

Virtopsy in the Coming Era of Forensic Investigation: A Hope of Ray

Dr. O. Gambhir Singh

Professor, SRM Medical College, Potheri, Chennai, India

Email: [drgambhirsingh\[at\]gmail.com](mailto:drgambhirsingh[at]gmail.com)

Mobile No.9629047798

Abstract: *Though there are different types of autopsies, the most important and commonest one is the medic-legal autopsy which is conducted throughout the world mainly to determine the cause & manner of death. The gold standard method of doing it is the age-old practice of dissecting and opening all the major body cavities by giving multiple incisions. In contrast to this, in Virtopsy different radio-imaging techniques, computers & robotic techniques are used. It is more convenient and gives more accurate results in certain cases though it has certain limitations. In the future, this technique may replace the traditional autopsy technique as it provides a wide range and systemic examination of the whole body in less time duration. The present article is an overview of this latest technology in the field of Forensic Medicine & Science.*

Keywords: Autopsy, Virtopsy, Virtobot, Post-mortem computed tomography, Magnetic resonance imaging

1. Introduction

An autopsy may be defined as a specialized surgical procedure where a dead body is dissected and examined meticulously. The term was derived from the ancient Greek word "Autopsia", which consists of two words; "Autos" which means "Oneself" and "Opis" which means "To see".¹ It is also known as a post-mortem examination, 'Post' which means 'after' and 'Mortem' which means 'Death'. There are different types of autopsies and the one which is most commonly done is known as the 'Medico-legal autopsy'.² Medico-legal autopsy is conducted in cases of unnatural and sudden suspicious death to determine the cause of death, manner of death, time since death, etc. Here all the three major body cavities such as the skull, chest, and abdomen are opened and dissected for a thorough examination which causes mutilation of the dead body to a certain extent.

Some sections of society may not like this conventional method of examination.³

Without dissecting the dead body, the examination can also be done by using different radiographic techniques such as X-rays, Ultrasound, CT Scan, MRI, etc. This new idea of autopsy examination is known as 'Virtopsy'. This word has derived from the combination of two words 'Virtual' and 'Autopsy'.⁴ Some authors prefer the use of the term 'Digital autopsy' instead of 'Virtopsy'.⁵

With the passage of time, it is gaining more popularity, and post-mortem imaging is now considered a routine modality worldwide.⁶ Postmortem computed tomography (PMCT) imaging technique is most frequently used for a quick and complete examination of parenchymal tissues and skeletal systems. Postmortem Magnetic Resonance Imaging (MRI) is mainly used to study the brain and heart.⁶ The main aim of this review article is to discuss the suitability of the application of this new technology and its advantages and disadvantages.

History of Virtopsy:

For more than 100 years radiological techniques have been in use in the investigation of crimes. It was from the time of Professor Conrad Roentgen (who invented the X-ray) X-rays were introduced as evidence in a court, demonstrating a bullet in the leg of a person who was shot. In many cases, X-ray findings were used as evidence in a court of law.

In the late 1990s, in Switzerland, there was a demand for accurate forensic opinions in some high-profile murder cases. The impressions of the skull of the victim had to be matched with a most likely murder weapon. For this radiographic methods were used for the analysis of the victim's remains. This led to the birth of the concept of virtopsy. In one another theory, certain religious groups such as the Jews, Muslims, Jehovah, etc. don't want mutilation of the body after death, and this led to the birth of virtopsy.

Initially, the concept of virtopsy was developed by Prof Richard Dirnhofer, the former Director of Forensic Medicine, University of Berne's Institute of Forensic Medicine, Switzerland, in the mid-1990. The term 'Virtopsy' was coined by him.⁷ This technique was subsequently developed by Michel Thali and his colleagues at the University of Berne's Institute of Forensic Medicine, Switzerland.

Now virtopsy is practiced worldwide. It is widely adopted by many states in the countries like USA, UK, Malaysia, Japan, etc. In India for the first time Virtopsy table is established in AIIMS, New Delhi.

2. Imaging Techniques in Virtopsy

- 1) Three-dimensional surface scanning or computer-aided design photogrammetry: Here multiple three-dimensional photographs are taken for body surface injury analysis. It is now done with the help of Virtobot. This technique also enables post-mortem image-guided soft tissue biopsies.⁸ Virtomobile is a newer technique that is a portable version of Virtobot.¹⁰
- 2) Post-mortem computed tomography (PMCT): The post-

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mortem computed tomography (PMCT) technique is mainly used for the study of hard tissue & skeletal injury. In a dead body higher dose of radiation can be used and the body can be studied by taking even smaller multiple slices. It is widely accepted and practiced worldwide.^{10,11}

- 3) Post-mortem magnetic resonance imaging (PMMRI): This technique is more convenient for the examination of soft tissues like the brain & heart. This gives a more accurate result in certain cases in comparison to a traditional autopsy.¹²
- 4) When the technique of PMCT & PMMRI are used together is more convenient when there is a need for comparison between two adjacent tissues and this may give a more accurate result.¹²
- 5) Magnetic resonance spectroscopy: This technique is more useful when there is any change in tissue. It is done by using an MRI Scanner.¹³ It is very useful in the estimation of time since death.

Image-guided percutaneous biopsy & Postmortem angiography techniques are also used in Virtopsy.

Advantages of Virtopsy:^{14,15}

- 1) It can be used to enhance the quality of the traditional autopsy or even replace it in a few cases.
- 2) It is one of the best methods to provide observer-independent documentation in forensically interested findings.
- 3) It provides excellent tools for crime and accident reconstruction.
- 4) Injuries are recorded in three dimensions, true to scale, and thus help in the identification of possible crime weapons without disturbing the body architecture.
- 5) It can reproduce critical forensic evidence in an unbiased and comprehensible fashion, suitable for presentation as evidence to laypersons and legal professionals.
- 6) These digital data can be stored permanently and may be re-examined whenever a second opinion is required.
- 7) Infection & health hazards can be minimized.
- 8) Less time-consuming, the body can be released once the scanning is over.
- 9) Better acceptability by the relatives of the deceased as there is no incision.

Disadvantages of Virtopsy:¹⁴

- 1) It can't determine color changes and the color of internal organs.
- 2) Pathological conditions such as inflammations can't be ascertained and so very difficult to know the status of infection.
- 3) It is very difficult to differentiate ante-mortem wounds from post-mortem artifacts.
- 4) Small tissue injury may not be detected.
- 5) It's very costly and legally not accepted so far.

3. Discussion & Future Prospect

In a study conducted by Michael Thali and colleagues, it was observed that the findings of Virtopsy were almost consistent with those of traditional autopsy procedures.^{16,17} The comparisons were counter-checked for a number of forensically pertinent points like detection

of fractures, gas, foreign bodies, as well as tissue and organ trauma. Peter Vock, Director of Radiology, University Hospital Berne, pointed out that the results of the post-mortem radiology imaging are much better as there is no movement of respiration and circulation in dead bodies. This new technique is even superior to the traditional autopsy in detecting certain cases of cranial, skeletal, or tissue trauma. The timing of death can be determined by virtopsy using changes seen in both MSCT and MRI in head injury cases. In the case of an unknown dead body, positive identification can be established by performing a CT scan on an unidentified cranium and comparing multiple landmarks, and images with corresponding features in an ante mortem CT scan of a missing man.¹⁹

In cases of road traffic accident cases & other injury cases, forensically important findings can be well documented using postmortem MSCT and MRI. Similar findings were found in the clinical autopsy, which was performed after the digital autopsy.²⁰ In cases of burns also this technique is very useful to document the injuries caused by burns as well as the forensic relevant vital reactions (air embolism and blood aspiration).²¹ In firearm complicated cases, this technique is useful in the reconstruction of the injury.²² Increasing application of virtopsy in solving criminal investigations shows its acceptability and a bright future prospect in the coming era,

4. Conclusion

Different radiological imaging techniques are used in virtopsy. The future may even see the up rise of a milestone in routine Histology wherein Magnetic resonance microscopy in the examination of forensic tissue specimens shall emerge as Virtual Histology, a merging milestone together with Virtual autopsy thus depicting the merciful scientific milestone after death.²³ In the near future there is quite a possibility of virtopsy replacing the traditional method of the autopsy. In India also at least one Virtopsy center must be established in each state for conducting a high-profile medico-legal autopsy.

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