Advanced skills of the radiology technician in Forensic Radiology: methodology and state of the art

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Abstract

The advent of advanced diagnostic imaging has revolutionized the field of forensic medicine, enabling the integration of virtual autopsy techniques such as post-mortem computed tomography and magnetic resonance imaging. These methods offer non-invasive, high-resolution evaluations of the cadaver, often serving as a complementary or alternative approach to conventional autopsy, particularly in religious, cultural, or logistically sensitive contexts. Within this evolving paradigm, the role of the Radiology Technician (RT) has emerged as pivotal. This study systematically analyzes the technical, methodological, and transversal skills required of RTs in post-mortem imaging, with emphasis on operational workflow, safety protocols, image post-processing, 3D reconstruction, and printing. The research reviews national and international practices, highlighting organizational models, skill gaps, and future directions for professional development. The findings underscore the necessity for structured training pathways and interdisciplinary collaboration to ensure quality, reliability, and innovation in forensic radiology. This work advocates for the formal recognition and standardization of advanced RT competencies, positioning the profession at the forefront of digital transformation in forensic imaging.

Introduction

In recent decades, technological progress in the field of diagnostic imaging has made it possible to introduce virtual autopsy (virtopsy) as a complementary tool or, in some cases, a replacement for traditional autopsy. This method, which uses advanced imaging techniques such as post-mortem computed tomography (PMCT) and post-mortem magnetic resonance imaging (PMMRI), allows a detailed and non-invasive evaluation of the human body, offering a significant contribution in terms of diagnostic accuracy, documentation and data storage [1].

The use of post-mortem imaging has, in fact, assumed increasing relevance in both the clinical and forensic fields, responding to specific medico-legal needs as well as religious and cultural ones such as for Islam, Orthodox Judaism and Hinduism. In particular, the possibility of performing a non-destructive post-mortem diagnosis is of fundamental importance in contexts in which conventional autopsy is contraindicated, refused or logistically complex to manage. Virtual autopsy has proven effective, for example, in identifying causes of sudden death, in the evaluation of trauma and internal injuries, of findings, as well as in documentation for insurance and legal purposes [2].

Within this scenario, the Radiology Technician (RT) is configured as a key professional figure, as he/she holds the technical and methodological skills necessary for the correct acquisition, processing and management of diagnostic images. The execution of radiological examinations in the post-mortem field implies the adaptation of specific protocols, the knowledge of the anatomical-physiological modifications of the cadaver and the application of necessary and accessory procedures, in a context in which interdisciplinarity is essential [3].

This work aims to systematically outline the skills of the RT in the virtual autopsy laboratory, analyzing the methodological and operational implications. The national and international state of the art of the practice will also be explored, with reference to the main existing organizational models and the development prospects of the professional figure in the forensic radiology field. The aim is to contribute to the valorization of an emerging sector with large potential for growth and innovation [4].

Background and state of the art

Virtual autopsy, or post-mortem imaging, represents an advanced methodology for the analysis of cadavers through the use of diagnostic imaging techniques, such as computed tomography (CT) and magnetic resonance imaging (MRI) which, unlike conventional autopsy, does not involve physical dissection, allowing the internal anatomy to be viewed in a non-invasive manner, preserving the integrity of the body and allowing subsequent review of the acquired data. The most frequently used techniques include PMCT, particularly useful for the analysis of skeletal trauma and evaluating the presence of air in different anatomical regions, and PMMRI, more suitable for the examination of soft tissues and the central nervous system [5].

In recent years, several centers in Europe, North

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America and Asia have started experimental projects or consolidated the use of virtual autopsy in forensic and clinical settings. In Switzerland, at the University of Bern, one of the first integrated virtopsy laboratories has been developed, with standardized protocols for the acquisition of post-mortem images [6]. Also in the UK, the PMCTA (Post-Mortem CT Angiography) project has demonstrated the efficacy of post-mortem angiography as a diagnostic alternative to traditional autopsy in cases requested by the coroner [4]. In Italy, the use of post-mortem imaging is still heterogeneous, with active experiences in some university centers and IRCCS, but with a lack of regulatory and training homogeneity.

International recommendations, including those issued by the International Society of Forensic Radiology and Imaging (ISFRI) and the Royal College of Pathologists, underline the importance of a structured and multidisciplinary approach to post-mortem imaging, in which collaboration between radiologist, forensic doctor, pathologist and radiology technician is essential to ensure diagnostic quality and reliability of results [7]. However, in the absence of shared regulation at European level, significant differences remain in protocols, in the skills required of operators and in the methods of archiving and reporting.

The role of RT in this area has been the subject of increasing attention, being able to offer its contribution with a high technical-scientific content, about image acquisition and correct data storage, management of PACS archiving systems, processing of sensitive data, post-processing, three-dimensional processing of virtual specimens and 3D printing of models. However, the definition of the specific skills of the RT in the virtual autopsy laboratory is still evolving, with a lack of dedicated guidelines and training that is often based on direct experience rather than on structured paths [8].

Materials and Methods

The workflow within a virtual autopsy laboratory is divided into several phases, each of which requires the active presence of the RT to ensure the technical quality and coherence of the diagnostic process. From taking charge of the cadaver, to performing the examination, up to post-processing, the RT is called upon to operate with competence and precision in a highly regulated and multidisciplinary technical-legal context [9].

Operational workflow

The process begins with the correct identification of the deceased subject and the planning of the examination protocol based on the clinical or forensic indication. The acquisition phase follows, in which the RT applies specific post-mortem radiological protocols, adapting the technical parameters based on the cadaveric changes, body temperature and time elapsed since death and the request for investigation. The use of PMCT is recommended for the study of the skeleton and intracorporeal gases, while PMMRI is preferable for the analysis of soft tissues or the central nervous system. In some cases, the protocol may also include the execution of post-mortem angiography with a liposoluble contrast medium [3].

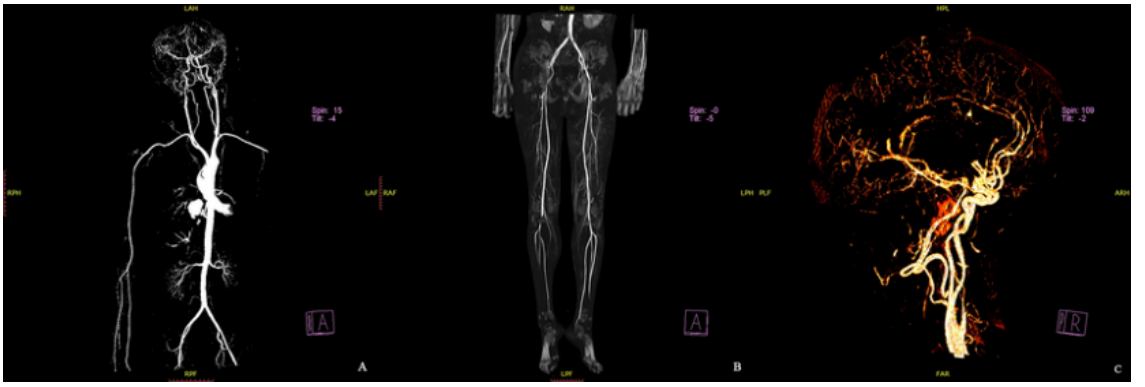


Figure 1. *Post-mortem CT angiography*

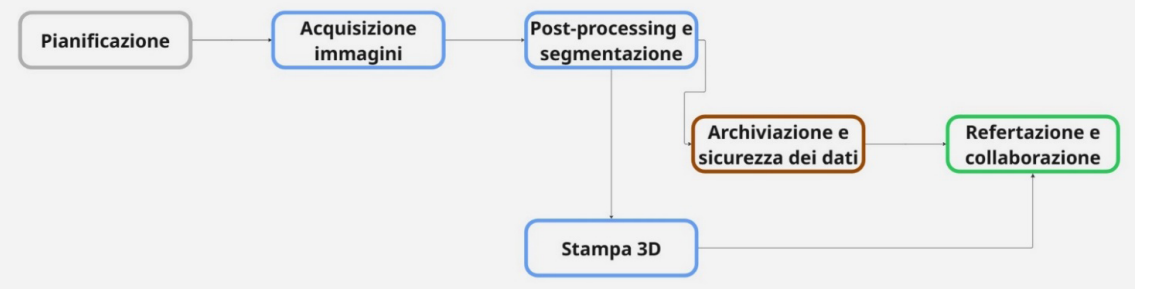


Figure 2. *Phases of the RT operational workflow in the virtual autopsy laboratory*

Specific technical skills

The technical skills required of the RT in this area include the **management of the deceased patient** according to safety, hygiene and respect protocols for the person, the **conduct of PMCT and PMMRI exams** with dedicated protocols, including the calibration and optimization of the scanning parameters also based on the conditions of the cadaver, the **post-processing and three-dimensional reconstruction** of which the RT must have technical expertise, knowing how to use advanced software for multiplanar reconstruction, volumetric rendering and segmentation, in order to generate detailed images that are functional for anatomopathological analysis.

3D printing, an emerging skill, useful to produce physical models of anatomical or pathological findings, useful both for forensic documentation and for forensic medical teaching [10]. The integration of imaging with 3D printing enables tangible representation of complex injuries, trauma and projectiles [11].

PACS and archiving management involves the organization of data according to traceability, security and privacy protection criteria in accordance with current legislation.

Transversal skills

In addition to technical skills, the RT must possess solid transversal skills, including the ability to work in an interdisciplinary team (radiologists, forensic doctors, laboratory technicians, pathologists), knowledge of data protection regulations, professional liability and bioethics and the management of biological risk and the adoption of suitable protective devices in potentially contaminated environments [12,13].

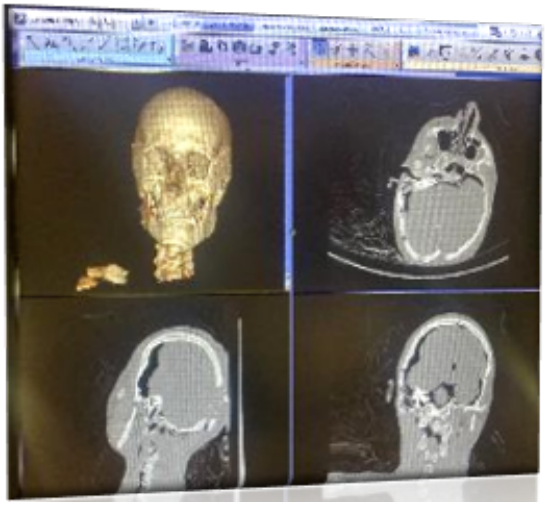
Conclusions and future perspectives

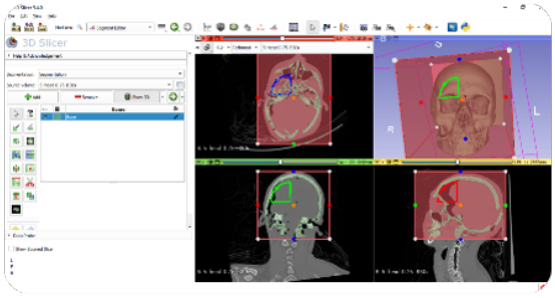
The evolution of virtual autopsy, driven by technological innovation, by the growing acceptance in the clinical and forensic fields in addition to the excellent results obtained so far, offers significant prospects for the profession of Medical Radiology Technician.

3D printing, volumetric processing and integration with collaborative reporting platforms represent areas of potential professional expansion, however, these opportunities require a structured commitment in terms of continuous updating, applied research, review of organizational models and with specific training paths.

This contribution aimed to outline the state of the art of the RT skills in the virtual autopsy laboratory, highlighting how the technical figure, adequately trained, constitutes a fundamental element to guarantee quality, reliability and innovation in a rapidly developing sector [14].

In a scenario characterized by digitalization, data interoperability and development of artificial intelligence applied to imaging, there is a need to strengthen the specialized training of RT and to define its advanced skills in a standardized way.





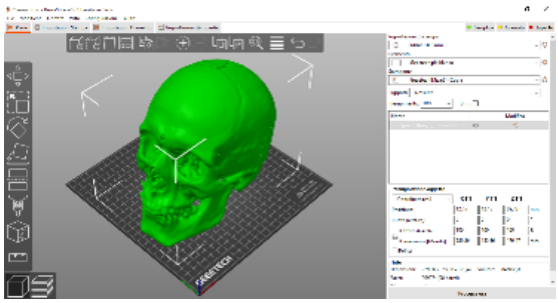


Figure 3. *Preparatory phases for 3D printing: acquisition, segmentation, slicing*

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References

1. *Dirnhofer, R., Jackowski, C., Vock, P., Potter, K., & Thali, M. J. (2006). Virtopsy: minimally invasive, imaging-guided autopsy. Radiographics, 26(5), 1305-1333.*
2. *O'Donnell, C., & Woodford, N. (2008). Post-mortem radiology–a new sub-speciality? Clinical Radiology, 63(11), 1189-1194.*
3. *Rutty, G. N., Morgan, B., Robinson, C., Raj, V., & Saunders, S. (2017). Diagnostic accuracy of post-mortem CT with targeted coronary angiography versus autopsy for coroner-requested post-mortem investigations: a prospective, masked, comparison study. The Lancet, 390(10090), 145-154.*
4. *Roberts, I. S. D., Benamore, R. E., Peebles, C., Roobottom, C., Traill, Z., & Wright, C. (2012). Post-mortem imaging as an alternative to autopsy in the diagnosis of adult deaths: a validation study. The Lancet, 379(9811), 136-142.*
5. *Jeffery, A. J., Raj, V., Morgan, B., & Rutty, G. N. (2011). Post-mortem imaging in forensic investigations: current perspectives. Clinical Radiology, 66(5), 459-465.*
6. *Thali, M. J., Yen, K., Schweitzer, W., Vock, P., & Dirnhofer, R. (2003). Virtopsy, a new imaging horizon in forensic pathology: virtual autopsy by postmortem multislice computed tomography (MSCT) and magnetic resonance imaging (MRI)—a feasibility study. Journal of Forensic Sciences, 48(2), 386-403.*
7. *ISFRI Guidelines. (2014). Standards for post-mortem imaging in forensic radiology and pathology. International Society for Forensic Radiology and Imaging.*
8. *Ampanozi, G., Grabherr, S., & Thali, M. J. (2020). The role of the radiographer in post-mortem CT: practical experience from a high-volume forensic imaging unit. Forensic Imaging, 20, 200347.*
9. *Grabherr, S., Grimm, J., Baumann, P., & Mangin, P. (2016). Advances in post-mortem imaging: PMCT, PMMR, and other imaging modalities. Forensic Sciences Research, 1(1), 3–9.*
10. *Baier, W., Warnett, J. M., Payne, M., & Williams, M. A. (2020). Forensic 3D printing from micro-CT for court use: process validation. Forensic Science International, 318, 110560.*
11. *Ebert, L. C., Thali, M. J., & Ross, S. (2011). Getting in touch—3D printing in forensic imaging. Forensic Science International, 211(1-3), e1–e6.*
12. *Baldi, D., Alfano, V., Punzo, B., Tramontano, L., Baselice, S., Spidalieri, G., ... & Cavaliere, C. (2020). A rare case of sigmoid colon carcinoma in incarcerated inguinal hernia. Diagnostics, 10(2), 99.*
13. *Agarwal, P., Ghosh, T. S., & Tripathi, M. (2021). Biosafety practices in handling post-mortem cases during COVID-19 pandemic: challenges and recommendations. Indian Journal of Medical Microbiology, 39(3), 369–375.*
14. *Grabherr, S., Gascho, D., & Grimm, J. (2022). Postmortem imaging in forensic medicine: present and future perspectives. Legal Medicine, 55, 102032.*

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