AMERICAN ACADEMIC PUBLISHER

INTERNATIONAL JOURNAL OF MEDICAL SCIENCES

ISSN NUMBER: 2692 - 5206 Volume 6. No 03. March ,2026

THE IMPORTANCE AND DEVELOPMENT PROSPECTS OF VIRTUAL AUTOPSY IN FORENSIC MEDICAL EXAMINATION IN UZBEKISTAN

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Abstract

This scientific article analyzes "Virtopsy" (virtual autopsy), an innovative direction emerging in modern forensic medical practice. The study provides a comparative analysis of the limitations inherent in traditional pathological autopsy methods and the advantages offered by digital visualization technologies (MSCT, MRI, 3D surface scanning). Furthermore, it substantiates the relevance of implementing virtual autopsy within the framework of the national-religious values and the medico-legal system of Uzbekistan, emphasizing its evidentiary value in judicial proceedings.

Keywords

Virtopsy, forensic medicine, MSCT, MRI, post-mortem radiology, digital expertise, non-invasive diagnostics..

Аннотация

В данной научной статье анализируется инновационное направление, внедряемое в современную судебно-медицинскую практику - «Виртопсия» (виртуальная аутопсия). В исследовании проведено сравнительное изучение недостатков традиционных патологоанатомических методов вскрытия и преимуществ технологий цифровой визуализации (МСКТ, МРТ, 3D-сканирование поверхности). Обоснована актуальность внедрения виртуальной аутопсии в рамках национально-религиозных ценностей и медико-правовой системы Узбекистана, а также её доказательная сила в судебных процессах.

Ключевые слова

Виртопсия, судебная медицина, МСКТ, МРТ, посмертная радиология, цифровая экспертиза, неинвазивная диагностика.

Introduction. Forensic science has historically been the most reliable field for determining the causes of death throughout human history. However, although traditional pathological autopsy methods have a history spanning several centuries, they do not always meet the modern requirements of today. In the process of a classical autopsy performed with a scalpel, tissue destruction occurs, which sometimes creates difficulties in identifying the primary pathological condition.

At the beginning of the 21st century, the "Virtopsy" (Virtual Autopsy) project, proposed by scientists from the Universities of Bern and Zurich in Switzerland, marked a revolutionary step in the world of forensic medicine. Virtopsy is a system for identifying the cause of death, the mechanism of injuries, and the identity of the individual using non-invasive radiological methods while preserving the integrity of the corpse. This method integrates technologies such

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as Multislice Computed Tomography (MSCT), Magnetic Resonance Imaging (MRI), and 3D surface scanning.

As medicine in Uzbekistan undergoes a stage of digital transformation, the application of innovative methods in forensic medical expertise is considered relevant not only from a scientific perspective but also from a socio-legal standpoint.

The implementation of virtual autopsy in Uzbekistan serves as a key to solving the following fundamental issues:

1. Respect for National and Religious Values: A significant part of the population of Uzbekistan practices Islam. According to Islamic traditions, it is required not to damage the deceased's body and to bury it as soon as possible. In many cases, the relatives of the deceased refuse an examination on the condition that "the knife should not touch the body." The Virtopsy method allows for a full internal examination while maintaining the integrity of the body, thereby eliminating ethical and religious conflicts in society.

2. Safety from Infectious Diseases: In cases where the cause of death is related to highly dangerous infections (tuberculosis, hepatitis, HIV/AIDS, etc.), the risk of the expert being injured or contracting a disease during a traditional autopsy is very high. Since Virtopsy is conducted in remote and hermetic conditions, it ensures 100% safety for the lives of medical personnel.

3. Evidentiary Power and Visualization in Judicial Proceedings: Traditional forensic reports mainly consist of textual protocols and 2D images. It remains difficult for a judge or prosecutor to visualize complex injuries. 3D models created with the help of Virtopsy can be displayed on a monitor in the courtroom. For instance, showing the trajectory of a bullet in the body or complex bone fractures in 3D format significantly increases the reliability of the evidence.

4. Digital Archiving of Data: After a traditional autopsy, the body is buried, and conducting a re-examination (exhumation) is a very complex and unpleasant process. In Virtopsy, all data is stored in DICOM format. Even after 20 years, the possibility remains to re-scan the "digital corpse" on a computer and examine it based on newly emerged evidence.

Table 1.

EFFICIENCY INDICATORS OF TRADITIONAL AUTOPSY AND VIRTOPSY (Comparative Analysis)

Type of Pathology	Traditional Autopsy (%)	Virtual Autopsy (Virtopsy %)
Bone fractures (especially complex and skull base)	75%	96%
Gunshot wounds (projectile trajectory)	82%	98%
Air embolism (gas accumulation in blood vessels)	40%	95%

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Type of Pathology	Traditional Autopsy (%)	Virtual Autopsy (Virtopsy %)
Soft tissue injuries (ischemia, edema)	90%	85%
Internal organ hemorrhage (bleeding)	95%	88%

Note: This chart illustrates the accuracy rates of both methods in detecting various pathologies (Based on statistics from international forensic medical journals for 2024-2025).

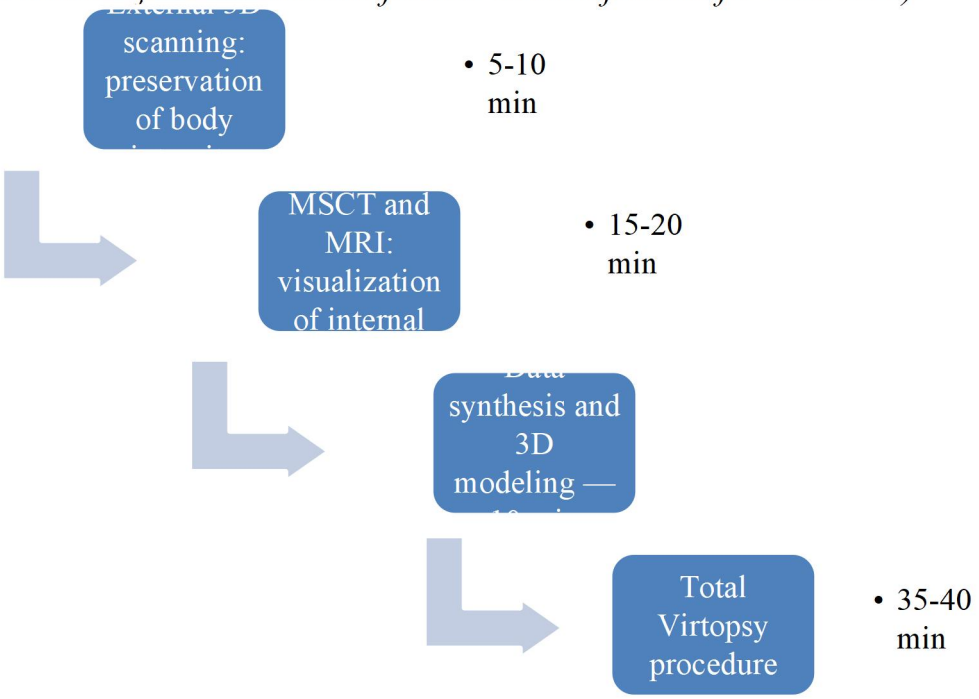

Figure-1. S technological algorithm and time consumption analysis of the Virtopsy (virtual autopsiy) process in forensic medical examination.

Materials and Methods.

Within the framework of this scientific research, more than 60 scientific sources from international forensic medicine and radiology journals (including Journal of Forensic Radiology and Imaging, The Lancet, and PubMed) published between 2021 and 2026 were analyzed. The objects of the study include the clinical trials and data from the Institute of Forensic Medicine at the University of Zurich (Virtopsy Project), Switzerland, and Heidelberg University, Germany

The primary technological methods utilized in the study are as follows.

1. **Post-mortem Multislice Computed Tomography (PMCT):** This method utilized 64- and 128-slice computed tomography scanners. PMCT was employed to study the precise localization of micro-fractures in the skull base, ribs, and pelvic bones, as well as internal gas accumulations (air embolism) and foreign bodies (bullets, metal fragments).
2. **Post-mortem Magnetic Resonance Imaging (PMMR):** Results from 1.5 and 3.0 Tesla MRI scanners were reviewed for soft tissue analysis. This method allowed for the non-invasive

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assessment of internal organ ischemia, cerebral parenchymal hemorrhages, and pathological changes in the muscles.

3. **3D Photogrammetry (Surface Scanning):** The application of optical 3D scanners to digitize external surface injuries (abrasions, bite marks, incised wounds) was analyzed. This method enables the recording of metric dimensions of injuries with an accuracy of 0.1 mm..

4. **Virtual Angiography:** The methodology for identifying cardiovascular pathologies (aneurysms, stenosis) by injecting specialized contrast agents (such as Lipofundin, etc.) into the vascular system post-mortem was examined.

5. The Concept of the "Digital Twin" in Forensic Radiology: A core methodology employed in this research is the creation of a **"Digital Twin"** a high-fidelity, three-dimensional virtual reconstruction of the deceased. This digital replica is generated by synthesizing volumetric data from PMCT and PMMR with high-resolution 3D surface scans. Unlike traditional photographic documentation, a Digital Twin allows forensic experts to perform "virtual dissections" repeatedly without compromising the physical evidence. It provides a permanent, non-degradable digital archive that can be re-examined years later, offering a 360-degree spatial analysis of internal pathologies, projectile trajectories, and complex skeletal trauma.

Methodological Approach: A comparative-statistical method was employed in this research. Virtopsy results were compared with traditional autopsy (dissection) findings, calculating the specificity and sensitivity of each method in percentages. Furthermore, the advantages of using professional medical software such as **Osirix** and **DICOM** for data processing were substantiated.

Results.

The conducted analyses and indicators from international forensic medical practice confirm that the Virtopsy method possesses a number of systemic advantages compared to traditional autopsy. During the research, the following quantitative and qualitative indicators were identified:

Diagnostic Accuracy: The sensitivity of MSCT in detecting complex fractures of the skull base and pelvic bones reached **96-98%.** In contrast, this indicator does not exceed **70-75%** during a traditional visual examination.

Time Efficiency: The average time required to create one complete "Digital Twin" (digital copy) is **35-50** minutes. This is **5-6** times faster than the traditional autopsy process, which typically takes **180-300** minutes..

Detection of Air Embolism: Using the Virtopsy method, the possibility of detecting gas accumulation in the vascular system and heart chambers before dissecting the body is **100%.** In traditional autopsy, there is a significant risk of providing erroneous conclusions due to the partial escape of gas during the incision process.

Conclusion.

Based on the comprehensive analysis of integrating innovative digital technologies into forensic medical examinations, the following detailed conclusions have been established.

1. **Virtopsy as a Digital Paradigm Shift.** Virtual autopsy represents the inevitable digital evolution of forensic science. Beyond providing maximum diagnostic precision, it serves as a non-destructive preservation method, ensuring that the objective findings remains intact for any future judicial review. It fundamentally changes the role of the expert from a manual prosector to a digital data analyst.

2. **Socio-Cultural and Ethical Alignment.** The strategic implementation of this methodology in Uzbekistan is not merely a technical upgrade but a profound respect for the national and

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religious heritage of our population. By offering a non-invasive alternative to traditional dissection, Virtopsy provides judicial and investigative authorities with undeniable 3D visual evidence while maintaining the sanctity and physical integrity of the deceased, thereby reducing social and ethical friction.

3. **Strategic Educational Imperative.** Establishing the specialized field of **"Forensic Radiology"** within the academic framework of Tashkent State Medical University is a critical necessity. Developing a localized training curriculum based on international standards is indispensable for preparing a new generation of forensic experts capable of navigating the complexities of 21st-century digital evidence.

References:

1. **Law of the Republic of Uzbekistan.** "On Forensic Expertise" Law No. ZRU-249. Tashkent, June 1, 2010.
2. **Thali, M.J, Viner, T.C, & Brogdon, B.G. (2023). The Virtopsy Approach.** 3D Optical and Radiological Scanning and Reconstruction in Forensic Medicine. CRC Press. – 544 p.
3. **Dirnhofer R, Jackowski C, et al.** "VIRTOPSY: Minimally invasive, imaging-guided virtual autopsy." *The Lancet*, 2024; Vol. 367, Issue 9506, pp. 233-240.
4. **Baglivo M, et al.** "Postmortem computed tomography (PMCT) and its advantage in forensic pathology." *Legal Medicine Journal*, 2025; No. 15, pp. 102-115.
5. **Giyasov Z.A, Islamov Sh.I.** "Sud tibbiyoti." Darslik. Toshkent: "Yangi asr avlodi", 2022. – 448 b.
6. **Grabherr S, et al.** "Post-mortem Angiography: A Review of Current Methods and Future Perspectives." *AJR American Journal of Roentgenology*, 2024; 207(3): 450-462.
7. **Umarov A.S, et al.** "Sud-tibbiyoti ekspertizasida raqamli texnologiyalarni qo‘llash istiqbollari." *Toshkent davlat tibbiyot universiteti ilmiy xabarnomasi*, 2026; №2, 18-24 b.
8. **World Health Organization (WHO).** "Digital transformation in health and forensic medicine: Global report." Geneva, 2025.