

REVIEW ARTICLE

Problems and prospects of conducting molecular genetic research for the identification of persons who went missing or died during the hostilities in the occupied territories of Ukraine

Oleksandr Sainchyn¹, Anatoliy Kisliy¹, Larysa Rosha^{2,3}, Dmytro Hrynkó¹, Illia Kotuza⁴, Valerii Zub⁵, Andrii Kotuza⁴

¹INTERREGIONAL ACADEMY OF PERSONNEL MANAGEMENT, KYIV, UKRAINE

²BOGOMOLETS NATIONAL MEDICAL UNIVERSITY, KYIV, UKRAINE

³ODESA STATE AGRARIAN UNIVERSITY, ODESA, UKRAINE

⁴FEOFANIYA CLINICAL HOSPITAL, STATE MANAGEMENT OF AFFAIRS OF UKRAINE, KYIV, UKRAINE

⁵CHERNIHIV POLYTECHNIC NATIONAL UNIVERSITY, CHERNIHIV, UKRAINE

ABSTRACT

Aim: To present modern conceptual, methodological, technical, and regulatory advancements in the identification of persons missing or killed in hostilities and propose strategies for improvement.

Materials and Methods: Standard forensic methods can be used to identify individuals in forensic science. For example, medical and dental records of victims (forensic odontology), analysis of protrusions and swirls on human fingers (fingerprinting), identification of implant serial numbers.

Conclusions: It is proposed to supplement Part 2 of Article 84 of the Criminal Procedure Code of Ukraine as a new source of evidence - "information from DNA databases".

KEY WORDS: hostilities, molecular genetic research, identification of persons, genomic information, forensic molecular genetic examination

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INTRODUCTION

The birth of molecular genetics is associated with a new stage in the development of biology, when a revolutionary breakthrough in the understanding of living nature occurred as a result of the joint work of scientists - physicists, chemists, microbiologists, and mathematicians. In 1953, two molecular biologists, J. Watson (USA) and F. Crick (UK), summarized the data of X-ray analysis and deciphered the structure of the DNA double helix. This was followed by an avalanche of discoveries (1956 - discovery of matrix RNA, 1958 - formulation of the "central dogma of molecular biology", the basic principles of molecular genetics concerning the matrix principles of transcription, translation and replication)[1]. In the next two decades, the prerequisites for the possibility of reading (sequencing) the nucleotide sequence were created. In 2000, a large group of scientists (more than 200) decoded the *Drosophila* genome. And the following year, scientists from Celera Genomics (USA) reported the decoding of the human genome [1].

Molecular genetics examines hereditary mechanisms at the molecular level, finding applications in medicine (early diagnosis, gene therapy), agriculture (GMOs), ecology (genetic toxicology), and forensics. DNA analysis, first employed in forensic science over 20 years ago in the UK, has since become a crucial tool for solving crimes, identifying missing persons, and recognizing unidentified corpses [2]. The ongoing war in Ukraine has highlighted the importance of forensic genetics in identifying victims and missing individuals [3-5].

Today, there are certain fragmentary developments in the identification of unidentified human remains after numerous military actions of the last two centuries on all continents, persons who have long been missing, victims of natural and technogenic disasters, and various options for material collection, processing, testing, and interpretation are proposed [3, 4].

The Ukrainian Commissioner for Persons Missing in Special Circumstances reports that as of July 2023, the Ukrainian register of missing persons contains data on

more than 24 thousand people, and there is no information about 7 thousand of them yet [5]. According to him, more than 8,000 people have been found, of whom 60% are alive and are or have been in captivity. Also, the possible whereabouts or places of death of more than 8 thousand Ukrainians are known. Since the beginning of the Russian-Ukrainian war, search groups have been set up and the bodies of more than 1,500 fallen soldiers have been returned.

It is not always possible to identify deceased persons returned from the aggressor country and extracted from the combat zone. It is also worth recalling the constant enemy attacks on the civilian objects with civilian casualties and the problems with identifying the remains. The identification of unknown victims is one of the most difficult tasks of forensic medicine. Most of the human remains found are heavily decomposed or completely skeletonized, making direct identification difficult. In many cases, human remains are dismembered (e.g., victims of mass accidents or terrorist attacks) or decomposed in a way that prevents anthropological analysis. Soft tissue decomposition is also connected with the degradation of genetic material inside cells, which is broken down into smaller fragments by released enzymes.

AIM

To present modern conceptual, methodological, technical, and regulatory advancements in the identification of persons missing or killed in hostilities and propose strategies for improvement.

MATERIALS AND METHODS

Forensic identification employs various standard methods: forensic odontology [7], fingerprint analysis, and implant serial number identification [8]. DNA profiling, introduced in 1984 and first successfully applied to human remains in 1991 [7], remains a gold standard in forensic genetics.

DNA profiling involves comparing genetic material from unknown samples with reference databases or relatives' samples. Various factors affect identification accuracy, including excavation conditions, sample collection, transportation, storage, and degradation due to environmental exposure [9]. Technological advancements have automated DNA extraction and comparison processes, facilitating international cooperation [10].

Interpol's guidelines recognize DNA analysis as one of the most reliable forensic methods [11]. The UN has acknowledged its humanitarian significance in Resolutions A/HRC/RES/10/26 and A/HRC/RES/15/5. To ensure accuracy, forensic DNA analysis requires high-quality,

uncontaminated samples from both victims and their relatives.

ETHICS

All sources used in this literature review are publicly available.

REVIEW AND DISCUSSION

For the purposes of identifying disaster victims, the comparative DNA analysis must fulfill two basic pre-conditions: a high-quality, non-contaminated DNA tissue sample from the victim's body or a separate body part (postmortem sample) is required, as well as a non-contaminated DNA reference sample from the presumed victim or his/her genetic relative(s) (ante mortem sample).

In the future, the issues of storage of postmortem samples, accreditation of the laboratory that performed the test may be necessary to determine whether the evidence can be admissible in court.

The next step in identifying a person is to compare the results with the data from the genomic information database. For the purpose of identification, databases containing physical anthropological characteristics and DNA profiles of victims have been created in different countries. The missing persons databases include a reference database containing mitochondrial DNA profiles of maternal relatives of missing persons, along with a separate database containing mitochondrial DNA profiles of unidentified human remains [7, 11]. These databases are also linked to relevant organizations (Polish Genetic Database of Victims of Totalitarianism, Institute of Genetic Engineering and Biotechnology in Sarajevo, Canadian Forces Victim Identification Program, Finnish Association for War Memorials, US Army Central Identification Laboratory in Hawaii, National Missing and Victims System of Australia, etc.) [11].

The development of DNA databases has contributed to the identification of missing persons and the development of investigative leads to assist law enforcement. Forensic DNA databases consist of DNA profiles of convicted individuals (and in some jurisdictions, arrested individuals), forensic DNA evidence, human remains of unidentified missing persons, and direct family DNA samples of missing persons. Long-term storage of tissue samples (including DNA) through biobanks of umbilical cord blood, sperm, eggs, etc. can be useful for future assessment of the deceased person and family members of the deceased.

In Ukraine, the Unified Register of Missing Persons was launched in May 2023 [12]. It contains all the data about

the missing military personnel. Since the launch of the register, more than 5,000 requests for extracts have been registered. The registry is a secure database with a clearly defined circle of officials who have access: representatives of the Office of the Commissioner for Missing Persons, the National Police and the Department of Informatization of the Ministry of Internal Affairs of Ukraine. Upon application to the National Police by relatives of missing persons, the register cards are formed, and the Office of the Commissioner for Missing Persons checks each person. The Armed Forces of Ukraine themselves must launch a search and submit information to the registry if they have reason to believe that a military person is missing or captured. For each case of disappearance, the police initiate a case, which is registered in the Unified Register of Pre-trial Investigations. If it is established that a person is in captivity or there is evidence of his or her death, the National Police must transfer the case to the Security Service of Ukraine to continue the pre-trial investigation.

The National Police and the Office of the Commissioner for Persons Missing in Special Circumstances are directly involved in the search for missing defenders. These two bodies use a joint electronic register of missing persons, where all identified information is collected. In addition, they receive data from the Ministry of Defense, which has its own groups to search for the dead, and from services involved in the return of the prisoners of war.

The International Committee of the Red Cross maintains its own register and can sometimes visit people in captivity (it must inform relatives of such visits).

On July 09, 2022, the Verkhovna Rada of Ukraine adopted the Law "On State Registration of Human Genomic Information" [12-15]. The law regulates the procedures for creating, recording and operating a register of human genomic information, improves the efficiency of law enforcement agencies by investigating crimes and identifying the perpetrators, systematizes and improves the search for missing persons and the identification of unidentified persons. The law provides for two options for registering human genomic information - mandatory state and voluntary. It is determined that persons who are prosecuted (or convicted, sentenced and serving a sentence of imprisonment or have an unexpunged or outstanding criminal record) for committing grave or especially grave crimes, as well as all categories of crimes against sexual freedom and sexual inviolability of a person, are subject to mandatory registration, and unidentified corpses and missing persons are also included in the register. Close relatives of missing persons are also subject to mandatory registration.

Taking into account the experience and difficulties in identifying those killed since the beginning of the

Russian-Ukrainian war, a mechanism was proposed for obtaining biological samples from persons mobilized, conscripted or voluntarily enrolled in military service, and military personnel, in order to ensure their identification if necessary. Other citizens of Ukraine are entered into the register of genomic data on a voluntary and paid basis.

Since the beginning of the Russian-Ukrainian war, there has been an urgent need for molecular genetic research related to the war crimes of the occupiers. It is known that more than 6,000 DNA examinations have already been ordered for the purpose of identifying individuals, and almost half of them have been completed. Obviously, there is a need to create a certain tool to systematize the information received and give it legal status for use as evidence in the processes of proving and presenting crimes against Ukraine in court. The generalized international experience (in the USA, Great Britain, Poland, Germany, Italy, Spain, France) convinces of the need to create a single DNA database and to determine the single holder of the DNA database information, where genomic anonymized information of persons specified in the law is collected [9]. For this reason, the law provides for the creation of a single state database with very limited access and the right of inspection in accordance with the established procedure for certain representatives of law enforcement and intelligence agencies.

Currently, the genomic database contains more than 45,000 DNA profiles, most of which are material obtained at crime scenes and less than a quarter of which are materials of the suspects. This Law opens up new opportunities for forensic physicians and forensic experts to identify individuals, which will not only make the work of law enforcement agencies much more efficient, but also allow them to coordinate efforts in the fight against crime.

In the context of full-scale aggression, the identification of persons who have gone missing or died is of high relevance, but the Law will be needed further, in peacetime. First of all, the adoption of this Law is necessary to regulate the provisions of a number of international documents. For example, Article 37 of the Law of Ukraine "On Ratification of the Council of Europe Convention on the Protection of Children against Sexual Exploitation and Sexual Abuse" requires the collection and storage of genomic information of persons convicted of offenses in order to prevent the commission of a crime and the possibility of criminal prosecution [13]. Article 6 of the Convention for the Protection of Individuals with regard to Automatic Processing of Personal Data requires that automated data processing be prohibited if the country's legislation is unable to provide appropriate security.

Since the adoption of the Law, domestic legislation has already met the requirements.

Secondly, the accumulated international experience convinces of the effectiveness of the procedure for collecting, accumulating and storing DNA profiles for the purpose of identifying criminals and effective investigation of crimes.

The Law also simplifies and speeds up the identification of missing military personnel. In 2014, the Armed Forces of Ukraine did not have a range of resources (specialized units, search specialists) to identify missing military personnel, so they relied on the assistance of the International Committee of the Red Cross Delegation in Ukraine. In 2016, the procurement of the necessary equipment for comprehensive genetic examinations began. Since the identification of a missing person requires the examination of samples of close relatives or personal belongings to conduct a kinship search, the question arose of obtaining permission from these relatives to process their personal data, as this is a prerequisite for placing genomic data in the DNA database. In the absence of close relatives, identification of the deceased becomes virtually impossible. In the world practice of identification of military personnel, the procedure of taking samples in advance, with their placement in repositories, is widely used, and after completion of military service and no need to use them, the samples are destroyed without being examined [7].

The new law provides that during martial law, biological material is subject to mandatory sampling from police officers, military personnel, and members of the territorial defense, but the sampling of material in peacetime from these persons should be carried out only with the person's consent.

The adopted Law will contribute to both crime prevention and to increasing the efficiency and speeding up the investigation of crimes (especially if a person has committed a crime repeatedly), as well as to minimizing crime in general and to the search for missing persons and identification of unidentified persons. According to the Law, persons who have been notified of suspicion of committing intentional grave or especially grave crimes against the foundations of national security of Ukraine, against peace, security of humanity and international law and order, health, life, dignity, honor, freedom, public safety sexual freedom and sexual inviolability of a person, property, in the field of trafficking in narcotic drugs, psychotropic substances, their analogues or precursors, a person must be registered in the Electronic Register of Human Genomic Information (as of the beginning of 2023, there are more than 50 thousand registered).

Despite the high relevance of the adopted law, we should focus on some of its drawbacks and risks that were not taken into account. For example, the opinions of legal scholars and human rights defenders about the

risks of violation of the rights and privacy of individuals were not taken into account. The final version of the Law stipulates that the Electronic Register is state property, and the Ministry of Internal Affairs of Ukraine is the holder of this property. The role of the administrator is performed by a legal entity appointed by the Ministry of Internal Affairs and managed by it or its subordinates. Therefore, the registry will be operated and regulated by the Ministry of Internal Affairs. However, there is no guarantee of transparent and independent work of the registry databases, which not only creates potential corruption risks, but also creates preconditions for misuse of information (transfer to other persons, other bodies).

According to the Law, the procedure for access to the Electronic Register and use of its information is determined by the holder of the Electronic Register (the Ministry of Internal Affairs). The Ukrainian Parliament Commissioner for Human Rights is supposed to monitor the observance of human rights during the state registration of the registry information. It was expected that this should be a certain preventive measure, as well as the possibility of appealing certain actions or decisions on state registration of genomic information in court. However, the Commissioner has no direct influence on the holder of the Electronic Registry. It is considered reasonable to entrust such supervision to a separate established body for periodic or permanent inspections and consultations.

The law does not detail/clarify a number of issues: minimizing the risks of access to personal data of relatives of a missing person after the death of that person is established by destroying genomic information; ensuring and finalizing procedures for monitoring compliance with the law in the operation of the register; developing a procedure for access to the register by other authorities to prevent misuse of this data.

In modern legal proceedings, DNA testing is considered the new "queen of evidence" or "gold standard". However, courts and judges do not consider the results of DNA genetic testing to be conclusive and compulsory. In their opinion and according to the case law, DNA analysis is one of the types of evidence, and according to Part 2 of Article 94 of the Criminal Procedure Code of Ukraine, none of the evidence has a pre-established force [16]. Therefore, there is a proposal to supplement Part 2 of Article 84 of the Criminal Procedure Code of Ukraine with this source of evidence - "information from DNA databases". This would be the basis for the development of the necessary acts at the departmental level for the use of genomic data for identification of persons, and one of the directions of implementation of such a project is the proposal to create a centralized (common) database of genomic data in Ukraine with the formation of a single coordination center [17].

CONCLUSIONS

Identification of unknown victims is one of the most difficult tasks in forensic medicine. DNA analysis is one of the "golden standards" by which an identity can be confirmed by comparing the profile of an unknown person with both a DNA profile taken during life (from genomic information databases) and biological relatives. The development of DNA databases has contributed to the identification of missing persons and the development of investigative leads to assist law enforcement agencies.

In May 2023, the Unified Register of Missing Persons was launched in Ukraine, which includes all data on missing military personnel. Previously, the Law "On State Registration of Human Genomic Information" was adopted, which regulates the procedures for creating, recording and maintaining a register of human genomic information, improves the efficiency of law enforcement agencies and provides for two options for registering human genomic information - mandatory state and voluntary. The Law also significantly simplifies the process of identifying missing military personnel.

The Law does not ensure transparent and independent work of the registry databases, which creates potential corruption risks and creates the possibility of misuse of information, in particular, its transfer to other persons or

bodies for other purposes. It is proposed to entrust control over the observance of human and civil rights when entering data into the registry to a separately created regulatory structure (body) for periodic or permanent inspections and consultations. The Law does not detail/clarify a number of issues: minimizing the risks of access to personal data of relatives of a missing person after the death of this person is established by destroying genomic information; it is necessary to ensure and finalize procedures for monitoring compliance with the law in the work of the registry; develop a procedure for access to the registry by other authorities to prevent misuse of this data.

It is proposed to supplement part 2 of Article 84 of the Criminal Procedure Code of Ukraine with a new source of evidence - "information from DNA databases".

FURTHER PROSPECTS

Use of existing and newly created databases, methodologies and development of a regulatory framework for the identification of children abducted by the Russian Federation for the purpose of confirming their identity and restoring their citizenship and rights, as well as in cases of illegal separation and abduction of children from their parents.

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CONFLICT OF INTEREST

The Authors declare no conflict of interest

CORRESPONDING AUTHOR

Andrii Kotuza

Feofaniya Clinical Hospital of the State Administration of Affairs
21 Academician Zabolotnogo St., 01000 Kyiv, Ukraine
e-mail: kotuza_a@ukr.net

ORCID AND CONTRIBUTIONSHIP

Oleksandr Sainchyn: 0000-0003-0243-7524 [B](#)
Anatoliy Kisliy: 0000-0003-3528-5061 [A](#) [E](#)
Larysa Rosha: 0000-0002-1027-1467 [D](#) [E](#)
Dmytro Hrynkо: 0000-0001-5403-2639 [A](#) [E](#)
Illia Kotuza: 0009-0001-8973-0215 [A](#) [F](#)
Valerii Zub: 0000-0001-9823-4216 [E](#) [F](#)
Andrii Kotuza: 0000-0002-1910-0197 [A](#) [B](#) [F](#)

[A](#) – Work concept and design, [B](#) – Data collection and analysis, [C](#) – Responsibility for statistical analysis, [D](#) – Writing the article, [E](#) – Critical review, [F](#) – Final approval of the article

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