



VIRTOPSY: AN EMERGING TOOL IN FORENSIC INVESTIGATION

Dr. Devangi Dwivedi*	Assistant Professor, Department of Oral Pathology and Microbiology, Babu Banarasi Das College of Dental Sciences, Lucknow. *Corresponding Author
Dr. Deba Kumar Das	PG student, Department of Oral Pathology and Microbiology, Babu Banarasi Das College of Dental Sciences, Lucknow.
Dr. Ankita Singh	Associate Professor, Department of Oral Pathology and Microbiology, Babu Banarasi Das College of Dental Sciences, Lucknow.
Dr. Jiji George	Professor And Head, Department Of Oral Pathology And Microbiology, Babu Banarasi Das College Of Dental Sciences, Lucknow.

ABSTRACT

Forensic Odontology is the branch of forensic science that deals with identification of the deceased in cases of mass disaster, natural calamities, crime scene etc. Virtopsy can be used as an alternative to autopsy as it uses scanning and imaging technology to detect findings in corpses. It is a multi-disciplinary technology that combines forensic medicine and pathology, roentgenology, computer graphics, biomechanics, and physics. Virtopsy is rapidly gaining importance in the field of forensics.

KEYWORDS : Virtopsy, Scanning, Identification.

INTRODUCTION

Forensic odontology is an investigative process which involves application of dental sciences in identification of the deceased by comparing ante mortem and post mortem records.¹

Autopsy is the post-mortem examination and the term - Virtopsy is a combination of "virtual" and "autopsy."²

Autopsy is a highly specialized surgical procedure in where thorough examination of a corpse is carried out for determining the cause and manner of death and for evaluation of any disease or injury that may be present, whereas Virtopsy, uses latest radiological techniques such as computed tomography (CT), magnetic resonance imaging (MRI), and three dimensional (3D) imaging for examination of the dead bodies.³

It is also known as Post Mortem imaging. It is the examination of a carcass with modern imaging modalities and includes use of post-mortem computed tomography (PMCT) and post-mortem magnetic resonance imaging (PMMRI).⁴

Virtopsy is a method used for broad and systemic examination of the whole body as it is less time consuming and aids in better diagnosis, and renders respect to religious sentiments of people.³

Autopsy gives two dimensional view of a particular object while taking a photograph. A wound photograph will give position, length and breadth of the wound but it does not display the depth. Virtopsy at the same time provides a three dimensional view of the wound.²

Virtopsy has many advantages over conventional autopsy, like the fracture lines, primary and secondary trauma can be effectively visualized, and depth of the foreign body can also be localized. Also, there is no cadaver contamination.²

IMAGING TECHNIQUES APPLIED**3D SURFACE SCAN -**

Three dimensional view of the wound is important to understand the actual extent; and this can be done without mutilating the tissue.⁵

MULTI-SLICE COMPUTED TOMOGRAPHY (MSCT) -

MSCT is an imaging technique which captures serial images

with multiple rows of CT detectors and integrates them to form a single image. Minute details of soft tissue and bone injuries can be recorded effectively and fast.⁶

MAGNETIC RESONANCE IMAGING (MRI) -

It visualizes the interior of body for detailed data collection and records the condition of different organs. In MRI Spectroscopy, time lapse since death can be estimated after measuring the metabolites in brain which are produced during post-mortem decomposition.⁶

MICROTOMOGRAPHY-

This method is used to study the weapon involved and the injury patterns.³

3D FACIAL RECONSTRUCTION -

Human face is made up of numerous bones that are joined by sutures. Facial reconstruction can help recreate the facial morphology using bony remains of the deceased. The first facial reconstruction was reported in 1895. When conventional identification methods are not beneficial, facial reconstruction methods plays a significant role. In 1946, five parameters were categorised i.e. the relation of eyeball to orbit, the shape of nose tip, the location and length of the ear and the width of the mouth which gives an accurate image of any distorted cadaver and helps in its identification. Facial reconstruction is therefore, the best tool for producing images that are a close approximation of what a face may have looked like in life.⁷

PHOTOGRAMMETRY BASED 3D OPTICAL SCANNING USING THE GOM TRITOP/ATOS 2 SYSTEM -

3D optical scanning is a method used for 3D photogrammetry documentation and measurements in prototyping and design technology. This is a high precision technique that can document not only the finer details of structures like skin or an instrument to complete documentation of the whole body or entire vehicle.⁸

POST MORTEM CT ANGIOGRAPHY -

It helps to visualize the cardiovascular system and detects minutest injuries to the blood capillaries which are often missed in the conventional autopsy. Contrast will be seen as spillage and any injury to a vessel will be visible in the CT images.⁹

POST MORTEM BIOPSY-

For assessment of pathologies, a biopsy needle or gun may be

used. This can be used when some tumour or lesional tissue has to be studied.¹⁰

MAXIMUM INTENSITY PROJECTION (MIP) -

It is a quick imaging procedure that can assemble a radiographic model of the dead body in few minutes.¹¹

PROCEDURE

Virtopsy is an amalgamation of the advancements in 3D imaging strategies and 3D surface scanning which aids in developing a 3D picture of the body surface in detail.¹²

First step in virtopsy is scanning the body surfaces: both internal surfaces and externally. In the preparatory phase small discs are placed alongside the body at predetermined points. To avoid human error while placement of the. The robot moves over the body & creates the 3D image in 10 seconds.¹³ aforementioned discs, an automated machine called 'Virtobot' can be used. The X-rays will pass through these discs, the details of which can be integrated to form a single 3-D color model of the corpse. Stereoscopic cameras (resolution of 0.02 mm) are used to capture the color image and projector is used to cast a virtual mesh pattern on the body. The robot moves over the body and creates the 3D image in 10 seconds.

Once the surface scan is completed, the body is secured inside a blue bag which allows X-rays to pass. The sack will stay shut while the body is subjected to a CT scan which in 20 seconds records up to 25,000 images. These serial images give a layer by layer information of the body without surgically opening it up. Any tumours, bone fractures, internal bleeding etc can be easily visualised using a CT.¹²

Following this stage, the corpse is exposed to MRI and MRS filters. MRI machines use magnets and radiowaves to record details of joints, brain, wrists, ankles, breasts, heart and blood vessels. Software programs and graphic processors are used to combine the data, in a short interval of 10 minutes. Soft and hard tissues as well as metallic objects (such as bullets or implants) absorb the scanning rays in a differential manner, which aids in a 3-D visualization. The density differences are standardized in a colour gradient with blue for air pockets, beige for soft tissues, red for blood vessels, and white for bones.¹⁴

3D Forensic Facial Reconstruction, is a fast, efficient and cost effective computer aided method where 3D animation softwares (Free Form Modelling Plus, Sensable Technologies, Wilmington MA) are used to model the face onto the skull whereas other systems use virtual sculpture system with Haptic feedback (Phantom Desktop Haptic Device; Sensable Technologies). During analysis, Haptic feedback system can feel the surface of the skull and give important skeletal details for facial reconstruction like muscle attachment strength, position of eye, position of malar tubercle etc. By using this method, multiple images of the same face can be efficiently recreated.¹⁵

PRACTICAL APPLICATION

The role of virtopsy in forensic science, cannot be ignored as it has a lot of advantages over conventional autopsy in examining the dead. When a human being dies in mysterious circumstances or is a part of a natural or manmade disaster, a need arises to evaluate the reason behind the death. Conventional autopsy procedures need a lot of manpower which brings to the fore, the role of whole body imaging and virtopsy. Minutest details from manually inaccessible areas can be obtained with ease using the virtual method. The spine, pelvis, and limbs, can be examined in detail without any body mutilation. It can be used to determine the cause of death, in mass disasters, anthropological examinations, skin lesion analysis and in examination of burned or charred bodies. It

can be used in dental age estimation or gender identification in difficult forensic cases as well as to identify body length and individual decedent features or distinct foreign bodies like retained bullets, blades or injuries and forensic three-dimensional reconstructions.^{6,14,16,17}

Virtopsy can be used in medicine and historical research. While examining Egyptian mummies, the content of sarcophagus can be determined without extracting or unbandaging the mummy. Use of non-invasive radiological methods, can prevent risk of damaging its conservation. CT evaluation of oral structures of mummies provided the insight of dental status and oral diseases of the Egyptian mummies. Low caries susceptibility and indications of periodontitis were noticed that perhaps relate to the lifestyle of Egyptians. In addition this technique also helps us understand, the materials that were used to embalm these bodies.¹⁸

Covid-19 pandemic blatantly exposed the shortcomings of health care systems around the world. While doctors were busy treating the dead, there was acute shortage in personnel to perform autopsies in COVID 19 related deaths. The risk of viral transmission from a corpse to the autopsy performing personnel was also an added scare. In addition to medico legal cases, autopsies should be mandatory in covid suspected deaths to study the type of damage Sars COV2 virus unleashed on lungs and other organs. 'Virtopsy' has been suggested as an effective alternative to these high-risk traditional autopsy procedures. The recent pandemic has further highlighted the need to use virtopsy in place of conventional autopsy techniques.¹⁶

CONCLUSION

Traditional autopsy has its own importance on the postmortem table and so does virtual 3D image of a decomposed body, as it helps to maintain the privacy of a deceased person and end the last chapter of life with dignity.¹²

More research needs to be done on the virtual autopsy, showing the benefits of the virtual approach, and overcoming difficulties the virtual autopsy may present. All autopsy outcomes can be achieved individually by virtual imaging technology thus becoming a "gold standard" of autopsy approaches.¹⁹

REFERENCES

- 1 Preethi S, Einstein A, Sivapathasundharam B. Awareness of forensic odontology among dental practitioners in Chennai: A knowledge , attitude, practice study. *J Forensic Dent Sci* 2011; 3:63-6
- 2 Vadivel JK. Virtual autopsy. *Int J Forensic Odontol* 2016; 1:14-6
- 3 Tejaswi KB, Hari Periya EA. Virtopsy (Virtual Autopsy): A new phase in Forensic Investigation. *J Forensic Dent Sci* 2013; 5: 146-8
- 4 Kot B.C.W, Fernando N, Gendron S, Heng H.G., Martelli P The Virtopsy Approach : Bridging Necroscopic and Radiological Data for Death Investigation of Standard Cetaceans in the Hong Kong Waters 2016 in Proceedings of the 47th International Association for Aquatic Animal Medicine Conference (Virginia Beach, VA)
- 5 Biswas UK, Hossain MA, Moinuddin KM, Khan NT. Virtopsy: New Dimension in the Field of Forensic Medicine communities. *Journal of Z H Sikder Women's Medical college* 2021; 3(1): 32-33
- 6 Singh A, Ahemd S, Sah K, Singh S. Virtopsy lends dignity to lazarus. *Int J Oral Health Dent* 2019; 5(2):76-80
- 7 Sharma D, Koshy G, Garg S, Sharma B, Grover S, Singh M. Oral Autopsy , Facial Reconstruction and Virtopsy-an Update on Endeavors to Human Identification. *RUHS Journal of Health Sciences* 2017; 2 (4): 199-206
- 8 Thali MJ, Braun M, Buck U, Aghayev E, Jackowski C, Vock P, Sonnenschein M, Dirnhofer R. Virtopsy- scientific documentation, reconstruction and animation in forensic : individual and real 3D data based geo-metric approach including optical body/object surface and radiological CT/MRI Scanning. *J Forensic Sci* 2005; 50(2): 428-42
- 9 Kumar R. Virtopsy complementing traditional autopsy. *IP International Journal of Forensic Medicine and Toxicological Sciences* 2020; 5(2): 39-42
- 10 Saini M, Pandey SK. Virtual Autopsy- An overview and use in the diagnosis of drowning. *IOSR Journal of Dental and Medical Sciences (IOSR-JDMS)* 2020; 19(9) : 44-53
- 11 Rai S, Misra D, Tyagi K, Prabhat M, Ganwal P. Image Guided Virtual Autopsy: An Adjunct with Radiographic and Computed Tomography Modalities- An Important Tool in Forensic Identification. *J Indian Acad Oral Med Radiol* 2017; 29: 368-70
- 12 Badam RK, Sownetha T, Babu DB, Waghayray S, Reddy L, Garlapati K, Chavva S. Virtopsy: Touch-free autopsy. *J Forensic Dent Sci* 2017; 9:42.

- 13 Gupta S, Gupta R, Singh VS, Dhingra V. Virtopsy- A New Innovation for Forensic Science . *Journal of Forensic Chemistry and Toxicology* 2015; 1(1): 43-46
- 14 Satish S. Virtopsy: The Digital Era of Autopsy. *Indian Journal of Forensic Odontology* 2018; 11(2): 69-73
- 15 Gupta S, Gupta V, Vij H, Vij R, Tyagi N. Forensic Facial Reconstruction: The Final Frontier. *J Clin Diagn Res* 2015; 9 (9) : ZE26- ZE28
- 16 Kanchan T, Saraf A, Krishan K, Misra S. The advantages of virtopsy during the Covid-19 pandemic. *Medico-Legal Journal* 2020; 88: 55-56
- 17 Iwase H, Yamada Y, Ootani S, Sasaki Y, Nagao M, Iwadate K, Takatori T. Evidence for an antemortem injury of a burned head dissected from a burned body. *Forensic Science International* 1998; 94: 9-14
- 18 Gerloni A, Cavalli F, Costantinides F, Bonetti S, Paganelli C . Dental status of three Egyptian mummies: radiological investigation by multislice computerized tomography. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod* 2009 jun; 107(6): e58-64
- 19 Rizzo A. Autopsy and Religion : Aiding Forensics, Medicine, and Families with the Virtual Autopsy. *Journal of Emerging Forensic Sciences Research* 2019; 4 (1): 31-42