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FORENSIC DENTAL IDENTIFICATION OF AN UNKNOWN PERSON BY THE FEATURES OF THE DENTOALVEOLAR APPARATUS, WHICH HAS BEEN SUBJECTED TO SIGNIFICANT THERMAL EFFECTS: A CASE STUDY

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Abstract. The use of scanning methods of computer identification based on orthopantomograms provided by the remains of the bones of the skull with upper and lower jaws, postmortem X-rays of the teeth, life-time photographs of the deceased person allows to successfully identify an unknown person even in cases of significant burning and destruction of the bones of the human skeleton.

The aim of the study. Carrying out identification of a person based on the features of the maxillofacial apparatus, which, together with other bones of the head and trunk, has undergone significant thermal effects.

Materials and methods. The archival materials of the Kherson Regional Bureau of Forensic Medical Examination and the State Specialized Institution "Main Bureau of Forensic Medical examination of The Ministry of Health of Ukraine" were used, which contained information on: the remains of the bone skeleton of the human body, including the bones of the facial skull and the maxillofacial apparatus, which were subjected to significant thermal action as a result of burning; lifelong x-ray panoramic image (orthopantomogram); lifelong radiograph of teeth and medical documentation (dental card of the patient); lifetime photograph of the victim; postmortem X-rays of the teeth. The research was conducted in accordance with current Ukrainian legislation, in particular with Order No. 6 of the Ministry of Health of Ukraine from 1995. General forensic and anthropometric methods and techniques were used, as well as original scanning methods of computer identification of a person based on digital orthopantomograms. Quantitative analysis was carried out using standard methods of variational statistics.

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Results. An example is presented that demonstrates a successful procedure for identifying an unknown person from burned bone fragments by using scanning computer identification methods from orthopantomograms provided by the remains of the skull bones with the upper and lower jaws, postmortem dental radiographs and a lifetime photograph of the deceased person. The issues considered are related to the need to use several identification methods to confirm the identity between the missing person and the burned bone fragments. All possible lines of evidence

were used, namely information about fragments of the human bone skeleton, including the bones of the facial skull and dentition, which were exposed to significant thermal effects as a result of burning, a lifetime panoramic X-ray (orthopantomogram), lifetime dental radiographs and medical records (dental records of the patient), a lifetime photograph of the victim and postmortem dental radiographs. The research used general forensic and anthropometric methods and techniques, as well as original scanning methods of computerized identification of a person based on digital orthopantomograms. The quantitative analysis was carried out using standard methods of variation statistics. It has been established that a comprehensive study of the object by experts of different specialties demonstrates the possibility of obtaining a large amount of information for analysis, which ensures the objectivity and qualitative identification of an unknown person by dental status.

Conclusions. A comprehensive investigation of the object by experts of various specialties demonstrates the possibility of obtaining a large amount of information for analysis, which ensures the objectivity and qualitative identification of an unknown person by dental status.

Key words: identification, forensic dental, forensic medical examination, orthopantomogram, postmortem dental radiograph.

Introduction. In the context of a military conflict accompanied by mass deaths, the identification of unidentified bodies is a rather urgent problem, especially in Ukraine, where the war caused by russian aggression has been going on for the past 10 years. At the same time, many servicemen who died in the combat zone may remain unidentified for a long time, and possibly forever, and may be missing. According to the official data of the Main Investigation Department of the National Police of Ukraine, as of January 2024, more than 2,100 bodies of military and civilian citizens of Ukraine remain unidentified.

As is well known, the identification of human remains is based on solving complex scientific, technical, legal, procedural and other problems [1-4]. In the context of the war, which has been going on for a long time in Ukraine with the use of mass destruction means, such as cluster munitions, bombs, missiles, etc., in most cases the bodies of the victims are mutilated beyond recognition or exposed to thermal effects until they are completely burned, including the bones of the skull and trunk. Therefore, in order to improve the quality of their identification in Ukraine, it is important to be guided by international systematic approaches to identification tasks, regardless of the causes that led to mass deaths [5].

Separately, new methodological approaches to forensic dental identification based on scanning methods of computerized identification of a person by orthopantomograms, which include digital processing of a significant array of morphological, topographic, physical, chemical and other data, have been proposed [6-8]. And as a result - successful forensic dental identification in complex and numerous fractures (fragmentation) of the skull bones using lifetime and postmortem sets of radiological materials [9]. At the same time, there is an urgent need to create a new system of identification by dental status during the ongoing military conflict in Ukraine.

The aim of the study is carrying out the identification of a person based on the features of the maxillofacial apparatus, which, together with other bones of the head and trunk, has undergone significant thermal effects.

Materials and methods. The archival materials of the Kherson Regional Bureau of Forensic Medical Examination and the State Specialized Institution "Main Bureau of Forensic Medical examination of The Ministry of Health of Ukraine" were used, which contained information on: the remains of the bone skeleton of the human body, including the bones of the facial skull and the maxillofacial apparatus, which were subjected to significant thermal action as a result of burning; lifelong x-ray panoramic image (orthopantomogram); lifelong radiograph of teeth and medical documentation (dental card of the patient); lifetime photograph of the victim; postmortem X-rays of the teeth. The research was conducted in accordance with current Ukrainian legislation, in particular with Order No. 6 of the Ministry of Health of Ukraine from 1995. General forensic and anthropometric methods and techniques were used, as well as original scanning methods of computer identification of a person based on digital orthopantomograms. Quantitative

analysis was carried out using standard methods of variational statistics.

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Results and case description.

During the inspection of the scene, the burnt bones of the skeleton of an unknown person and some melted personal belongings were found (Fig. 1). During the forensic and medical examination, it was found that the gray and light gray color of the bone fragments indicates that they were exposed to flame and high temperature.

Due to the burning, skeletalization and fragmentation of the corpse, the cause of death and the time of its occurrence have not been established. Using the comparative method, assessing the general appearance of the bone fragments, their size, configuration, characteristic anatomical formations - articular surfaces, holes for blood vessels and nerves, characteristic bone structure and number of bones - allowed us to establish that the bones belonged to one person. However, their distinct degraded changes due to burning made it impossible to extract material suitable for establishing the group affiliation of the corpse and DNA research.

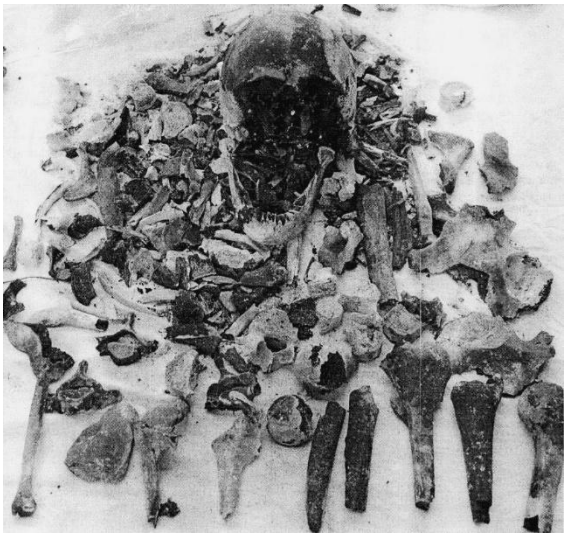

Figure 1. General view of the burned bones of an unknown person.

The forensic anthropological examination of the skull and lower jaw bones of the unknown person revealed that the bones belonged to a man who, according to the condition of the sutures of the skull vault, had a biological age of 20-30 years (Fig. 2). During his life, the unknown person was missing 5-8 teeth on the right lower jaw. On the left, the 8th tooth was unerupted.

Fig. 2. View of the lower jaw and skull with a fragment of the upper jaw of an unknown person.

The forensic dental examination of the lower jaw revealed damage to the crowns of the teeth, dystopic and retained position of the third molar on the left, its horizontal position in relation to the long axis of the second molar on the left, specific interposition of the sockets (alveoli) of the left canine and left lateral incisor with a more vestibular position of the socket of the left canine, which partially overlaps the area of the lateral incisor, specific interposition of the sockets (alveoli) of the teeth in the area from the right canine to the left canine, which may indirectly indicate a lifelong crowding of teeth in this area, the absence of the first molar on the right (Fig. 3).

a b

Fig. 3. Photographic illustration of the mandible. Symbols: 1. Dystopic and retained position of the third molar on the left, its horizontal placement in relation to the long axis of the second molar on the left 2. Absence of the first molar on the right side 3-4. Vestibular position of the socket

(alveolus) of the canine on the right side and overlapping of the lateral incisor on the right side (more lingual position of the lateral incisor in relation to the canine) 5-6. More lingual position of the central incisor socket on the right side in relation to the position of the central incisor socket on the left side.

Examination of the skull with a fragment of the upper jaw revealed damage to the crowns of the teeth and severe bone fenestration in the area of the missing central incisor on the right side (Fig. 4).

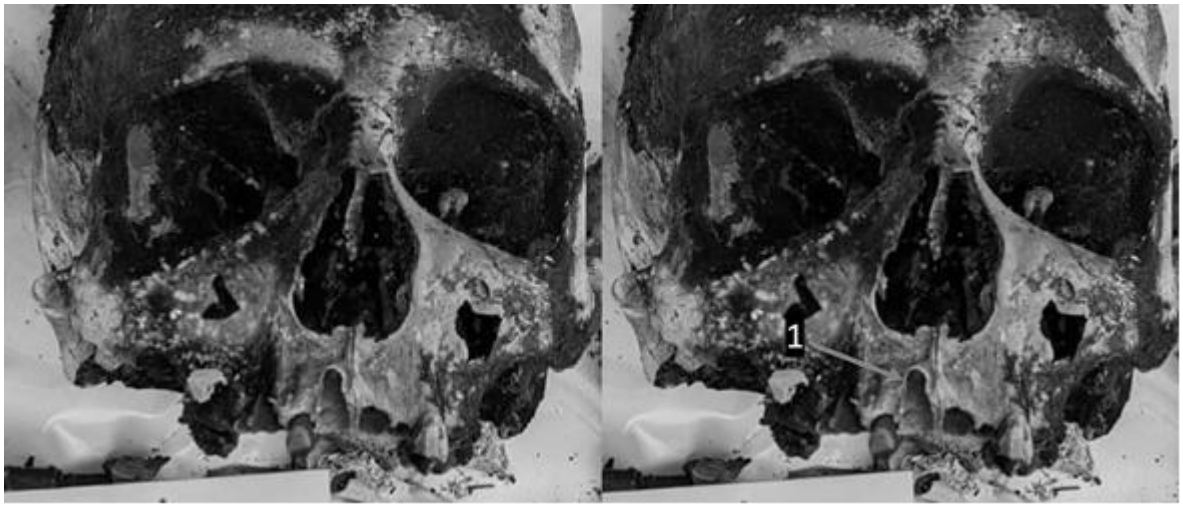

Fig. 4. Photographic illustration of a skull with a fragment of the upper jaw. Symbols: 1. Bone fenestration in the area of the missing central incisor on the right side.

After conducting the initial forensic examination at the Kherson Regional Bureau of Forensic Medicine to confirm the results of the identification of a person K., the investigator sent the materials to the Association of Forensic Dentistry of Ukraine, whose group of experts is headed by Ye. Kostenko.

In the study of the lifetime orthopantomogram of a person K., forensic dentists found the following unique signs of dental status (Fig. 5) – the presence of unerupted third molars on the left and right sides of the upper jaw; – the presence of only the root part of the central incisor on the right side in the absence of the crown part of the tooth on the upper jaw; – the absence of unambiguous radiological signs of iatrogenic interventions in the areas of all teeth, except for the central incisor on the right side; – dystopic and retained position of the third molar on the left side of the lower jaw; – its horizontal position in relation to the long axis of the second molar on the left, the absence of the first molar on the right side of the lower jaw.

In addition to the above, the vestibular position of the canine on the right side and its overlap with the lateral incisor on the right side (more lingual position of the lateral incisor in relation to the canine) on the mandible and more lingual position of the central incisor 8 on the right side in relation to the position of the central incisor on the left side on the mandible were revealed.

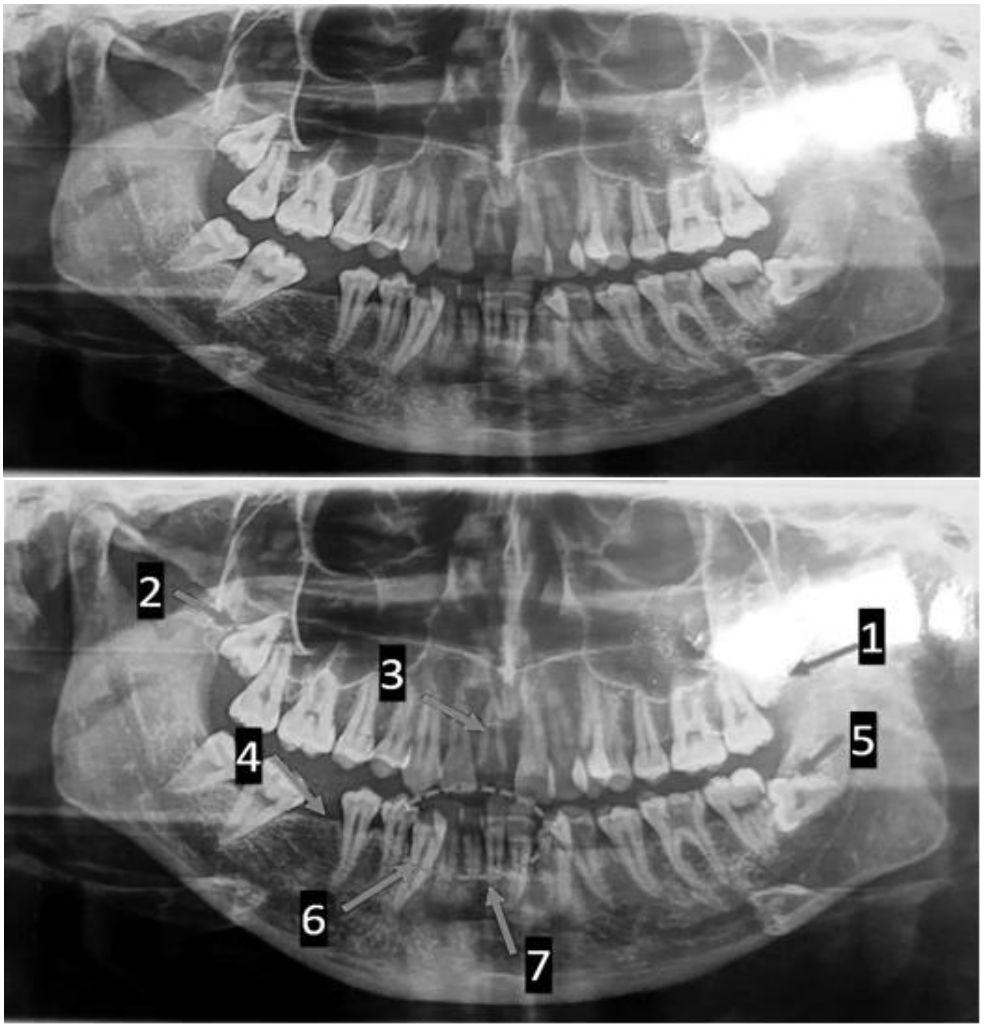

Fig. 5. Orthopantomogram of a person K. Symbols: 1. Untreated molar on the left side of the upper jaw; 2. Untreated molar on the right side of the upper jaw; 3. Presence of only the root part of the central incisor of the upper jaw on the right side in the absence of the crown part of the tooth; 4. Absence of the first molar on the right side of the lower jaw; 5. Dystopic and retained position of the third molar on the left side, its horizontal placement in relation to the long axis of the second molar on the left; 6. Vestibular position of the canine on the right side and overlapping of the lateral incisor on the right side (this feature is established taking into account the peculiarities of constructing an image of the orthopantomogram and the effect of projective overlap of three-dimensional structures of the oral cavity on a two-dimensional image); 7. More lingual position of the central incisor on the right side in relation to the position of the central incisor on the left side (this feature is established taking into account the peculiarities of constructing an orthopantomogram image and the effect of projection overlap of three-dimensional structures of the oral cavity on a two-dimensional image).

Assessing the provided vital photograph of a person K. (Fig. 6), the absence of the central incisor of the upper jaw on the right, a more lingual position of the lateral incisor on the right side relative to the position of the canine on the right side (the right canine is located more vestibularly relative to the right lateral incisor), a more lingual position of the central incisor on the right side relative to the position of the central incisor on the left side (the left central incisor is located more vestibularly relative to the right central incisor) are determined.

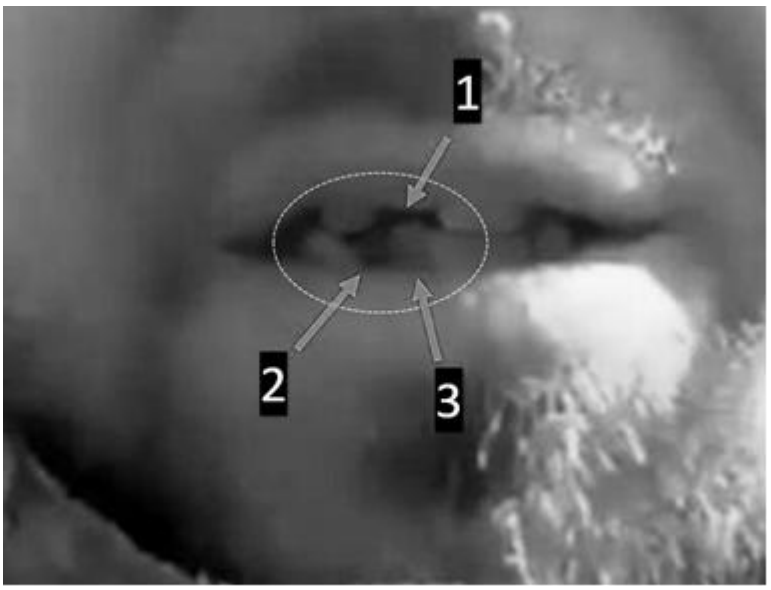

Fig. 6. Lifetime photograph of a person K. Symbols: 1. Absence of the central incisor of the upper jaw on the right 2. More lingual position of the lateral incisor on the right side relative to the position of the canine on the right side (the right canine is located more vestibular to the right lateral incisor) 3. More lingual position of the central incisor on the right side relative to the position of the central incisor on the left side (the left central incisor is placed more vestibularly relative to the right central incisor)

Discussion.

It is common knowledge that forensic dental identification is an important evidentiary component in the identification of unknown or missing persons. The identification of deceased servicemen during hostilities is one of the components of such a comprehensive approach and a mandatory element of the generally accepted rules that apply to all parties to the conflict and are provided for by humanitarian law [10]. In world practice, there is a well-known experience of involving targeted groups of specialists in the format of DVI Interpol teams in the process of identifying victims of mass disasters (including those killed in hostilities) based on dental status [11,12]. At the same time, obtaining information on the formation of individual dental patterns is extremely important, as their features can be effectively used in dental identification [13].

Thus, as a result of the forensic dental examination, a clear consistency of such odontological features was revealed, such as: 1) dystopic and retained position of the third molar on the left, its horizontal position in relation to the long axis of the second molar on the left in the lower jaw and the absence of the first molar of the lower jaw on the right, which were determined both in the photo illustration of the lower jaw and in the orthopantomogram of the patient; 2) the absence of the crown of a person K.; 2) consistency of the sign of the absence of the crown of the central right incisor of the upper jaw, which was determined on the photo illustration of the lower jaw, the orthopantomogram of the lower jaw of a person K. lower jaw and his lifetime photograph; 3) consistency of the sign of specific interposition of the sockets (alveoli)/teeth of the left canine and the left lateral incisor of the mandible with a more vestibular position of the socket/tooth of the left canine, which partially overlaps the area of the lateral incisor, more lingual position of the socket (alveolus)/tooth of the central incisor on the right side in relation to the position of the socket (alveolus)/tooth of the central incisor on the left side on the mandible, which was determined in the photo illustration of the mandible, on the orthopantomogram of a person K. orthopantomogram and his lifetime photograph. The above gives grounds to conclude that the lower jaw and a fragment of the upper jaw on the skull of an unknown person, the photo illustrations of which were submitted for examination, may belong to a person K., born in 1993.

This research is a very interesting case in forensic practice, as it once again confirms that the use of several mutually confirming identification methods ensures the validity of the results [14, 15]. Accordingly, in addition to forensic dentistry, a forensic anthropological examination was conducted in this case. The case file was sent to the International Commission on Missing Persons

(ICMP) (The Hague, the Netherlands), namely to forensic anthropologist Soren Blau, who received the following results: "... Based on the review of the information on the ante-mortem examination of a person K., and photographs of the postmortem examination of the burnt human remains taken at the scene and in the morgue, there are several coincidences (age, gender, dental features) between the ante-mortem and postmortem data that confirm the identification hypothesis that the skeletal remains of the person belong to a person K. Other contextual information should be taken into account to confirm the identification".

She provided comments and the following recommendations: "...the skull potentially provides the greatest amount of information for human identification. Consequently, the remains should be documented in detail at the crime scene and then properly packaged before being transported to the morgue. If everything is documented at the crime scene and properly packaged, a detailed analysis can be performed at the morgue. If unfortunately the remains are damaged during transportation from the scene to the morgue, good documentation at the scene means that detailed information is still available. Best practice should include documenting to scale and in 6 standard views of the skull (cranium and mandible) at the morgue (regardless of preservation status). The teeth that have fallen out should be collected from the scene for further examination at the morgue. In cases where the dentition is restored and age determination is required, an X-ray of the skull and dentition (X-ray) should be taken...".

Therefore, after the above two consultative studies, it was necessary to conduct an examination of the bone remains after their exhumation and comparison with the lifetime dental information. At the Main Bureau of Forensic Medicine, both jaws were reconstructed, with the relocation of the teeth that had fallen out (as the bones had suffered further destruction during burial and exhumation). After that, targeted X-rays of the jaw areas with preserved teeth were taken and the lifetime orthopantomogram and X-ray were compared with postmortem digital radiographs. In doing so, individual features suitable for comparison were identified, some of which are shown in Fig. 7.

Thus, in Fig. 7 shows a retained (unerupted) and dystopic (incorrect position and direction of growth) tooth №38 (eighth tooth on the left side of the mandible). The targeted postmortem X-ray is rotated to the position corresponding to the position of the corresponding teeth on the orthopantomogram. The crowns on the targeted X-ray are partially destroyed due to massive thermal effects, but there is still a match in position and shape.

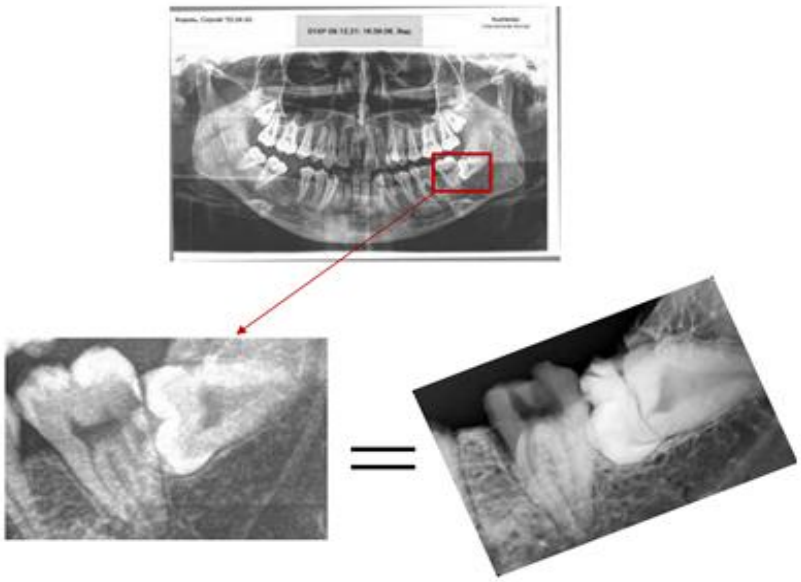

Fig. 7. Retained and dystopic tooth №38 on the lifetime orthopantomogram and postmortem sight X-ray.

The dental features found in the photo illustration of the lower jaw, orthopantomogram and

lifetime photograph of a person K. dental signs:

a) the dystopic and retained position of the third molar on the left, its horizontal placement in relation to the long axis of the second molar on the left in the lower jaw and the absence of the first molar of the lower jaw on the right;

b) the consistency of the sign of the absence of the crown of the central right incisor of the upper jaw, which was determined on the photo illustration of the lower jaw, the orthopantomogram of the lower jaw of a perso K. and his lifetime photograph;

c) consistency of the sign of specific interposition of the sockets (alveoli)/teeth of the left canine and the left lateral incisor of the mandible with a more vestibular position of the socket/tooth of the left canine, which partially overlaps the area of the lateral incisor, more lingual position of the socket (alveolus)/tooth of the central incisor on the right side in relation to the position of the socket (alveolus)/tooth of the central incisor on the left side on the mandible, which was determined in the photo illustration of the mandible, on the orthopantomogram of a person K. and on his lifetime photograph – can be categorized as unique odontological identifiers according to the Keiser-Nielsen classification, DVI standards and recommendations of the International Organization for Forensic Odonto-Stomatology, which, in their entirety, allow us to conclude a positive result of dental identification and to state the correspondence of dental evidence verified on the photo illustration of the lower jaw, on the orthopantomogram and on the vital photo illustration.

When comparing the data of the lifetime orthopantomogram of a person K. and postmortem dental radiographs revealed the following coincidences: a) retained and dystopic tooth 38 (third molar on the left of the lower jaw); b) vestibular position of tooth 23 (click on the left of the upper jaw), with its crown overlapping the crowns of teeth 22 and 24; d) overgrown alveolar socket of tooth 46 (first molar on the right of the lower jaw). The crowns of the teeth are partially destroyed due to massive thermal effects, but there is still a match in position and shape.

The use of scanning methods of computer identification based on orthopantomograms provided by the remains of the skull bones with the upper and lower jaws, a lifetime photograph of the deceased person, allows for the successful identification of an unknown person even in cases of significant burning and destruction of the bones of the human skeleton, but a prerequisite is the comparison of lifetime and postmortem X-ray images of the dentition.

This, and some other less pronounced individual features of the dentition (vestibular position of tooth 23, with its crown overlapping the crowns of teeth 22 and 24, overgrown alveolar socket of tooth 46), as well as the coincidence of such general features as gender and age, made it possible to assert a positive identification and that the bone remains submitted for examination belong to a person K.

Conclusions. A comprehensive investigation of the object by experts of various specialties demonstrates the possibility of obtaining a large amount of information for analysis, which ensures the objectivity and qualitative identification of an unknown person by dental status.

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СУДОВО-СТОМАТОЛОГІЧНА ІДЕНТИФІКАЦІЇ НЕВІДОМОЇ ОСОБИ ЗА ОСОБЛИВОСТЯМИ ЗУБО-ЩЕЛЕПОВОГО АПАРАТУ, ЯКИЙ ЗАЗНАВ ЗНАЧНОГО ТЕРМІЧНОГО ВПЛИВУ

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Резюме. Використання скануючих методів комп'ютерної ідентифікації за ортопантомограмами, наданими залишками кісток черепа з верхньою і нижньою щелепами, посмертною рентгенографією зубів, зажиттєвою фотографією померлої особи, дозволяє успішно проводити ідентифікацію невідомої особи навіть у випадках значного спалювання і руйнації кісток скелету людини.

Мета роботи. Проведення ідентифікації особи за особливостями зубо-щелепового апарату, який разом з іншими кістками голови і тулуба зазнав значного термічного впливу.

Матеріал і методи. Були використані архівні матеріали Херсонського обласного бюро судово-медичної експертизи та Державної спеціалізованої установи «Головне бюро судово-медичної експертизи МОЗ України», які містили інформацію про останки кісткового скелету організму людини, у тому числі кістки лицевого черепа і зубо-щелеповий апарат, які були піддані значній термічній дії внаслідок спалювання, зажиттєвий рентгенівський панорамний знімок (ортопантомограма), зажиттєву рентгенограму зубів і медичну документацію (стоматологічна карта хворого), зажиттєву фотографію потерпілого та посмертні рентгенограми зубів. Дослідження проводились згідно з чинним українським законодавством, зокрема з Наказом №6 МОЗ України від 1995 р. Були використані загальні судово-медичні, антропометричні методи і методики, оригінальні скануючі методики комп'ютерної ідентифікації особи за цифровими ортопантомограмами. Кількісний аналіз проводився з використанням стандартних методів варіаційної статистики.

Науково-дослідна робота. «Експертна оцінка вдосконалених стоматологічних технологій лікування та реабілітації» Державний реєстраційний номер: 0123U101509. Терміни виконання: 2023-2027 р.р.

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Результати. За виявленими особливостями зубо-щелепового апарату, який зазнав значного термічного впливу, даними ортопантомограми, посмертної рентгенографії обох щелеп, фотоілюстраціями верхньої та нижньої щелепи, а також за зажиттєвою фотографією померлого чоловіка, була проведена комплексна судово-медична, судово-стоматологічна та судово-антропологічна ідентифікація особи, яка зазнала значного термічного впливу.

Висновки. Комплексне дослідження об'єкту експертами, різних спеціальностей, демонструє можливість отримання великого обсягу інформації для аналізу, що забезпечує об'єктивність і якісну ідентифікацію невідомої особи за стоматологічним статусом.

Ключові слова: ідентифікація, судова стоматологія, судово-медична експертиза, ортопантомограма, посмертна рентгенограма зубів.

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