

POST-MORTEM EXAMINATION:-COMBINING CONVENTIONAL AUTOPSY TECHNIQUE WITH VIRTUAL AUTOPSY- CONCERTED EFFORT BY THE DEPARTMENTS OF FORENSIC MEDICINE & TOXICOLOGY AND RADIOLOGY

Dipayan Deb Barman, *Assistant Professor*
Vijaya Kumar Nair G, *Professor and HOD*
Department of Forensic Medicine and Toxicology,

Sri Balaji Vidyapeeth, Sri Sathya Sai Medical College and Research Institute
Pillaiyarkuppam, Puducherry - 607403, India

Email: drvkng@gmail.com

Abstract ► Obesity is linked to a variety of metabolic disorders, such as insulin resistance and atherosclerosis. The increased incidence of obesity has led to rise in interest in the biology of white adipose tissue (WAT). The tissue is no longer considered as a passive fat storage tissue but is a key endocrine and signaling organ secreting a multiplicity of protein factors called adipokines. In obesity, there is an enhanced secretion of a number of adipokines underpinning the role of inflammation in white adipose tissue towards the development of obesity and associated diseases. There is a substantial evidence, particularly from animal studies, that hypoxia develops in adipose tissue as the tissue mass expands in obesity, and the reduction in PO₂ is considered to underlie the inflammatory response. The cells present within the WAT respond to hypoxia, by inhibiting the differentiation of pre-adipocytes to adipocytes and instead being transformed into leptin-secreting cells. The dynamic change found in the adipose tissue can be referred to as “adipose tissue remodeling,” in which stromal cells change dramatically in number and type during the course of obesity. Among stromal cells, infiltration of macrophages in the adipose tissue precedes the development of insulin resistance in animal models, suggesting that they are responsible for obesity-related adipose tissue inflammation. Understanding the molecular mechanism underlying adipose tissue remodeling may lead to the identification of novel, therapeutic strategies to prevent obesity-induced adipose tissue inflammation.

Key Words: Adipose tissue, Obesity, Hypoxia, Macrophage infiltration.

Introduction

Autopsy procedures have become increasingly challenging in modern days due to the evolvement of newer methods of crime and unknown pathological conditions which could be the putative cause of death. This paper is an attempt to explore the scope of collaboration between departments of forensic medicine and radiology in the field of virtual autopsy. Exploration of body cavities which is done during conventional autopsy sometimes faces resistance due to the social, customary and religious issues. The term, “Virtopsy” came from the

term virtual autopsy which means autopsy carried out using modern medical, imaging and measuring technology. Virtual autopsy or digital autopsy is a new radiologic technique that uses a combination of post-mortem multi-slice computed tomography (MSCT) and magnetic resonance imaging (MRI).

The advancement of MSCT and MRI technology with improved contrast and resolution technique as well the options for 2D and 3D reconstruction, provides an observer-independent, objective and reproducible forensic assessment. Minimally invasive forensic autopsy with the aid of imaging technique can look deeper and precise inside the body cavity with three

dimensional views, which provides all the information like position and dimensions of the wound, including other pathological conditions in the body.

Historical aspects of virtual autopsy

Richard Dirnhofer, former Director of Forensic Medicine University, Berne, Switzerland, was credited for the development of this excellent technology. His work was carried on further by Michel Thali and his colleagues at the University of Berne's Institute of Forensic Medicine, Switzerland. Michel Thali, forensic pathologist and project manager for Virtopsy, says that, "when an autopsy is done it destroys the 3-D geometry of the body"¹.

Imaging modalities used in a virtual autopsy

Before discussing the imaging modalities used in virtual autopsy we have to understand the limitations of doing a conventional autopsy. In a conventional autopsy the external injuries are noted and photographs are taken to compare them later with the findings observed during the dissection of the body. Photographs even though can give an excellent idea about the type of injury, their location, approximate size, and nature (simple or grievous) of injury; it has the limitation of being only 2D. In the context of size of a wound, especially in stab wounds, which are caused by sharp pointed instruments or weapon like knife/dagger and firearm wounds it sometimes becomes impossible to establish the actual depth and track of a wound. In case of gunshot wounds, which forms a track inside the body, the chance of creating a false track sometimes becomes inevitable if the person doing the procedure is not aptly skilled. In India where there is a lack of forensic medicine experts, most autopsies are performed by MBBS doctors, which can be a factor in inaccurate findings that hampers with justice.

Virtual autopsy employs a combination of the medical imaging technologies and as well as technology which is used in other fields of science such as:

- 3-D surface scan which is used in the automobile designing can be used to map the exterior of the body. It provides and documents the three dimensional image of the body surface area in details
- Multi-slice computed tomography(MSCT)
- Magnetic Resonance imaging

Both MSCT and MRI technique can give excellent and accurate view of the interior of the body. Histo-pathological samples can be accurately obtained from the body using CT guided biopsy technique. The condition and pathologic findings of different organs can be seen and understood in depth using these techniques. The body can be examined slice by slice in the desired plane according to the need. The time since

death can also be estimated using MRI with spectroscopy by measuring the metabolites in the brain during the process of post-mortem decomposition of the body. Examination of the heart is vital in every autopsy to rule out any cardiac cause of death, especially in cases like sudden cardiac death in a young individual without any documented history of cardiac disease. It may not be possible to study the cardiac muscle pathology during a conventional autopsy and hence 3-D angiography technique is used to confirm or refute any underlying coronary artery disease²⁻⁴. In case of any injury to the blood vessel, there will be spillage of dye to the surrounding tissues, making it visible in the CT images.

Comparison of the advantages of virtual autopsy over conventional autopsy

In more than 100 virtual autopsies performed by Michel Thali and colleagues^{4, 5} the results were comparable with those of conventional autopsy. Various forensically pertinent parameters were considered during the comparison such as presence of fractures and foreign bodies, as well as tissue and organ trauma. While performing post-mortem angiography and biopsy procedures, Michel Thali and colleagues observed that in cadavers where there is no respiratory movements and cardiovascular activities, the results were much better. MSCT images provide information about the general pathology of the body and can give detailed information about trauma or injuries. MRI on the other hand is used to focus on specific areas of the body, providing details about soft tissues, muscles and organs. Digital autopsy provides a 3D geometric documentation of injuries on the body surface and internal injuries in the living as well as in deceased cases. Surface scanner is the means for measuring and depicting the images in 3-dimensional views with precision. The body is scanned in all angles using a sensor which takes pictures using two cameras. The computer then gives image of the body in three dimensional views which can be rotated as per requirement without any distortion for collection of the findings. In case of gunshot injuries where sometimes traditional autopsy may not yield very subtle findings, the use spiral CT and MRI examinations with the subsequent 2D multi-planar reformation and 3D shaded surface display reconstruction, the entire gunshot created complex skull fractures and brain injuries (such as wound channels and deeply-driven bone splinters) could be documented in complete and graphic detail. Thali *et al.*, in their study by fusing CT and MRI found vital reaction to gunshot seen as air emboli in the heart and blood vessels and the classic pattern of blood aspiration to the lung. Gunshot residues deposited within and under the skin were visible using imaging modalities⁶.

According to one study by Plattner it was reported that in a case of virtual autopsy in a death due to

drowning, massive vital decompression with pulmonary barotraumas and lethal gas embolism were identified in the radiological images. In this study, MSCT and MRI were found superior to conventional autopsy in their ability to demonstrate the extent and distribution of gas accumulation in intra-parenchymal blood vessels of internal organs as well as in areas of the body⁷.

A rapidly evolving facility in the western countries is digital mortuary. The concept of digital mortuary is a novel one where the digital morgue stores the body structure of each case as a 3D data set consisting of sectioning planes of the whole body obtained from MSCT or MRI figures. According to Takatsu *et al.*, a retrospective observation with a detailed quantitative analysis of the structural damage of the body has become possible using very high dimension medical imaging and medical virtual reality⁸.

Foetal autopsy is another important area, where in addition to conventional autopsy, the application of virtual autopsy can yield valuable and accurate results. However there is a decrease in number of peri-natal autopsy and importantly, a large majority of parents often refuse to give their consent to perform autopsy because of concerns about disfigurement of their deceased child during the procedure^{9,10}. The reasons justifying the autopsy, with the need to know the cause of death or the identity of an unknown deceased individual overrules this emotional involvement. Therefore, the families and relatives of the victim often remain in a conflicting situation with the forensic examiners on whether to give permission or not¹¹.

In virtual autopsy, an interdisciplinary approach by a team comprising of a radiologist, forensic pathologist and pathologist is required so that the findings of the conventional autopsy can be coupled with virtual autopsy and this can be analyzed, stored in the form digital data and will later be reported in

the same database and specified according to the ICD-10. The risk of infection to autopsy surgeon and staff always exists in a conventional autopsy. Nowadays, with emergence of newer and deadly infections coming, it very hazardous doing a conventional autopsy as the infectivity from the body is always unknown and infection can easily spread from a fresh dead body as well as a highly putrefied body. Virtopsy is a much safer procedure that does not involve any blood-shed or exposure to contaminated body fluid. The main advantage of virtopsy is visualization of 3D anatomical structures thoroughly, in real time, without damaging the body¹².

However in comparison to the conventional autopsy virtual autopsy has some disadvantages. Rügger *et al.*, in their study found that in imaging based autopsy, the tissue for microbiological and histopathological examination cannot be collected, which may result in poor accuracy of MRI, since infection may be a primary cause of death¹³.

Conclusions

In the era of scientific advancements where progress is happening by leaps and bounds in order to solve the questions pertinent to forensic medicine and science investigations, the use of both conventional autopsy and radiological imaging techniques can be the best mechanism, whereby many difficult domains may be reached. There are differences in the ante-mortem radiological findings as well as the post-mortem finding which need more intensive study. In India, it has not yet been possible to use imaging technology to aid in post-mortem examination due to restraints of resources and priority for the dead. However, future implementation of these modalities will greatly augment Forensic Medicine study and investigation.

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