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Identification of a person by bone remains – the main tasks of today and prospects

Abstract

This article reflects the results of an analysis of the state of affairs in the field of knowledge focused on solving problems of personal identification. In addition, scientific approaches are considered that have probabilistic chances for development and broad prospects as future methodologies in this branch of scientific knowledge. The essence of the work can be described as a meta-analysis of data from various researchers. Taking into account this analysis, our own statistical and mathematical considerations are also given. It is concluded that, in the context of mathematics and cybernetics, personal identification methods based on earlier diagnostic methods are not inferior to the results of DNA analysis when several different traditional methods are used simultaneously.

Keywords: person identification, forensic anthropology, DNA technologies, Bayes' theorem, cybernetics

Volume 11 Issue 3 - 2023

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Received: August 25, 2023 | **Published:** September 26, 2023

Introduction

Before proceeding to consider some aspects related to the current state of affairs and problems in the field of personal identification, we note that personal identification by and large is the main content of forensic anthropology as a scientific discipline. Forensic anthropology is a system of knowledge about a person and his traces, and aims to identify the personality and actions of the subject in relation to solving problems defined by law and legal acts.[1] In our opinion, this is one of the most successful formulations that reveals the goals and objectives of this scientific discipline. As we can see, the main issues that are solved by forensic anthropology come down to the identification of a person and the reflections that he leaves in the environment (traces, secretions, etc.). In this context, two sets of methods are used - methods for obtaining scientific information and methods of analysis (assessment of existing results). In general, the basic provisions of the methodology are as follows: unambiguous differentiation of objects into identifiable and identifying, changeable and unchangeable (of course, with respect to any time interval), consistent objective assessment of features individually and in combination in order to identify similarities (or differences), weight assessment individual features (specificity, specificity, etc.). Taking into account these provisions, identification of a specific person is carried out, the classical scheme of which necessarily includes three stages: 1) separate examination of the signs of a missing person on the one hand and signs (or traces) of an unknown corpse or human bone remains; 2) comparison of the received data and comparison of two information flows; 3) assessment (mathematical, logical, etc.) of the comparison results and formulation of conclusions (identity or its negation). An important aspect in this work is personality traits, which form two separate clusters of compared information.

Personality traits are divided into medical-biological and biological-forensic. Medical and biological characteristics include general (gender, race, age, height, weight, etc.) and individual characteristics. Individual signs are congenital (anomalies, skeletal features, eye color, birthmarks, etc.) and acquired (consequences of pathologies, dental status, consequences of professional activity, tattoos, etc.). The genetic individuality of a person also refers to congenital traits. Biological and forensic signs include fingerprints, handwriting, voice features, gait and some other signs (facial expressions, gestures, stereotypes in manners, clothes, etc.). Thus, we see that the procedure for identifying a person is reduced to the accumulation of two arrays of information, then their comparison and formulation of conclusions.

Research objectives and results

For a long time, such examinations were very complex, carried out by highly qualified specialists, and expert opinions were necessarily accompanied by data on the statistical probability of error. However, at present, after the advent of DNA analysis technology, a science-intensive, complex and multi-stage examination of personality identification has become much simpler and is rarely associated with difficulties. Only a small part of the issues remained unresolved. Examinations, the motive of which is the comparison of the DNA of a person's remains found somewhere with the DNA of an alleged person (a missing person or a group of people), make sense when there is a suspect who disappeared some time ago. Difficulties begin when there is no one who is potentially suitable for the role of the "master" of the discovered remains – that is, there is nothing to compare DNA samples from the remains. Similar problems arise when it is not possible to extract DNA from the remains – that is, there are no samples for comparison. But due to the fact that the number of these situations in the practice of experts is small, and the technology of DNA analysis has taken root over the past 20-25 years, there are almost no specialists who are well versed in other identification methods (at least in our country). From this it becomes clear how severe the consequences of this situation can be if you suddenly have to identify a huge array of unidentified remains, the DNA material of which will be inaccessible.

Actually, one of the main goals of this article is to present the possibilities of forensic science (at the current stage of its development) in the context of the problem of personal identification, to show ways to overcome potential difficulties in the designated format. First of all, here it is necessary to show the limits of the possibilities of DNA technology in mathematical terms. As you know, the human genome is a combination of nucleotides, which, together with a set of different proteins, forms 23 pairs of chromosomes, in which the main part of hereditary information is concentrated (part of the information is contained in mitochondria). That is, it is a kind of code for each subject, which is unique. But statistically this code is not exceptional and, of course, can be repeated. Therefore, geneticists usually do not give an expert opinion on absolute identification, but mark the limits of reliability in the interval in which identification error is excluded. So in one of the works of the last year,[2] Indian forensic experts give calculations of the probability of motherhood, which were carried out during the examination of the discovery of the remains of one woman. They compared DNA samples from the corpse of an unknown woman with the DNA of her potential son and potential mother. They calculated the probability of relationship between the deceased woman and her son (P=0.998102706) and between this woman and her mother (P=0.999714959). In these results, mathematically, we are talking about (approximately) one error per 500 similar DNA matches for a mother-son pair, and three per 10,000 cases for a mother-daughter pair. As you can see, although DNA technology is considered the gold standard for personal identification, it is not unconditional. However, in this particular case, the identification was reliably positive. Since the results of two examinations were actually obtained and their total power (according to the sum of the probability for two joint independent events) allowed the probability of one error per 20 million cases, the authors quite reasonably considered positive identification within the state of Rajasthan with a population of 70-80 million people to be quite reliable.

Using this example, we wanted to show that from the point of view of mathematics and cybernetics, DNA technologies also have their limitations and are not something exceptional. Now consider the effectiveness of other methods of personal identification. First of all, we note that general biomedical features serve rather to isolate the smallest possible group of remains from a large array, with which it is necessary to work further (that is, to eliminate excess material). When carrying out personal identification, biomedical characteristics that individualize a person play an indispensable role. Often several specific features (or sometimes even a single feature) contribute to a positive identification with the same level of confidence as DNA testing. So Vladimirsky B.M. and co-authors[3] report a case of identification by chest radiographs. The case was associated with the study of a complex of acquired (injury or disease, not specified in the text) X-ray anatomical features of the chest of one individual. The expert commission found that the probability of meeting another person with a similar morphocomplex is possible only in a sample of people of 3.7×10^{19} people (the population of the planet at the moment is about 8×10^{9}). That is, the individual had some very rare pathology, accompanied by an almost unique change in the configuration of the chest. These two factors (the uniqueness of the form and the presence of pathology) made it possible to carry out an unambiguous positive identification. Of course, such a case is an exception, not a rule, but, nevertheless, it clearly reveals the possibilities of the old, previously traditional ways of identifying a person. In general, each of the particular biomedical and bioforensic features has a certain relative weight in the context of the confidence level of the identification results. For example, Zinin A.M., Kirsanova LZ[4] believe that if group biomedical features and one bioforensic feature (facial structure) coincide, the chance of making a mistake with identification is one in 5×10^{6}. It is clear that with an increase in the number of coincidences of personality traits, the probability of error will decrease. Based on mathematical calculations, Keiser-Nielsen S[5] came to the conclusion that 12-13 particular features are sufficient for unconditional identification. However, these conclusions were made almost 50 years ago, when there were no more high-tech methods (craniofacial, CT-stomatological and others) developed subsequently. Currently, for example, methods of 3D computer reconstruction (and alignment) of the skull, combined plastic and computer reconstruction, reconstruction (and alignment) using computed tomography are used.[6] Many developers of such personal identification methods indicate that the probability of error for these methods is extremely low (P<0.01). Thus, it becomes clear that for the high reliability of the conclusions of an expert study, sometimes a few particular medical and biological signs (they are also called individualizing signs) will be enough.

Using the example of using Bayesian procedures for calculating the probability for joint independent events,[7,8] it can be shown how several individualizing features with a positive outcome of the comparison (in a pair of a missing person – the remains of an unknown person) have the same reliability as DNA technologies. The probability that at least one of the mutually independent events will occur is calculated by subtracting from unity the product of the probabilities opposite to the event in question:

$$P(A) = 1 - P(A_1') \times P(A_2') \times \ldots \times P(An')$$

Let's take an example where 4 different methods were used to identify a person, the reliability for each of which is P = 0.97 (that is, the probability of three errors per 100 diagnostic cases is allowed). Note that the value of P=0.97 was not chosen by chance. Almost 30 years ago, Azerbaijani scientist Musaev Sh M[9] developed a comprehensive method of personal identification based on craniological studies. This method takes into account the population characteristics of the population of the Caucasus and has a diagnostic reliability of P>0.97. Assume that all four methods used have unambiguously positive identification results. Find the probability of their joint error. To do this, we first find the probabilities of opposite events, that is, the probability that an error will occur during diagnostics using each of the methods:

$P(A_1') = 1 - 0{,}97 = 0{,}03$; $P(A_2') = 1 - 0{,}97 = 0{,}03$; $P(A_3') = 1 - 0{,}97 = 0{,}03$; $P(A_4') = 1 - 0{,}97 = 0{,}03$

Now let's plug these values into the above formula:

$$P(A) = 1 - P(A_1') x P(A_2') x P(A_3') x P(A_4') = 1 - 0{,}03 x 0{,}03 x 0{,}03 x 0{,}03 = 1 - 0{,}00000081 = 0{,}99999919$$

Of course, even the value of P=0.99999919 (the probability of 8 errors per 10 million cases) can be considered reliable enough for a positive conclusion about the identification results. In any case, for our country with a population of 10 million people, these are very unambiguous results. We also note that many developers of methods for identifying a person by bones give even higher values of the confidence level (P = 0.99 and even higher).

However, we would like to note once again that in this article we did not plan to conduct a specific comparison of the capabilities of some traditional methods with DNA analysis technologies. Information about the high values of the methods of different authors can be found directly on the Internet or look at the reviews of individual researchers, where the corresponding summaries are provided.[10,11] Even with the most pessimistic approach, we can assume that the results of at least half of the developed methods correspond to the declared power (meaning the level of reliability of the forecast or identification – P). We base our analysis precisely on this assumption and highlight the problem as a whole. Yes, in the future it will be possible to consider several well-proven methods of traditional diagnostics, once again check their level of reliability (on individual local populations or large racial groups) and compare their total power with the capabilities of DNA analysis in the context of personal identification. But in our article we are still only considering the theoretical aspect of this situation from the point of view of mathematics. It is easy to see that if identification is implemented by at least four such methods, the probability of overall identification success (i.e., the probability that at least one of four mutually independent events will undoubtedly occur) will be equal to: P(A) = 1 - 0.00000001 = 0.99999999. That is,

Citation: Ibragimov AS. Identification of a person by bone remains – the main tasks of today and prospects. *Forensic Res Criminol Int J.* 2023;11(3):114–116. DOI: 10.15406/frcij.2023.11.00378

the probability of error will be equal to one in 100 million diagnostic cases.

Of course the described methods are inferior in power to DNA technologies. As you can see, with the old methods of identification, it is necessary to apply at least 3-4 different methods in order to obtain a statistically reliable result. But at the same time, sometimes only one DNA analysis can give a similar result in terms of reliability. However, in this case, our goal was to show that traditional methods have not lost their relevance. In cybernetic terms, the complex use of 3-4 earlier methods of identifying a person by bones (for example, one of the methods of superimposing an intravital photo or video image on an image of the skull, one of the methods of comparing intravital and postmortem radiographs (or CT) images, etc., one of the methods of identification by dental status and also identifying any pathology (anomaly or other unusual feature) on the skeleton and then comparing all this data with facts from the life of the missing person) is equivalent to one or two DNA tests. Therefore, neglecting these methods is a very reckless decision. As we pointed out above, in the absence of the ability to apply DNA technologies, these techniques (no matter how outdated they may seem) are simply irreplaceable. In addition, these old methods of identifying a person are still very useful not only in the search for missing people. Studies of bone remains in this format can also provide a lot of interesting information to archaeologists, ethnographers and historians.[12]

Conclusion

Perhaps, in the society of forensic anthropologists, the issue we are discussing has already been raised. However, during a cursory search of relevant publications, we were unable to find a lot of papers on this topic. Therefore, we considered it appropriate to once again draw the attention of colleagues to this problem. Our results have shown that DNA technologies, although they have a number of advantages over earlier identification methods, this leadership is not all-encompassing. The simultaneous use of several different methods of personal identification based on earlier diagnostic methods from the point of view of cybernetics is not inferior to the results of DNA analysis. In some practical situations (for example, the impossibility of obtaining DNA material from bone remains), early identification methods can become trivially uncontested.

Acknowledgments

The author expresses gratitude to assistant professor I.G. Shirobokov, employee of the Museum of Anthropology and Ethnography named after. Peter the Great (St. Petersburg) for valuable advice in writing this article.

Conflicts of interest

The author declares there is no conflict of interest.

References

1. Popov VL. *Theoretical Foundations of Forensic Anthropology*. Actual issues of personal identification. Russia: St. Petersburg; 1999. p. 31–38.
2. Singh R, Kumawat RK, Singh G, et al. A skeletal remains unrevealed the murder mystery of missing lady through DNA technology. *GSC Biological and Pharmaceutical Sciences*. 2022;19(2):160–164.
3. Vladimirsky BM. *Mathematical analysis in the identification of personality*. Actual issues of personal identification. Russia: St. Petersburg; 1999:65–68.
4. Zinin AM, Kirsanova LZ. *Forensic photo-portrait examination*. Russia: Moscow; 1991. p. 88.
5. Keiser Nielsen S. Dental identification: Certainty V Probability. *Forensic Science*. 1977;9(2):87–97.
6. Wilkinson C. Facial reconstruction – anatomical art or artistic anatomy? *Journal of Anatomy*. 2010;216(2):235–250.
7. Robert CP. *The Bayesian Choice: From Decision-Theoretic Foundations to Computational Implementation.* 2nd edn. New York: Springer. Verlag; 2007.
8. https://byjus.com/jee/probability-of-independent-events/
9. Musayev Sh M. *Medico-criminalistic identification populations of Caucasus on skull*. Baku; 1999. p. 127.
10. Jervas E. Anatomy in forensics: applications and need for collaboration. *Forensic Research and Criminology International Journal*. 2017;5(1):215–219.
11. Ubelaker DH, Yaohan W Cordero QR. Craniofacial photographic superimposition: New developments. *Forensic Science International Synergy*. 2019;1:271–274.
12. Ibragimov A Sh, Yevseyev RV, Aliev AA. Restoration of the appearance of a man from the Shemakha burial ground of the early Middle (in Russian). *Lomonosov Journal of Anthropology*. 2023;1:129–137.