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Modern Aspects of the Use of Virtopsy in Forensic Examination

Ochilov Kamil Rakhimovich
Bukhara State Medical Institute

Annotation: Of course, traditional, or invasive, autopsy throughout the world still remains the only way to scientifically monitor the correctness of the diagnosis and establish the cause of death and is the "gold standard" for post-mortem diagnosis. However, computed tomography (CT) and magnetic resonance imaging (MRI) have long become an integral and important part of the forensic medical examination of living persons, when expert conclusions are based on the opinions of radiologists and data from radiation diagnostic methods [7]. Virtopsy is a technique for post-mortem examination of the body, combining a classical pathological or forensic autopsy with the preliminary use of CT and/or MRI examination of the whole body without the use of contrast agents [5, 6]. The literature review examines questions about modern aspects of the use of virtopsy in forensic medicine.

Key words: virtopsy, method, forensic medicine, innovative technologies, computed tomography.

Relevance. Forensic medical examination of a corpse is traditionally based on a sectional examination of the body (its autopsy) - a method that is classic for this type of examination. At the same time, modern high-tech research methods are used today in the examination of physical evidence, for example, in the molecular genetic identification of individuals and the establishment of biological relationships; during forensic chemical and chemical toxicological analysis of narcotic and psychoactive substances; in the production of medical and forensic examinations to establish (identify) the person and the instrument of injury. Despite this, forensic thanatology continues to use traditional methods of examining a corpse without alternative [1–3]. Of course, traditional, or invasive, autopsy throughout the world still remains the only way to scientifically monitor the correctness of the diagnosis and establish the cause of death and is the "gold standard" for post-mortem diagnosis. The "gold standard" in this situation is a research method that reflects the condition of the organ or body being studied with maximum accuracy. This method most often uses autopsy and biopsy data, less often other methods, including radiation diagnostic methods.

A diagnosis based on the "gold standard" is called "reference" or "reference". The dissection technique has been refined over many centuries, and any new method of post-mortem examination that purports to be a complement or alternative to traditional autopsy is accepted with caution by the forensic community [4–6]. However, computed tomography (CT) and magnetic resonance imaging (MRI) have long become an integral and important part of the forensic medical examination of living persons, when expert conclusions are based on the opinions of radiologists and data from radiation diagnostic methods [7]. Post-mortem imaging, being the youngest field of radiation diagnostics, has deep historical roots. Radiography of corpses and organs began to be performed within a few months after the discovery of X-rays by the famous German physicist

Wilhelm Conrad Roentgen in 1895. Most of the modern uses of radiology in forensic science have been predicted and practiced since 1898: archaeological/anthropological research, explosive device detection, bone age determination, dental identification, projectile identification, etc. Some of these early techniques have become obsolete, others have fallen into disrepair or been forgotten over the years; some were later revived (such as skeletal identification). Exciting new developments added to the traditional arsenal around the last quarter of the twentieth century—notably ultrasound (US), endoscopy, computed tomography (CT), and magnetic resonance imaging (MRI). Two recent developments in sectional imaging have appeared particularly attractive for forensic research [8]. The first CT examination of a corpse with a penetrating gunshot wound to the head was carried out by Professor Robert Wüllenweber of the University of Bonn and his colleagues in 1977. However, it did not arouse interest in the professional community due to the low quality of the images. Gil Brogdon, professor emeritus of radiology at the University of South Alabama, considered by many to be the "godfather" of forensic radiology, wrote in 1998: "The sad truth is that half a century after the first x-ray was presented in court, there is no general recognition assessment of the degree of radiological potential in forensic medicine." This plaintive note struck a chord with Richard Dirnhofer, professor and director of the Institute of Legal Medicine at the University of Bern. Together with Professor of Radiology Peter Vock, Director of the Institute of Diagnostic Radiology at the same medical center in Bern, they created a uniquely organized collaborative interdisciplinary group and proved the usefulness and relevance of post-mortem imaging. Professor Dirnhofer created a neologism to identify the project and process of minimally invasive visual virtual autopsy by combining the words "virtual" and "autopsy" into a convenient, short but succinct word – virtopsy. Virtopsy is a technique for post-mortem examination of the body, combining a classical pathological or forensic autopsy with the preliminary use of CT and/or MRI examination of the whole body without the use of contrast agents [5, 6]. Professor Dirnhofer emphasized the fact that 3D visualization allows one to clearly illustrate the expert's conclusions, which is very important for people without medical training who have little understanding of the complex and detailed narrative parts of autopsy reports - law enforcement officers, lawyers, judges and juries. Professor Michael Thali, Professor Dirnhofer's successor, should also be commended for his dedication and leadership in promoting this method in global forensic practice. In order to further disseminate knowledge and experience, the founders of the "virtopsy" project have published monographs, manuals and atlases, which, without exaggeration, can be called "works of art" in forensic medicine. An extremely successful model of interdepartmental and interdisciplinary cooperation has been introduced into the forensic medical examination of a number of countries (Germany, France, Great Britain, USA, Israel, Australia), where Virtopsy is now routinely used to conduct screening examinations of almost all corpses to determine the need for further sectional research.

The use of a computed tomograph as a pre-sectional research method helped the forensic expert plan the upcoming autopsy and made it possible to assess the condition of "hard-to-reach" areas for subsequent sectional examination of the corpse. Clear CT images helped document the position of the radiopaque foreign object in the oral cavity; indirect radiological signs indicated the presence of another, but non-contrast foreign object in the lumen of the right main bronchus. Visualization of the fracture of the horn of the hyoid bone reliably confirmed the fact of its intravital origin and excluded the possibility of accidental formation during extraction and processing of the laryngeal-hyoid complex [10].

The undeniable advantages of pre-sectional and alternative virtopsy: 1. Preservation of the body that has not been subjected to autopsy, which is extremely important for representatives of

many religions and communities. This point was put first, since it was the negative attitude of relatives of the deceased towards traditional autopsy in many countries of the world that became a powerful incentive for research in the field of post-mortem imaging. 2. Visualization, including volumetric, of wound channels for gunshot, stab, stab, chopped and other wounds. Three-dimensional reconstruction with post-mortem MSCT provides a unique opportunity to use the method to solve issues of medical and forensic identification of the instrument of injury and reconstruction of the circumstances of the incident in case of gunshot, blunt trauma and injuries caused by sharp objects. At the same time, law enforcement agencies can obtain the necessary information very quickly, which is extremely important when carrying out urgent investigative actions. 3. The possibility of detailed, quick and gentle examination of areas of the body that are technically difficult for traditional dissection: the facial skeleton, base of the skull, spine and spinal cord, pelvis, distal limbs. 4. Identification of signs of intravital damage in cases of asphyxia, mechanical trauma, exposure to flame, drowning. 5. Successful use in cases of mass death and for conducting a screening study of corpses in cases of sudden death to decide on further tactics. 6. CT examination, being an operator-independent method, makes it possible to exclude the human factor in cases of inattentive, hasty and technically erroneous autopsies of corpses. 7. The risk of infection of morgue staff (doctors, laboratory assistants and orderlies) with tuberculosis, hepatitis, HIV and other dangerous infectious diseases is significantly reduced. 8. The ability to quickly and completely collect data on a specific case, as well as exchange data as part of the analysis of similar crimes (serial and multiple murders, transport and man-made disasters, terrorist attacks, etc.). 9. The results of a virtual autopsy can be stored in digital format for a long time, which allows for retrospective repeated expert examination without exhumation of the corpse and in cases of cremation of the latter. They can be used to conduct commission and complex forensic medical examinations with the participation of various specialists, including from different regions, for the bodies of inquiry, preliminary investigation and the court. 10. Electronic virtual autopsy databases can serve as educational material when students study anatomy, pathological anatomy and forensic medicine. Despite the undoubted advantages, the use of Virtopsy in forensic practice is associated with certain difficulties:

• insufficient material and technical equipment of individual departments and entire bureaus for the acquisition and operation of expensive CT equipment;

• lack of qualified radiologists and specialists in the field of post-mortem imaging;

• lack of a legal framework regulating the activities of the forensic medical service in post-mortem imaging and the use of virtopsy as an alternative to the traditional examination of a corpse.

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