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Traditional Autopsy to Virtopsy: A Novel Approach in Forensics

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Abstract

In a time when non-invasive and minimally intrusive techniques are ushering in medical advancements and health science technologies, Necrological analysis is not exempt from this trend. Autopsy (post-mortem) is a procedure that involves a thorough examination of the demise observing everything associated to anatomy, surface wounds, histological studies. Virtopsy is a term derived from two words "virtual" and "autopsy." It involves imaging techniques that are regularly used in clinical medicine such as computed tomography and magnetic resonance imaging to find the reason for death in the process of autopsy. Virtual autopsy is done with the help of imaging technologies with more sophisticated instruments thus minimizing the mutilation of the dead body. The standard internal autopsy approach involves corpse mutilation methods. Virtopsy is a comprehensive technology that combines forensic medicine pathology, radiology, biomechanics, and physical studies. It is rapidly securing importance in the department of forensics. It holds an abundance in the future of forensics to deliver justice. The review mainly deals with advantages of virtopsy over traditional autopsy.

Keywords: Autopsy; Virtopsy; Anatomy; Computed tomography; Magnetic Resonance Imaging.

INTRODUCTION

Death, the ultimate fate of every human life is a process where complete and irreversible top page of the three bodily functions that is circulation, respiration, brain function occurs (Bishop's tripod of life). According to Section 46 IPC: Death means death of a human being except opposing appears from the context. Registration of Births and Deaths Act Section 2(b) defines death as a permanent disappearance of all evidence of life at any time after live birth has taken place.[1]

Every death deserves an investigation to obtain any information about the cause of death; therefore the dead body should be subjected to post-mortem examination. Usually death with doubt of foul play is the one that is put in to a post–mortem examination. Autopsy is derived from a Greek word "autopsia", which means "seeing for oneself". An autopsy is a very important tool which includes a thorough external examination as

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well as dissection of organs from the different body cavities-cranial, thoracic, abdominal and pelvic. It is made by using a scale, rulers, autopsy saw, scalpels, biopsy needles, camera, etc. Forensic pathologists are the one who perform autopsy of a dead body. Forensic pathology has developed an important part of today's crime investigation. With advanced technology and science, Forensic pathology delivers vital evidence. Thus Forensic pathology is a division of medicine that applies the principles and knowledge of the medical sciences to problems in the field of law.[2] Forensic autopsy or Medico -legal autopsy is executed following instructions of legal authority in unexpected, suspicious, doubtful, unnatural or criminal demises. The most important features of medico-legal post-mortem are that it must be correct and complete. The pathologist must recognize, preserve physical evidence (which would undergo further examination), interpret it in the court of law on the basis of testimony. Virtual autopsy is done with the help of imaging technologies with more sophisticated instruments thus minimizing the mutilation of the dead body.

Although it is a very valued tool, the use of it is declining globally. Even though new imaging techniques are helpful, an autopsy is still very appropriate. It is fairly cheaper, could be accomplished in almost all major hospitals and its results could be easily interpreted.

Alternative aids were developed to find the cause of death. Radiography has been in use in Forensic Medicine for the last 120 years. In radiography, the body is examined by exposure to X-rays, structures exposed to the beam are projected out on to a radiographic image. The image is consists of different tones of black and white, due to the distinct absorption properties of body structures. Instantly after the discovery of X-rays in 1895 by Roentgen, they were employed in post-mortem investigations, mainly in anthropology. Its use for medico-legal purposes started in 1896. Martin and Arrorio showed that the post-mortem radiographic techniques can be used to compare the cranial sinuses, thus leading to identification of the bodies. X-ray examinations were done in many cases where liver, heart, brain, bone injuries were examined in order to know the cause of death. More specifically it is used to detect the healing bone fractures which will not bedetected by traditional auto psymethods. Radiography is easy to perform, fast and less expensive and thus is regularly used for child corpses, highly putrefied bodies or bodies of unidentified.

Post-Mortem Magnetic Resonance Imaging (PMMRI) is still underutilized in Forensic pathology, even though it is a prevailing tool in Forensic radiology. MRI offers high 3-Dresolution as well as exceptional soft tissue contrast. It is used by several institutions for investigation in cases of child abuse, natural death, traumatic soft tissue injuries, etc. Even though MRI is used for inspecting the inside of a corpse, it is not widely used in contemporary Forensic imaging because of its low availability, time consuming, complex and expensivenature.[3]

Post-Mortem Ultrasonography in pathological background helps to identify manner and cause of death.[4] In Ultrasonography autopsy or echopsy samples are obtained under ultrasonography control. It is considered to be a safer alternate to risky post-mortem measures, especially in infectious diseases. Post-Mortem ultrasound scanner is simply accessible and reasonably priced than other cross-sectional imaging modalities.

Virtual autopsy is being followed in Switzerland, Malaysia, Sweden, Germany, Japan and they are in process of getting judicial validity. In India virtopsy is still not developed. Since it is a non-destructive technique, it could be used in cultures where autopsy is not tolerated by religions, in case of charred bodies, road traffic accidents, etc. Although it has certain drawbacks like cost, equipment, availability of experts to handle the instrument, collection of organs for pathological and chemical examination, it can be employed as an aid to traditional autopsies for broad and systemic examination.[5] The purpose of this project is to understand the development of different methods of autopsy and the emergence of Virtopsy in the field of Forensic Science, thus providing an aid in investigation leading to justice.

DIFFERENT METHODS FOR AUTOPSY

Traditional Forensic Autopsy

Autopsy involves detailed and extensive external and internal examination of the deceased body. Internal examination involves examining the following:

- Clothing on the body (type of garment, its colour, size, manufacturers label, logos, loss of buttons or disarrangement indicating a struggle, etc are described).
- Belongings over the body (like ornaments /Jewellery, it's type, colour, design etc) are listed.

- Nail scrapings should be taken and vaginal and anal swabs are collected in cases of sexual assaults.
- Height and weight, general state, body build, etc are listed.
- General descriptions like age, sex, stature, race, scars, miles, tattoo marks, any deformities, etc. are noted.
- Any abnormal stains like blood, semen, mud, sand, colour change, faecal matter, foreign bodies etc. present over the body are examined and listed down.
- State of natural orifices are noted. E.g., ear, eye, mouth, nose, vagina, etc.
- Condition of the eye (includes conditions of pupils, eyelids, opacity of cornea, etc) is to be noted.
- Position of limbs particularly arms, hands and fingers are noted. Presence of signs of any disease is noted. E.g., Oedema, skin disease, etc. External wounds: their nature, cause, site, length, breadth, condition of edges, presence of foreign matter, etc. are noted. Good colour photographs of the wound or injury are useful to preserve its appearance. Identify whether the wound is ante-mortem or post -mortem.
- Are port must be made of all the articles removed from the body. E.g., Clothes, ornaments, etc. They are categorized and handed over to the police constable.
- Evidence of any surgical procedures are noted down in the report so that if any discrepancy arises the can doctor can show this to make the necessary changes in the inquest report

There are certain guidelines which are to be followed while conducting an autopsy:

The dead body should be labelled properly, autopsy should be conducted by the medical officers after reading the inquest report. It should be conducted in a mortuary (exception body in case of advanced state of decomposition) only under an official order from the policeor magistrate in daylight hours. Autopsy reports should not be issued to the party. Traditional Forensic autopsy is an extensive invasive technique leading to mutilation and disFigment of the body. It requires time and workforce and is conducted only during the daytime in limited hours. Exposure may lead to contamination of the carcass. While interpreting the findings among different examiners by this method, there can be subjective errors.[6]

X-Ray Radiography

X-rays are a form of electromagnetic energy formed when high-speed electrons bombard a tungsten anode target. They have a much shorter wavelength than visible light, allowing the mtopenetrate the matter and exhibit properties of both waves and particles.[7] The body is composed of tissues containing many different elements, which vary by atomic number (the number of protons present in the nucleus of an atom). Thus, there will be differences in the body tissue densities, which is what in turn allows us to see inside the body by creating a shadow gram. The higher the atomic number, the denser the element and the more effectively X-ray is blocked. Therefore specific shadows of internal body structures become visible because they contain varying types of elements.

Example

1. When X-ray strikes the calcium in the bone, it is blocked and on the radiographic image the bone will appear white.
2. When an X-ray strikes an element like nitrogen (present in the air contained in the lungs) it passes all the way through and lungs will appear darker, approaching black on the radiographic image.

In case of fractures in bone, the fracture line will be dark while the intact bone will remain white.[7]

Post-Mortem Magnetic Resonance Imaging

Post-Mortem Magnetic Resonance Imaging is works on the basis of Nuclear Magnetic Resonance (NMR).[3]

A MRI machine may use a fixed magnet (has lower field strength, used in open MRI) and a superconducting magnet (has higher field strength, use dinclosed MRI). Another important tool is surface coils, which is an antenna that fits closely around the body part to be examined and it increases the radio frequency signal produced by the body.[7]

Magnetic Resonance Imaging does not contain ionizing radiation. It offers high spatial resolution and good visualization of soft tissue, organs, and vascular wall. MRI eliminates overlapping shadows, which is a problem in case of X-rays.

MRI is a time consuming method which requires specific architectural construction (3D

reconstructions need special sequences). It is very difficult to handle, has high maintenance costs and less data storage. Proper training should be provided to the technicians for correct interpretations.

It is mainly used in cases of child abuse, death due to strangulation, blunt trauma, sharp trauma, medical errors, and death after surgical interventions, to identify the unknown deceased body. It is also used to detect the foreign bodies and estimate the age of the deceased body.[3]

VIRTOPSY

Virtual autopsy, anon-invasive technique of post-mortem examination is carried out primarily to find the reason behind death and give an opinion about the deceased person.[5]

Virtopsyincludes:

- Computed Tomography, Magnetic Resonance Imaging and micro-radiology for assessment and analysis of body volume
- 3D optical scanning and Forensic photogrammetry for 3D body surface imaging.[6]

Virtopsy is a scalpel free method, which gives a 3D illustration of the corpse. It is an observer in dependent method, thus giving more precise results. Certain body are as like pelvis or neck which are not properly exposed in traditional Forensic autopsy can be visualised by Virtopsy.

Expensive operation, non-availability of instruments and expertise in remote areas are one of the major demerits of Virtopsy. Collection of organs for histopathological examination and chemical analysis, differentiating ante-mortem and post-mortem injuries, detecting fat embolism is difficult. Smell of the tissues, rigor mortis, livormort is cannot be appreciated and collection of evidence in firearm injury cases is not possible. Also, it has not yet received judicial acceptance.[5] It is used in cases of mass disasters, age estimation, drowning deaths, dentistry, traffic accidents, differentiating of tissue damage, tissue emphysema in strangulation cases, etc.[8,9]

DISCUSSION

Malizia et al. (2020) - The paper describes carrying out post-mortem examination by virtual autopsy technique in cases of emergencies, thus reducing the risks of operators. The COVID-19 pandemic has been the cruelest epidemic emergency in the recent past. Italian National Institute of Health and other institutions have advocated the limitations of traditional autopsy and have supported the practice of modern technique, that is Virtual autopsy by PMCT and percutaneous biopsy (minimally invasive technique) which can be used for analysis of suspected or confirmed SARS-COV-2 deaths, in order to reduce the risk of infection and increase the quantity of data available to perform the investigation properly. The virus mainly attacks the upper respiratory tract, lungs, and kidney. In 2007, the Swiss group became the pioneer in the Virtopsy field. PMCT angiography has been introduced in the virtual autopsy as a corresponding technique to give information regarding non-decomposed bodies.[10]

Lakshmi Shree & Ram (2019) - The paper explains about an investigative technique for Forensic identification, that is, Virtopsy. In order to solve a medico-legal case, a Forensic autopsy has to be performed. In the study, a series of suicide rates autopsy cases were analysed and the manner of death was classified as undetermined after complete investigation. 48 cases were examined among which in 23 cases death was determined. In undetermined investigations, there were wide ranges of homicidal conditions too. 3-D MDCT data will reduce the uncertainty of bullets entry and exit wounds thus providing proper information about bullets depth, angle of fire which will help in investigation of the case. The image obtained by CT (gray scale) is pre-processed and then segmented by Otsu's thresholding technique to get binary image as output. The binary image is normalized by morphological operations to calculate the volume area of gunshot region. On the basis of the maximum peak pixel region in the output, identification of the depth of bullet is possible. Thus, Virtopsy using maxillofacial imaging provides a new tool for forensic identification as well as favours the development of Virtopsy for Forensic purpose.[11]

Aggarwal et al. (2019): The paper aims to describe the implementation of a new technique in Forensic Medicine, that is the Virtopsy. The various imaging techniques included in Forensic imaging are Computed Tomography, Micro-Computed Tomography, Magnetic Resonance Microscopy, Magnetic Resonance Spectroscopy. Virtopsy provides a 3D view of the cadaver. Virtibot, the robotic machine, helps in accomplishing the task. Virtopsy is less feasible in underdeveloped and developing countries, since here the pathologists

lack the senses like touch, feel, smell, etc. Presently, Armed Forces Medical Examiner of Washington, the Institute of Forensic Medicine from Denmark, the Victorian Institute of Pathology (Australia) have implemented the use of CT scanning technique. If all the countries try to adapt to this Virtopsy technique it will really be amile stone in the field of Forensic Science.[12]

Chandru (2019): The paper explains about Virtopsy, the emerging trend in Forensic Medicine and how it is used against traditional post-mortem examination. Virtopsy involves various techniques: 3D photogrammetry, 2D and 3D imaging is done with MSCT. In 1980, one of the first documented virtopsies was conducted in University hospital Mainz, Germany where 105 specimens of stillborn and live born babies were studied. Virtopsy is being practised in some of the developed countries (Switzerland, Japan, Sweden) and is considered as a replacing method or an aid to traditional Forensic autopsy. Although Virtopsy uses various modern radiological techniques, it has its own limitations also and is thus considered as an incomplete autopsy. Virtopsy, a non-destructive method, which has high social acceptance (in cases where traditional autopsy is against religious beliefs) has not received judicial validity yet and thus conventional autopsy remains the gold standard for post-mortem examination in medico-legal cases. Hence, Virtopsy cannot be replaced completely by traditional invasive autopsy methods, but can be an adjuvant for it.[5]

Cirielli et al. (2018): The paper focuses on virtual autopsy methods which should be performed as a screening test before traditional autopsy in traumatic cases. This was explained with the help of a study of 25 post-mortem cases (from March 2011 to February 2015) which underwent CT scanning with Philips Brilliance CT-64 at radiology unit prior to traditional autopsy. The images acquired from CT scan in DICOM format were sent to the iGene company which rendered the images using their INFOPSY®, iDASS™ system software (for 3D visualization). Traditional autopsy was carried out by other Forensic pathologists for toxicological screening and histopathological examination. The number of causes of deaths in various cases was compared among MDCT and conventional autopsy. In 65% cases, the results of Virtopsy and traditional autopsy matched, whereas in 35% of the cases conducting standard autopsy was mandatory to find the reason behind death. In 9 cases of traumatic death, digital data was sufficient to know about the cause and manner of death. This Virtopsy method was more valid in cases of traumatic deaths when compared to any other cause. Hence, it can be understood that Virtopsy can be used as an alternative diagnostic tool for post-mortem investigation.[13]

***Badam et al. (2017)*:** The paper describes Virtopsy, a touch-free autopsy technique which is being carried out nowadays in order to establish the reason behind and manner of death in medico- legal cases. Virtopsy, a multi-disciplinary technology is gaining much importance in the field of autopsy. The various tools and the detailed procedure in the process of Virtopsy is explained in the paper. Virtopsy gives promising results in cases of: estimating time of death, identification of missing persons, drug abuse case, and road traffic accident, cardio respiratory failure from non-traumatic origin, hanging / manual strangulation, death due to burns, age and sex determination of the deceased. Although traditional autopsy has its mark on the post-mortem table, virtual autopsy also does the virtual 3D image of the dead body and is a developing technology which lends future advancement in Forensic Science due to its own advantages.[14]

CONCLUSION

Introduction of Virtopsy is a path in Forensic practise. It is a non-destructive, observer in dependent and time-efficient method, where the data stored in the workstation can be used for future purpose. Since it involves 3D reconstruction, without causing any harm to the cadaver, it is considered as a better link between the case and the evidences. Although traditional method of autopsy has already set its benchmark in the field of Forensic medicine, the modern technique of Virtopsy proves to stand along with it. It is being carried out among various developed countries and is on its way of getting judicial acceptance. Even though, Virtopsy has few limitations (high cost, is used in selected cases, etc.), it serves as an adjuvant, rather than being a complete substitute for the conventional method. It has to be implemented in all countries, especially among those communities where traditional autopsy is considered as a bane and should be made a prerequisite to traditional autopsy in every case. In order to bring into light the reason behind the cause of death and improve the justice rate both methods should be carried out hand in hand. This novel multidisciplinary approach has become a milestone in Forensic Science which will definitely help to attain and

regulate a proper balance in the criminal justice system.

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