Virtopsy: Emerging frontier in forensics

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Abstract
It is long back that the autopsy procedures were invented and till now the same age old technique for autopsy are being used, though in the other fields of Forensic Medicine, there is rapid growth and advancement in the procedures performed and technology employed. Virtopsy is one step towards this end. Virtopsy came from virtual autopsy, which is a scalpel free procedure of autopsy carried out using modern medical, imaging and measuring technology. The technique could offer an alternative to the standard invasive procedure that upsets many families and is prohibited by some religion. With the help of this paper an effort is made to discuss a few points in the field of Forensics.

Keywords: Virtopsy, Virtual autopsy, Forensics, Autopsy.

Introduction
Forensic science is the branch of medicine which aims for the documentation of medical and other forensic findings in living and deceased persons, for the police and the judiciary system. As we know that death is an inevitable part of everyone's life, but sometimes for furtherance of law scientific examination of bodies after death becomes mandatory to find out the reasons for death. The contribution of Forensic science involving ten disciplines (which include Criminalistics, engineering science, general, jurisprudence, odontology, pathology/biology, psychiatry and behavioral science, questioned documents, toxicology and physical anthropology) in achieving this is appreciable.[1,2]

The term autopsy often referred to as "medico-legal autopsy" or "medicolegal necropsy" is thought to be the most important forensic tool to know the cause of death, and therefore it is even called "the expertise of expertises". The conventional autopsy procedure where whole surface of the body as well as all the body cavities are explored to record the findings or is body dissection or mutilating techniques which is objected by the emotional aspects of the victim's relatives as they know these mutilation forms of autopsies. But most importantly the need to know the cause of death and identification of an unknown deceased individual and also may help the law enforcement overrules this emotional involvement and justify the autopsy procedure. Therefore, the families and relatives of the victim often remain in a conflicting situation with the forensic examiners and are usually not in favor of autopsy. Even some religious and cultural beliefs also stand against the autopsy procedure. An example is observed in religious strands, such as Judaism, where it is not permitted to undergo the process of autopsy. To overcome, this rapid growth and advancement have been done in the procedures performed and technology employed in autopsy procedure. Virtopsy is one step towards this end which came from virtual autopsy, which is a scalpel free procedure of autopsy wherein modern medical, imaging and measuring technology are used such that there is no need of any dissection of the body for opening the body cavities or dissection of the different organs of the body.[2-4]

Virtopsy versus autopsy: Term autopsy was derived from Greek words as autos (self) and opsomei (I will see) – "To see with one's own eyes". Whereas virtopsy or "virtual autopsy" was derived from the words "virtual" (Latin: virtus: effective) which means useful, efficient and good" and elimination of autos ie, self thus leading to the scientific word virtopsy.[1,4]

Conventional Autopsy procedure involves invasive body opening through incisions and dissection – the traditional means of postmortem investigation in Humans and with the same time one have to consider the sentiment of the relatives of the deceased, who are always upset and usually against conventional autopsies. On the other hand virtopsy is a minimally invasive or noninvasive emerging technology in the field of Forensic medicine which incorporates imaging technology wherein radiologists and forensic clinicians reflect documentation of the body in the observation of the anatomical structures through computed tomography (CT), magnetic resonance (MRI) and micro radiology devices. Thus there is no need of any dissection of the body for opening the body cavities or dissection of the different organs of the body and also keep sentiments, cultural and religious beliefs of patient's family members.[1,4-6]

Background of virtopsy: It was in the nineties when Richard Dirnhofer, former Director of Forensic Medicine, at the Institute of Forensic Medicine of the University of Bern, Switzerland, started working on the

characteristics of the human body (observation of the anatomical structures) in a concrete, objective and non-invasive protocol created a new discipline in autopsy, named as "Virtopsy", which was a virtual project of autopsy and anatomy of body was observed and examined through computed tomography (CT), magnetic resonance (MRI) and micro radiology devices. The same research was then continued by his successor, Michel Thali (the forensic pathologist and project manager for virtopsy) and his colleagues at the University of Berne's Institute of Forensic Medicine, Switzerland who said "If you are doing an autopsy, you are always destroying the 3-D geometry of the body". Using this cross-section imaging technique, it is possible to document the same findings in a noninvasive way. Idea of "all in one research area" was proposed encouraging virtopsy as a promising field with clear and controlled procedure. Virtopsy procedure start from surface documentations carry on with CT scanning and fallowed with image-controlled sampling for histological, bacteriological and toxicological examination.[2-4,7]

Imaging techniques of virtopsy: A two dimensional view of the particular object is given by a photograph. Same way, if photograph of a wound is taken, it will give the position, as well as length and breadth of the wound but cannot display the depth of the wound. So for determination of the depth, a three dimensional view of the wound is essential to understand the actual dimensions. In autopsy dissection is done to get this three dimensional view but same can be done without the use of scalpel in virtopsy by using combination of imaging modalities.[4]

So virtopsy involves combination of the different technologies of medical imaging as well as other technologies used in other field of science. An insight into the future of forensic is visualized by the emerging involvement of advanced imaging technology that can enhance or even in the future may be an alternative to conventional forensic examination. It relies on certain fundamental techniques of imaging which include (i) Computed Tomography (CT) – for three-dimensional imaging and analysis of autopsy findings including gross tissue injury and pathologic gas collections, CT guided needle biopsy is used to collect sample for histological examination, (ii) Multi-slice computed tomography (MSCT): done for better differentiation, (iii) Magnetic resonance imaging (MRI) – by which the interior of the body is visualized for collection of all the data and details in regards of status of different organs. One can examine the part of the body slice by slice in different planes according to the requirement by the examiners depending upon situation, (iv) Magnetic resonance imaging spectroscopy by which estimation of the time since death by measuring the metabolites in the brain emerging during post mortem decomposition can be done, (v) GOM – high-resolution surface scanner: It is able to produce true 3D colour of surface of body and vehicles with high stability and accuracy, (vi) Angiography – post-mortem heart-lung machine: it is done to se intravascular and intra-articular display for small as well as longer circulatory system, to analyze individual body organs, vascular injury leakages and to estimate quantity of stenosis, (vii) Programmable biopsy – contamination-free sampling: by this the body fluids can be examined for toxicological purpose without contamination and requires less manpower, (viii) Ultrasound Technology: done to produce pictures of anatomical structures like cardiac evaluation, tumours, abscesses, vascular structures, solid organ assessment, and pregnancy etc, (ix) Animations in Forensic Pathology: this helps the forensic pathologists to process complex evidence in animated series to communicate for juries in a clear-cut and easy mode so that jury can easily understand the justifications and observations, and (x) Photography: Digital imaging technique is used for photography because provides it provides exact image record of the crime scene along with it show present physical evidence.[2-4,7-11]

Applications of virtopsy: Virtopsy technique is used in multiple number of forensic situations/science, such as thanatological investigations; carbonized and putrefied body identifications; mass disaster cases; age estimation; anthropological examinations and skin lesion analyses.[3]

a. Cause of death in drowned cases is diagnosed by CT images by giving information about the volume, density, size of the lungs and the amount of liquid observed.[3,12]
b. Human identification is possible in mass disaster cases as CT images ease in data collection on the disaster field.[3,13]
c. In forensic odontology branch, respiratory obstruction by foreign body is best differentiated by virtopsy using CT and MRI images as compared to conventional autopsy where it is difficult to know the exact depth of obstructed foreign body.[3,14]
d. Personal identification is possible by superimposition and comparing AM orthopantomograms and PM reconstructed panoramic overviews of cranial CT images.[3,13]
e. Identification is also possible through the analysis of different density of restoration materials, such as composites, temporary fillings and ceramics, by ultra-high-resolution CT imaging.[3,15]
f. Age determination is correctly done in charred and decomposed bodies by examining dental and anthropological data through the CT analysis based on age estimation techniques. On the other hand age estimation is difficult in totally decomposed bodies.[3,16]

Advantages:[1,2,4]

a. It is non-invasive imaging technology free from scalpel use.

b. As it is scalpel free, chances of infectious hazards from blood and bodily tissues are minimal.
c. "Tele-forensics" is possible as data is digital and thus can be stored over years or decades, can be transferred to any part of world for second opinion.
d. Keep emotions and sentiments of victim's relative as no incision or mutilation of body done.
e. It is time saving and body can be released immediately after scanning.
f. Location and time is not concern as digital data can be reopened again and again for judgmental opinion.

Disadvantages:[1,2,4]

a. Small tissue injuries may be missed sometimes.
b. Establishing infection status is not possible.
c. Difficult to differentiate ante-mortem or the postmortem artifacts.
d. It is not possible to distinguish all the pathological conditions with this technique as there is insufficient data base when compared to conventional autopsy.
e. The set of virtopsy is not available worldwide.

Future vertopsy-virtibot: Nanotechnology is crossing milestones in the field of medicine which utilize control, manipulation, study and manufacture of structures and devices in the nanometer size range. Virtibot is a robotic nanotechnology that carries out virtopsies and improves the outcome of forensic investigations. Vertibot is newest multifunctional robotic system technology that serves to perform 3D surface scanning and automatic post mortem image guided biopsies using nanoparticles.[1,7,17]

Conclusion

The aim of this paper is to evaluate importance of virtopsy. Virtual autopsy emerges as a useful tool for forensic investigations. Its main benefits are related to the improved collection of data compared to the traditional technique and its non-invasiveness and ethical to emotions and sentiments of relatives. Virtopsy is a recent advance in the field of investigation but still it has a long way to go to establish itself as an alternative to the conventional autopsy.

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