba-n (bazion-nazion) - the length of the base of the head;
- ft-ft (frontotemporale – frontotemporale) - the smallest width of the forehead;
- zy-zy (zygion – zygion) - diameter of the cheek;
- ids-n (alveoliare-nazion) - high height of the face;
- gn-n (gnation – nazion) - full height of the face;
- ba-ids (endobasion – prostion) - the length of the base of the face;
- pr-alv (prostion-staphylococcus) - the length of the alveolar arch;
- ecm-ecm (ectomolyare-ectomolyare) - width of the alveolar arch;
- n-ns (nazion – nasospinale) - height of the nose;
- al-al (alyare – alyare) - the width of the nose;
- mf-ec (maxillofrontale – ectoconjion) - the width of the orbit from the maxillofrontale;
- orb.h - height of the orbit;
- mf-mf (maxilofrontale – maxillofrontale) - maxillofrontal latitude.
- go-go (gonion – gonion) - angular (bigonial) width;
- gn-go (gnation - the line connecting the gonions) - the length of the lower jaw from the corners;
- mp body (gnation - the line connecting the outer edges of the ridges) - the length of the lower jaw from the ridges;
- go-cdl (gonion - condylion laterale) - length of the lower jaw horn (left);
- ramus b - the smallest width of the lower jaw horn;
- gn-idi (gnation– infradentale) - height of the symphysis;
- po-ms (porion - mastoidale) - the length of the mammary gland;
- body h (height of the lower jaw body between the first and second molars) - body height of the lower jaw;
- body b (thickness of the lower jaw body at the second molar level) - body thickness of the lower jaw.

Table 2: Qualitative traits that characterize the sexual dimorphism of the head structure (V. N. Zvyagin, 1983)

Mark	Gender	
1. Part of the brain A. The frontal bone	M	W
1. Longitudinal flattening of the squamous part (forehead tilted back)		
2. Forehead ridges		
3. The surface of the bridge of the nose is flattened		
4. Eyebrow arches: slightly swollen or unknown		
5. Height along the center line of the squamous part		
6. Eye socket: with or without scars bordered on the side by neoplasm		
7. The bulge of the cheek and the crowned edge of the the squamous part		
B. The upper part of the skull		
8. Flattening of the front of the contour of the skull dome		
9. The ridges at the top of the skull		
10. Genum		
11. Elevation along the axial seam		
C. Temporal bone		
12. Outer cervical bulge with or without scars		
Beak		
13. Rough lines: traces or not		
Diffuse		
14. Clamp of neoplasm (strong roughness)		
D. Sphenoid bone		
15. The broad angles of the great wing on the temple surface have a sharp crowned edge(crowned edge between the temples)*		
E. Temporal bone		
16. The round end of the squamous part		
17. The flattened back edge of the squamous part		
18. An arched zygomatic process with a broad-cheeked zygomatic bone		
19. The temporal line in the form of a continuous sharpened coronal edge (the junction of the temporal muscle)*		
20. A deepened nipple-like groove		
21. Strong roughness on the ribs and outer surface of the styloid process		
22. The flattened inner surface and sharpened apex of the mammalian growth		
2. Part of the face		
23. Orbits: round in shape		
quadrangular shape		
24. Rounded upper and outer edges of the orbits		
25. Deepened surface of nasal bones		
26. The lower sharp edges of the nasal hole		
27. Strong (length greater than the width of the base) developed angular nasal growth		
28. A bulge on the facial surface of the zygomatic bone		
29. The lower sharp of the zygomatic bone		
30. The shape of the maxillar bone's alveolar arch: paraboloid		

Note: * - comments from the authors.

U-shaped
3. Mandible bone
32 Square contour of mandibular symphysis
33 The strong winking and outer chains of mandibular symphysis
34 The angle of the corners behind the base line
35 The deviation of the corners
36 Rough of the corner's edge
37 Fossa of digastric muscle
38 Mandibular process (with or without traces)
39 Mandible – Submandibular infundibular line
4 Sutures
40 The degree of closure of the crown and axial sutures in the temporal(C3) and obelion (S3) areas: C3>S3
C3<S3
41 The degree of closure (C), axial ( ) and nape of the neck (L): C=S>L,L<C>S
C<S>L

The essence of the method consisted of calculating the diagnostic coefficient on the basis of discriminant functions: the results of the measurements made in the equation are put. If the obtained diagnostic coefficient exceeds the control value, then the head is male; if the diagnostic coefficient is less than the control value, then the head belongs to the woman.

V. I. Pashkova studied various methods and came to the following conclusion: sex can be determined only in 75-80% of cases on the basis of measurable traits, and taking into account morphological traits, the reliability of the test can increase to 80-93%. Thus, both craniometric and cranioscopic approaches in sex determination can give the best results only when used in combination. [15]

Note: Equations 1-6 do not take into account lower jaw marks, i.e. they can be used when they are not present.

In cranioscopic studies, W.M. Krogman, G.Acsadi, J. Nemeskeri, and V.N. The advantages and disadvantages of Zvyagin methods are revealed. A. I. According to R. Martin and H. Welcker, who performed the craniometric method on the craniometric method of Bogdanov and a number of English craniologists, a comparative comparative analysis of the study was given in the modification. The authors note that the Center for Forensic Medicine has developed a craniological blank containing 79 types of head sizes. With this, it is possible to determine not only the sexual orientation of the head, but also the estimated age of the person. V. I. A method of comparative evaluation of Pashkova and foreign (E. Giles) craniometric studies is also presented. V. I. According to Pashkova, using only craniometric methods, it is possible to determine the sex of the head only in 75-80% of cases, and in a complex approach in 83-86% of cases. The E. Giles method, based on the study of the regression equation, is objective in 83-86% of cases.

Conclusion

In conducting craniometric examinations in forensic practice. N. Zvyagin's modification, which included 40 registered diagnostic signs described and registered, was further informative. Its efficiency was 93.5%.

Hence, research to determine gender based on the head of an adult should be comprehensive, including both cranioscopic and craniometric methods.

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Table 3: Equation of discriminant functions for representatives of large European races (E. Giles, 1970)

No	Formula	Control value	Reliability of results %
1.	3,107(g-op)-4,643(eu-eu)+5,786x(zy-zy)+1,0x(ba-ids)+2,714x(ids-n)-5,179x(pr-alv)+6,071x(po-ms)=	2676,39	86,6
2.	3,4x(g-op)-3,833(eu-eu)+5,433x(ba-b)-0,167x(ba-n)+12,2x(zy-zy)-0,1x(ba-ids)+2,2x(ids-n)+5,367x(po-ms)=	2592,32	86,4
3.	1,8x(g-op)-1,1783x(eu-eu)+2,767x(ba-b)-0,1x(ba-n+6,3x(zy-zy)+2,833x(po-ms)=	1296,2	86,4
4.	10,714x(ba-n)+16,381x(zy-zy)-1,0x(ba-ids)+4,333x33x(ids-n)-6,571x(pr-alv)+14,81x(po-ms)=	3348,27	84,5
5.	1,236x(g-op)-1,0x(eu-eu)+3,291x(zy-zy)+1,528x(po-ms)=	536,93	85,5
6.	9,875x(g-op)+7,092x(ba-n)+19,062x(zy-zy)-1,0x(ba-ids)+4,375x(ids-n)=	5066,69	84,9
7.	1,39x(gn-idi)+2,304x(go-cdl)+1,0x(go-go)=	287,43	83,2
8.	22,206x(gn-idi)-30,265x(body h)+1,0x(mp body 1)+19,708x(go-cdl)+7,36x(go-go)=	1960,05	85,9
9.	2,862x(gn-idi)+2,54x(mp body 1)-1,0x(body b)-5,954x(ramus b)+1,483x(gn-go0+5,172x(go-cdl)=	524,79	84,1

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