

# Review Article

## Virtual Autopsy

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ABSTRACT

Forensic odontology has been emerging as a major branch of the forensic science as an identification aid. Teeth by its resistant nature to degradative forces offer us an identification tool. Virtual autopsy is a virtual dissection of the human body through imaging to analyze the internal aspects of the body. This article speaks on the applications of virtual autopsy in forensic science.

**KEY WORDS:** *Computed tomography, forensic odontology, magnetic resonance imaging, virtual autopsy, three-dimensional imaging*

### INTRODUCTION

Forensic odontology or forensic dentistry is a major challenging and fascinating branch of forensic science and it was defined by Keiser-Neilson in 1970 as “that branch of forensic medicine which in the interest of justice deals with the proper handling and examination of dental evidence and with the proper evaluation and presentation of the dental findings.”<sup>[1]</sup> Forensic odontology is an important investigations that involves the application of dental sciences in the identification of deceased individuals through the comparison of ante- and post-mortem records.<sup>[2]</sup> The dental tissues are the most durable organs in the bodies of vertebrates and humankind’s,<sup>[1]</sup> and therefore their characteristics can often survive long periods of immersion under water, burial under soil, fire, and exposure to biological agents in the natural environment. Thus, the importance of dental identification is increasing year by year.<sup>[3]</sup> The important applications of forensic odontology include identification of human dental records and assisting at the scene of crime; in cases of suspected child or adult abuse through bite marks or physical injuries; determination of age and gender of the living or deceased; and to testify as an expert witness in the court to present forensic dental evidence.<sup>[2]</sup>

### VIRTUAL AUTOPSY

The autopsy is from the Greek word autopsia, which means “to see with one’s own eyes.”<sup>[4]</sup> An autopsy means postmortem examination. It is a highly specialized surgical procedure that consists of a thorough examination of a corpse to determine the cause and manner of death and to evaluate any disease or injury that may be present.

Virtopsy is a word combining “virtual” and “autopsy.” The former term is derived from the Latin word virtus, which means “useful, efficient, and good.”<sup>[5]</sup> Virtopsy that uses latest radiological techniques such as computed tomography (CT), magnetic resonance imaging (MRI), and

three-dimensional (3D) imaging for the examination of dead bodies.<sup>[6]</sup> Virtopsy can be employed as an alternative to standard autopsies for broad and systemic examination of the whole body as it is less time-consuming, aids better diagnosis, and renders respect to religious sentiments.<sup>[6]</sup> Virtopsy combines surveying technology, pathology, radiology, image processing, computer sciences, telematics, physics, and biomechanics.<sup>[7]</sup>

Virtopsy basically consists of (a) body volume documentation and analysis using CT, MRI, and microradiology; and (b) 3D body surface documentation using forensic photogrammetry and 3D optical scanning. The aim of the virtopsy project is to validate this new approach by systematically comparing the radiologic and surface scanning findings with those obtained at traditional autopsy.<sup>[5]</sup>

In virtopsy, 3D imaging in postmortem victims is effectively performed using the principle of triangulation.<sup>[6]</sup>

### VIRTOPSY: AN ALTERNATIVE TO THE CONVENTIONAL AUTOPSY

The progress in imagistic domains CT and nuclear magnetic resonance (NMR) has brought great changes in the field of forensics and it has changed the face of conventional autopsies into a virtual autopsy or “virtopsy.” The imagistic domains can also be used in the field of histopathology which can help in a noninvasive, nondestructive, and 3D examination of naturally preserved specimens.<sup>[4]</sup>

The comparative evaluation of the radiological and conventional autopsies was made taking into account the following five aspects:

1. Medical cause of death
2. Relevant morphopathological modifications

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3. Vital responses
4. Lesion reconstruction
5. Death causes re-examination and visualization.

From the point of view of the vital response study, the comparative analyses showed the same results in the case of the multislice CT and NMR techniques use, both being superior to the conventional autopsy for pneumothorax, subcutaneous emphysema, and aeroembolism, but inferior to it in hemorrhage and fat embolism. It does not identify the vascular or metabolic modifications because the contrast substance cannot be injected.

The imagery's 2D, 3D reconstruction possibilities are highly superior to the oral description. The 2D and 3D reconstruction methods improve significantly the clarity and understanding of the evidence presented by the experts.

Virtopsy represents not only the first step toward a better acquiring of information regarding death causes, lesions' types, etc., through modern technologies but also an alternative that ensures the right to body integrity, to intimacy, and attributing an intrinsic value to the human body. At the same time, virtopsy avoids social stigma, whose huge prejudices would manifest on the family members and on the deceased person, influencing the image of his life.

#### **VIRTUAL AUTOPSY IN FORENSIC SCIENCES AND ITS APPLICATIONS IN THE FORENSIC ODONTOLOGY**

Dental identification procedures often include the comparison between postmortem and antemortem data, development of dental postmortem victim details, and dental deoxyribonucleic acid techniques.<sup>[6]</sup>

3D imaging in postmortem victims is effectively performed using the principle of triangulation. Along with this, virtopsy has many advantages which are not there in conventional autopsies such as the fracture lines can be noticed, primary and secondary traumas can be effectively visualized, and depth of the foreign body can be effectively localized which is the greatest disadvantage of conventional autopsy. Furthermore, the examination through virtopsy can be done without any fuss as there is no cadaver contamination.

Disadvantages of this imaging technology is such as limited tissue resolution by current scanning technology, no visualization of organ colors and depending on the used non/minimally-invasive procedures, the physiological senses of an anatomical pathologist such as smell, texture, and color are restricted as there is no direct contact with the dead body of the victim, and the main disadvantage is the feasibility in using these high technology imaging devices in less developed countries.

#### **VIRTOPSY: THE SWISS VIRTUAL AUTOPSY APPROACH**

Virtopsy is consisting of the following tools: 3D photogrammetry-based optical surface scanning, postmortem CT, postmortem MRI, postmortem CT-guided biopsy, and postmortem CT-guided angiography.<sup>[7]</sup>

3D photogrammetry followed by a 3D surface scanning. MRI is used to examine soft tissue injuries, organ trauma, and

nontraumatic conditions. CT angio is also possible to display the vessel system. It supports the vascular cross-section diagnostic and enables examination of structures are either not visible or visible only with major destruction of the corpse during traditional autopsy.

3D photogrammetry followed by a 3D surface scanning with a GOM ATOS III 3D (Gom MBH, Mittelweg, Germany) digitizer mounted on the virtobot arm is performed. 3D surface digitizing is an optical measuring method based on the principle of triangulation. Some disadvantages of this imaging technology such as limited tissue resolution by current scanning technology, no visualization of organ colors and depending on the used non/minimally-invasive procedures, the number of procedures, and the cost of virtopsy. Some advantages are:

- 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.

#### **ESTIMATION OF SEX AND AGE OF "VIRTUAL SKELETONS": A FEASIBILITY STUDY**

The potential of multidetector CT (MDCT) in estimating the bone age and sex of deceased persons is demonstrated in this study. The sex of 22 cases was determined correctly by the anthropologists upon examining the virtual skull and pelvis. Bones were estimated without sampling and maceration by MDCT, also virtual skeleton can be easily handled without destruction and therefore used for infinite investigations.<sup>[6]</sup>

#### **CONCLUSION**

I would like to say virtual autopsy or virtopsy is a virtual segmentation tool without dissecting the cadaver or the body. It promises to be a great tool in forensic medicine. It still remains underused in the branch of forensic odontology and can be explored further to expand its scope into dentistry.

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#### **CONFLICTS OF INTEREST**

There are no conflicts of interest.

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