An Update on Virtopsy- A Modern Forensic Investigation Tool

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Abstract
Virtopsy is a virtual alternative to a traditional autopsy, conducted with scanning and imaging technology. In developed countries Computed Tomography (CT) and Magnetic Resonance Imaging (MRI) are now being evaluated as complementary means for determination of cause of death. This paper explores the latest development and implication of virtopsy from ethical, clinical and technical point of view. Published literature in different journals with strict inclusion and exclusion criteria were extensively reviewed through use of general and Meta search engines to elucidate the applications and implications of virtual autopsy. The modern high-resolution imaging has been used as a well described aid in the setting of post-mortem investigations. Virtopsy introduces a new era in autopsy examination. It utilizes the technological innovation of modern imaging system to obtain best results and three Dimensional (3D) images of the body in multiple plains without mutilation of the human body. Now a days virtopsy is very much acceptable procedure to the forensic society. In western worlds virtopsy is likely to replace conventional autopsies in future. We can also try to implement this modern system in our country.

Key words: Virtopsy, Forensic investigation.

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This paper explores the implication of virtopsy from ethical, clinical and technical point of view. In this article the history of forensic autopsy and the reasons for the gradual decrease in conventional autopsy rates over the last few decades have been briefly described. An overview of advantages and limitations of modern imaging autopsy techniques and potential future applications of modern imaging techniques in postmortem analysis are also discussed. Published literature with strict inclusion and exclusion criteria were extensively reviewed through use of general and Meta search engines to elucidate the applications and implications of virtopsy. Articles containing information regarding the history of virtopsy, its application in different cases, and gradual development of the procedures in western countries, future aspects of this method have been taken into count for collection of data and references.

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Discussion

Autopsy is a special type of scientific examination of a dead body carried out under the law of state. A model autopsy procedure has been produced by United Nations within the context of investigation of human rights abuses called the "Minnesota Protocol" (The United Nations Manual on the Effective presentation and investigation of extra legal, arbitrary and summary execution). It can be used to deal with difficult, controversial or sensitive cases. The word "autopsy" has come from the Greek words – "Autos"- which means self and "opsis" which means view or to see for one self. It is also has come from the Greek words – "Autos"- which means self and "opis" which means view or to see for one self. It is also called necropsy. ("Necros" means- dead body) or post mortem examination ("post" - means after, "mortem" means death). The first medicolegal autopsy was done by Bartolomio De Varignana in Italy in 1302. In this Subcontinent the first medicolegal autopsy in India was performed by Dr Edward Bulkley on 28th August 1693. The first organized treatise on pathological findings at autopsy was “The seats and causes of diseases investigated by anatomy”, published in 1761 by Giovanni Batista Morgagni when he was 79 years old. This book, describing nearly 700 autopsies performed by the author, is the foundation of modern post-mortem science. At the end of the nineteenth century, Osler established autopsy as a curricular/educational value of autopsies. In the United States, the 1960's to between 5% and 23% at present. The most commonly cited factors accounting for this phenomenon are: medical causes of death, relevant injuries and forensic three dimensional reconstructions, bullet tract identification; education and clinical performance improvement process and research purposes.

The virtual autopsy was developed by Richard D’Inthofer, former Director of Forensic Medicine, Berne, which was then continued by his successor, Michel Thali and his colleagues at the University of Berne’s Institute of Forensic Medicine, Switzerland. A research team from the Institute of Forensic Medicine, University of Berne, Switzerland suggested a project on virtopsy as an alternative to the conventional autopsy. Total number of 40 forensic cases until the year 2006 were examined through multislice CT (MSCT)/NMR and conventional autopsy and comparative evaluation of radiological and conventional autopsies was done taking five aspects into account viz. medical causes of death, relevant morphopathological modifications, vital responses, lesion reconstruction, death cause reexamination, and visualization. In determining the medical cause, 55% causes of death discovered in autopsies were identified through imagistic methods independently.

A multi-section computed tomography (MSCT), Micro CT, MRI, MR Microscopy, MR Spectroscopy (MRS) and three dimensional photogrammetric based optical surface scanning visualize the interior of the body for collection of all the data in details in regards to condition of different organs. MRS is a technique in virtopsy which helps in determining the metabolic concentrations in the tissues, thus helping in estimating the time of death. MR microscopy is a microimaging technique which is used to study the soft tissue injuries like retinal hemorrhage, electric injury to the skin, etc. Micro tomography is used to study the weapon involved and its injury patterns. Specific software (e.g. Tera Recon Aquarius NET®, Foster City, California, United States of America) allowed for 3D reconstructions of the computed tomography images from the observed structures. Another part of the documentation concerns the body surface recording, performed by forensic photogrammetric and 3D optical scanning. One can examine the part of the body slice by slice in different planes according to the requirement of the situation. Apart from these, using the magnetic resonance imaging spectroscopy, time since death can also be estimated by measuring metabolites in the brain, emerging during postmortem decomposition. The samples for histopathological examination if required can be collected more precisely using CT guided needle biopsy. Postmortem angiography is used to visualise the cardiovascular system. Since 2005, United States Army Forces Institute of Pathology has scanned and analyzed about 800 bodies killed in war zones in order to determine cause of death and examine the injuries. In 2007, Levy et al published a series of postmortem CT examinations of military air mishap victims describing pockets of ectopic air in various anatomic areas in 24% of victims. They also noted that detection of solid organ injury and superficial traumas were significantly worse on CT than on a traditional autopsy. The application of virtopsy is diversified. It can be applied in a broad number of forensic situations, such as critical forensic investigations; carbonized, charred and putrefied body identifications; mass disaster cases; age estimation; anthropological examinations and skin lesion analyses, determining cause of death and decedent gender, identification in difficult forensic cases, body length and Individual decedent feature identification; identifying distinct foreign bodies – retained bullets, blades etc, identification of injuries and forensic three dimensional reconstructions, bullet tract identification; education and clinical performance improvement process and research purposes.

Virtopsy in court can also play a major advantage. Virtopsy provides excellent tools for crime and accident evidences. It portrays 3D analysis of internal injuries, 3D true color representations of surface injuries and even 3D scaled models of entire crime scenes and events which is of great help during court scenes. The Virtopsy approach shows critical forensic evidence in an unbiased, which is used as an evidence to laypersons and legal professionals. Several studies have compared the value of virtopsy with a traditional autopsy and suggested that virtopsy could reveal internal injuries which may be missed by a traditional autopsy. Studies have shown that postmortem CT scans could provide valuable information in the evaluation of victims who succumbed to a variety of fatal events, including gunshot wounds, blunt trauma, airplane accidents and drowning. The other advantages of virtopsy include the 3D illustration and real scientific animation based on real data improve also the understandability of complex pathological findings, respectively, forensic evidence in court • Digital stored data (3D images) on computers is accessible any time • The whole process is observer independent and results in an objective
data archiving because of mechanical precision • No forensic evidence is touched or even destroyed • Examination of difficult body areas for traditional forensic autopsy, for example, pelvis or neck, a body can be scanned from “tip to toe” • No risk of infection (e.g., tuberculosis, toxic substances) and • Higher acceptance by the relatives, who do not tolerate and object to traditional forensic autopsy because of religious or cultural reasons.40 Thali et al 37 have shown that virtopsy in gunshot wound victims is useful to localize the bullet in three dimensions, document the bullet path, visualize fracture patterns associated with gunshot wounds, and evaluate internal organ injury prior to autopsy.41

Previous studies also relates the role the forensic odontologist on age estimations. In one study over 40% of postmortem CT studies revealed clinically significant findings that were not identified on traditional autopsy.42-45 Imaging autopsies provide visualization of soft tissue patterns in cases of severe putrefaction. Aghayev et al described the use of both MSCT and MRI to document herniation of cerebellar tonsils prior to traditional autopsy in patients with blunt head injuries.46 The same group also advocated postmortem imaging as a good forensic visualization tool for documentation and examination of traumatic injuries and other pathologic findings in a broad range of scenarios.47 Oyake et al conducted an study to help determine the etiology of sudden death due to non-traumatic causes in infants and children and were able to point to the cause of death in 14 of 15 decedents when radiographic information was combined with pre-mortem clinical and laboratory data.48-50

Now a days Medical imaging database is investigated, stored and analyzed by radiologists using a Picture Archiving and Communication System (P A C S ). All PACSs have a Multi Planar Reformation (MPR) tool, allows the investigator to reformat images in the axial, coronal and sagital image plane. This provides image in three dimension and reviews better analysis. Other technique to display the image database as a whole is the Volume Rendering procedure. Similar to windowing, a transparency and a color is given to each pixel, based on its Hounsfield value. This 'defining' is called transfer function. As the x-ray densities of different tissues and pathologies are known already, predefined transfer functions allow the depiction of bone, soft tissue and skin in color. An animation software 3D studio MAX is used which allows the polygon models (bones, surface etc.) to be imported directly. A virtual bone system for animation (biped) can be created to better analyze the properties of the polygon model that is to be animated .51-56

Like all other latest inventions, virtopsy also has a number of disadvantages. Autopsy still produces both different and ancillary findings compared to Virtopsy results so that currently, virtopsy is not a generally accepted method to entirely replace autopsies. It is not possible to distinguish all the pathological conditions with this modern technique. Virtopsy cannot give the infection status. In virtopsy it is difficult to differentiate antemortem or the postmortem wounds, difficult to appreciate the postmortem artifacts and the colour changes. In some cases small tissue injury may also be missed.

Conclusion

Presently, the imaging techniques are excellent tools used for forensic medicine. In comparison to other methods, they are able to capture the findings at the moment of investigation without causing any damage and provides better analyses. Now a days virtopsy is very much acceptable procedure to the forensic society. In western worlds virtual autopsy is likely to replace conventional autopsies in future. We can also utilize this modern technology to upgrade the forensic investigation system in our country.

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