

## Review Article

### **Virtopsy: New Dimension in the Field of Forensic Medicine communities**

Utpal Kumar Biswas<sup>1</sup>, Mohammad Ahad Hossain<sup>2</sup>, K. M. Moinuddin<sup>3</sup>, Nashid Tabassum Khan<sup>4</sup>

#### **Abstract**

Forensic medicine aims for the documentation of medical and other forensic findings in living and deceased persons, for the police and the judiciary system. An Autopsy is a highly surgical procedure that consists of a thorough examination of a corpse to determine the cause and manner of death to evaluate any disease or injury that may be present. Though in other branches of the specialty, newer techniques are part of daily routine, in autopsy, the same century old techniques are still being used. Virtopsy is one step ahead in this field which literally means virtual autopsy. New methods like 3D-surface scanning and modern radiological procedures like computed tomography (CT) or magnetic resonance imaging (MRI) are becoming more and more part of scientific research in forensic sciences and are today part of the routine work flow in a some institutes of legal medicine. This paper is aimed to discuss a few points in the field of Virtopsy.

**Keywords:** Forensic Radiology, 3D surface scanning, Virtopsy, Virtual autopsy

#### **Introduction**

Autopsy is the scientific examination of bodies after death, where whole surface of the body as well as all the body cavities are explored to record the findings. While doing so, we have to collect all the possible findings which will help in establishing the circumstances leading to the death and also may help the law enforcing agencies. At the same time, it is also equally important to consider the sentiment of the relatives of the deceased, who are always upset at the conventional autopsies. So, if there exists a means by which all the findings in the body can be collected, it should be accepted by all.

It is long back that the autopsy procedures were invented and till now the same age old techniques 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.

The term Virtopsy came from Virtual autopsy, which is a scalpel free procedure of autopsy carried out using modern medical, imaging and measuring technology<sup>1</sup>. Here, there is no need of any dissection of the body

For opening the body cavities or dissection of the different organs of the body. Using the different imaging techniques, which provide a complete three dimensional view of the inside as well as outside of the body, all the vital information like position and dimensions of the

wounds, or other pathological conditions in the body can be known and documented without use of any scalpel. The technique could offer an alternative to the standard invasive procedure that upsets many families and is prohibited by some religions, the developers say.

The Virtopsy, or "virtual autopsy" was developed by Richard Dirnhofer, 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. "If you are doing an autopsy, you are always destroying the 3-D geometry of the body," says Thali, the forensic pathologist and project manager for Virtopsy. "Using this cross-section imaging technique, it is possible to document the same findings in a noninvasive way."<sup>2</sup>

#### **The imaging techniques applied**

Whenever a photograph is taken, it always gives a two dimensional view of the particular object. So, if a wound photograph 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.

So, in Virtopsy, there is combination of the technologies of medical imaging techniques as well as other technologies used in other field of science.

1. Assistant Professor, Department of Forensic Medicine and Toxicology, Monowara Sikder Medical College Shariatpur
2. Assistant Professor, Department of Forensic Medicine and Toxicology, Dhaka Central International Medical College, Dhaka
3. Lecturer, Department of Forensic Medicine and Toxicology Shahis Sohrwardi Medical College, Dhaka
4. Associate Professor, Department of Forensic Medicine and Toxicology, Z H Sikder Women's Medical College, Dhaka

**Address of Correspondence:** Dr Utpal Kumar Biswas, Assistant Professor, Department of Forensic Medicine and Toxicology, Monowara Sikder Medical College, Shariatpur

- 3-D surface scan used in the automobile designing is used to map the exterior of the body. It gives and documents the three dimensional image of the body surface area in details.
- Multi-slice computed tomography (MSCT) and
- Magnetic resonance imaging (MRI) – which visualizes the interior of the body for collection of all the data in details in regards of condition of different organs. 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 visualize the cardiovascular system.<sup>1,3,4,5</sup>

### Discussion: conventional autopsy vs virtopsy

Michael Thali and colleague's<sup>5,6</sup> at the University of Berne's Institute of Forensic Medicine has studied in more than 100 autopsies in Switzerland and the findings of the Virtopsy procedure has matched almost perfectly in side by side comparisons with those of the conventional autopsy procedures. The comparisons were checked for a number of forensically pertinent points such as detection of gas, fractures and foreign bodies, as well as tissue and organ trauma.

When teamed with postmortem angiography and biopsy procedures, Michael Thali says that there is little of forensic importance that the virtual autopsy cannot detect. As per Peter Vock, Director of Radiology, University Hospital Berne<sup>2</sup> the results of the imaging technique in case of cadaver are better, as there is no movement due to the respiratory and cardiovascular activities as in case of the living, which may at times distort the images.

Surface scanner is the means for measuring and depicting the images in three dimensional views with precision. Here, the object is photographed from different angles using digital camera which are then fed in to a computer. The body is scanned from all sides using a sensor which takes pictures using two cameras. The computer then reproduces the image of the body in three dimensional views which can be rotated as per requirement without any distortion for collection of the findings.

In the initial period, In Virtopsy, researchers use only the CT and the MRI for detection of the findings; but in that method, there were limitations as the images formed were only in gray scale, and so many findings were difficult to appreciate. But the new combined method of 3-D/CAD-supported Photogrammetry and the medical imaging technique like the MSCT, MRI etc.,

give a much better result. Using this merging method of colored photogrammetric surface scan and gray-scale radiological internal documentation, a great step towards a new kind of reality-based, high-tech wound documentation and visualization in forensic medicine is made. The combination of the methods of 3D/CAD Photogrammetry and Radiology has the advantage of being observer-independent, no subjective, on-invasive, digitally storable over years or decades and even transferable over the web for second opinion. Moreover, by using this method, matching of the weapon of offence or the offending object with the wound can be made.

Using the postmortem angiography, the whole cardiovascular system can be visualized. If there is any injury to a vessel, there will be spillage of the dye to the surrounding tissues, making it visible in the CT images. So, minute injuries to the blood vessels even to a capillary also can be detected in this method which is usually missed in the conventional autopsy. Apart from that, it is not possible to determine the findings in the heart muscles immediately after an ischemic attack, and so using this technique, the coronary vessels can be better assessed for any occlusion etc. than in case of the conventional autopsy.

Take the example of a bullet injury, the bullet has entered the body through the entry wound and has passed out of the body through the exit wound, leaving the entry and exit wounds as well as the tract of the bullet in the body. Now in conventional autopsies, many a time extensive dissection of the body has to be done to evaluate the path of the bullet, mutilating the body. But by using the Virtopsy, all precise information required can be acquired and these can be preserved as digital images. The main advantage of this imaging technique is that the image of the wound or any other findings can be viewed from different angles by changing the viewing angles for better understanding of the findings. Moreover, the body can be viewed in layer by layer, from different angles for better collection of the evidence. Many a time, some findings, as for example, fracture of some bones, which may not be detected in the conventional autopsy, can be better visualized in this technique.<sup>3,7</sup>

Another advantage of this procedure is that, the body is not subjected to any incision, so it is better accepted by the relatives of the deceased. Many a time the relatives of the deceased create hurdles in autopsy procedure on the plea of emotional ground or for religious sentiment. There are many country in this globe, where, autopsy procedure can be avoided if the relatives of the deceased object or do not permit. These people are mostly scared of the mutilation of the body during autopsy and they do not want that any incision to be made on the body. Moreover, the whole architecture of the body is preserved in Virtopsy, which is not in case of conventional autopsy; where all the organs are removed and examined. So, if the body is subjected to a second autopsy, it becomes a

very tough job for the second autopsy surgeon to come to a conclusion with all the dislodged and dissected organs where the normal architecture is lost. The findings of the Virtopsy are in the digital format, so it can be sent for second opinion to any expert sitting in some distant place in this world. The body can be subjected to second autopsy till it is cremated, even can be examined using the conventional autopsy procedure, if need arises.<sup>1,3,4,6,7</sup>

Again, during autopsy procedure, which involves opening of all the body cavities and dissection and examination of all the organs, there is every chance that infections may be acquired by the mortuary staff as well as the concerned doctor. Nowadays, where newer infecting agents have coming in, it very hazardous in the conventional autopsy as the infectivity from the body is not known and infection can spread from a fresh dead body as well as a highly putrefied body. So, in this aspect, Virtopsy is much safer procedure as it does not involve any blood shed or it is a blood less procedure<sup>4</sup>

Regarding the reliability of the results of the procedure, only comparative study of the cases by Virtopsy as well as conventional autopsy can give a correct analysis. R A L Bisset et al<sup>8</sup> has studied in 53 cases at Manchester, UK in the year 1997, using MRI where the findings were confirmed by conventional autopsy. According to their study, the findings were more or less similar in both the methods. In their study, all the cases were non-suspicious deaths referred to the coroner because the general practitioner or hospital doctor could not issue a death certificate or there had been recent surgery or other condition needing automatic referral to the coroner. All the scans were done in private centers and according to this study, they could detect cardiac ischemia, pneumonic consolidations, pleural effusion or pulmonary oedema etc. apart from the other cases.

Computed tomography (CT) is the imaging modality of choice for two- and three-dimensional documentation and analysis of autopsy findings including fractures, pathologic gas collections (e.g., air embolism, subcutaneous emphysema after

trauma, hyperbaric trauma, decomposition effects), gross tissue injury and identification of foreign objects. Various post processing techniques can provide strong forensic evidence for use in legal proceedings. Magnetic resonance (MR) imaging has had a greater impact in demonstrating soft-tissue injury, organ trauma, and non-traumatic conditions. A comprehensive analysis of both surface and deep tissue findings may require fusion of CT, MRI and 3D surface data. However, the differences in morphologic features and signal intensity characteristics seen at ante mortem versus postmortem MR imaging have not yet been studied systematically.

Many argue that it is not at all a reliable method in comparison to the conventional method of autopsy. To some extent it is true that in many cases, it is not

possible to detect some findings by Virtopsy, like a fresh case of MI, where the ischemic changes may not appear at the time of imaging; but here also, as already discussed, combined with angiography, it gives better result in detection of the thrombotic vessels. Similarly, for collection of the samples, it is not possible by the scanners. Another disadvantage of the procedure is that, recognition of the colour changes which cannot be achieved by the technique. Moreover, there is every chance that some minute findings of tissue injury might be missed, which are easily detectable in conventional autopsy.

## Summary

So, to sum up, Virtopsy is a recent advance in the field of investigation in to the cause of death which has many advantages over the conventional autopsy as well as many disadvantages.

## Advantages

- Complete, non-destructive gathering of findings from head to toe.
- Most effective in study of the wounds including the matching of the probable weapon. The wound can be studied without disturbing the body architecture.
- No scalpel method, so no hazard of infections from the blood or other tissue fluids.
- No mutilation of the body, so, can be examined again without any autopsy artifacts. The data is stored in digital format, so can be transmitted to any part of the world easily.
- Data acquisition in regions that are difficult to dissect and access (e.g. atlanto-occipital joints) and in case of advanced decomposition.
- Less time consuming and body can be released immediately after the scanning.
- Visualization of the cardiovascular system.
- Improvement in the quality of forensic report-simultaneous examination by different experts via tele-forensics.
- The complete saved data-set can be re-examined at any time if a second expert opinion is required, even after burial or cremation of the body.
- Better acceptance for the relatives of the diseased and also by the religious customs as incisions not are used.

## Disadvantages

- Insufficient data base of comparative study of Virtopsy and conventional autopsy.

- It is not possible to distinguish all the pathological conditions with this technique.
- Cannot give the infection status.
- Difficult to differentiate ante mortem or the postmortem wounds.
- Difficult to appreciate the postmortem artifacts.
- Difficult to appreciate the colour changes.
- Small tissue injury may be missed.
- Recording reflective or transparent surface (e.g. the eye)
- Merging data from multiple techniques will always result in some loss of precision.
- A reliance on imagery alone may lead to omissions (e.g. bruising under the scalp not visible with surface scanning)
- In our scenario, it is not possible to provide these types of investigations to all the living persons, so how far it will be practical to start with the same for the dead is questionable, as in our setup, dead come last in the priority list.

## Conclusion

In Japan, postmortem computed tomography (PMCT) has been widely applied for

Three major roles –

- (1) Screening the cause of death,
- (2) Screening candidates for autopsy, and
- (3) Guidance and/or supplemental information for autopsy. In a study conducted in Japan, questionnaire sheets were distributed, regarding the use of PMCT, to 183 major medical establishments having Emergency Rooms. Of these, 67% responded and it was found that 89% of the respondents use PMCT. This high rate is likely because the number of CTs in Japan is greater than 10,000 units, constituting more than one-third of those in world wide.

So, use of the radiological investigations in the form of CT and MRI etc. are picking up in many places.

So, postmortem radiological examination to detect diseases is a useful tool but it cannot replace the conventional autopsy in the present stage. There are differences in the ante mortem radiological findings as well as the postmortem findings which need more intensive study. Moreover, there may be postmortem artifacts and it may not be possible to distinguish between the ante mortem phenomenon and the postmortem phenomenon which is only possible by naked eye examination and many a time by histopathological or histochemical methods only.

Never the less, it is a new development in the field of investigation of death, but still it has a long way to go to establish itself as an alternative to the conventional autopsy. Its acceptability in the court of law is to prove. But we can hope that in near future, we all will be accustomed to some kind of virtual autopsy or non-invasive autopsy technique which will be beneficial for the courts as well as the autopsy surgeons and the relatives of the deceased.

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