

Virtopsy: A Contemporary Tool for the Forensic Odontologist

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ABSTRACT

Background: Forensic science is a multi-disciplinary branch involving Criminalistics, engineering science, general, jurisprudence, odontology, pathology/biology, psychiatry and behavioral science, questioned documents, toxicology and physical anthropology. This article aims at interlinking forensic pathological techniques with modern imaging techniques and enlighten the avenues for forensic odontologist in this new area. A new procedure called "Virtopsy derived from Greek words "virtual" and "autopsy" is developed as an alternative to traditional autopsy. Virtopsy is a multi-disciplinary approach that combines Forensic medicine, pathology, radiology, image processing, physics and biomechanics.

Keywords: Virtopsy, forensic odontology, autopsy.

INTRODUCTION

In this modern era of the technological advancements' mankind is still facing problems due to global terrorism, violence, and natural disasters curbing many lives. Damage in these situations is in large scale and irreparable in terms of personal life and property loss. The main motto of identifying the dead in these situations is for personal, social, and legal purposes (1) In criminal law, lack of identification seriously hampers murder enquires. False identification helps in switching identity. In civilized societies, it is socially and legally essential to identify and establish the cause of death before a death certificate is issued (2) Modern day investigations have reached to a point of sophistication interconnecting the involvement of many different disciplines to serve problems including establishing reasons for death. (3)

FORENSIC SCIENCE AND ODONTOLOGY

Forensic Science is an area of specialization that can be used in a judicial setting and involves principles and procedures for the systematic application of knowledge involving collection of data through

observation and experimentation thus leading to recognition and formulation of a problem (4) Forensic science deals with the identification of the dead using numerous techniques.(1) Forensic science is a multi-disciplinary branch involving Criminalistics, engineering science, general, jurisprudence, odontology, pathology/biology, psychiatry and behavioral science, questioned documents, toxicology and physical anthropology. (3)

Aim of the present article:

This article aims at interlinking forensic pathological techniques with modern imaging techniques and enlighten the avenues for forensic odontologist in this new area.

Forensic pathology is a discipline of Forensic science which deals with pathologic and physiologic changes of a body before and after death. Autopsy is a pathological procedure which establishes the circumstance leading to death by scientific examination of the whole surface of the body as well as body cavities (4) Keiser-Neilson defined forensic dentistry as "that branch of forensic science that in

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the interest of justice deals with the proper handling and examination of dental evidence and the proper evaluation and presentation of dental findings.

Forensic odontology has a lot of scope in human identification using various tools like bite marks, lip prints, etc. (1). Forensic dentistry principally relies on the indestructibility of teeth, and its scientific advancement is designed to extract increasing amounts of identifiable information from oral structures, which, more than any other part of the body, mirror the fortunes of the individual concerned. The main aim of the forensic dentist is to identify the dead person and to identify an assailant who has used his or her teeth as weapons (2). Advancement in technology revolutionized fields such as forensic genetics and forensic toxicology while forensic pathology is still using the evidence-based procedures like autopsy introduced centuries ago. The subsequent section of this review article aims at interconnecting the various disciplines of forensic science – pathology, odontology, imaging and emphasizing on the new avenues for the forensic odontologist.

DISCUSSION

Alternative to autopsy : do we need it

An autopsy (postmortem examination, autopsia cadaverum, or obduction) 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 (5)

The etymology of “autopsy” refers to the doctor examining a body, and the union of the terms “autos” and “psia” meaning “own” and “view” respectively.(6) Though autopsy is considered as the gold standard pathological procedure to establish the cause of the death, the technique is still not widely accepted globally as it consists of body mutilating techniques. The emotional aspects of the victim’s relatives, their knowledge of these mutilation forms the major objection against autopsies. The families and relatives of the victim often remain in a conflicting situation with the forensic examiners. Parallel to that, some religious and cultural aspects such as Judaism, represent relevant objections for the autopsy procedure. (6,4)

Another major drawback in autopsy is that the technique cannot be repeated as body has been cremated. Findings that have not been documented are therefore irrevocably destroyed.(7) Based on these objections, and in an attempt to ameliorate the autopsy results, alternative aids in diagnosing the cause of death were developed. One of these is radiological imaging. Its use for medico-legal purposes was seen in the forensic practice since 1896 (6)

A new procedure called “Virtopsy derived from Greek words “virtual” (virtus: effective) and “autopsy” (autos: own + opsomei: to see) is developed as an alternative to traditional autopsy.{1} (6). Virtopsy is a multi-disciplinary approach that combines Forensic medicine, pathology, radiology, image processing, physics and biomechanics.(4) This technique involves the internal examination of dead bodies using imaging techniques like computed tomography (CT) and magnetic resonance imaging (MRI), and reconstruction of a 3D view of the analyzed cadaver (3,4) The technique employs Magnetic resonance imaging spectroscopy that estimates the time since death by measuring the metabolites in the brain emerging during post mortem decomposition (3)

In cases of death pathological findings of the soft tissues such as subcutaneous fat, inner organs, fatal haemorrhage and hypothermia can be examined by using MRI in combination with MSCT. A special indication of MRI in virtopsy is its use in fatal strangulation in hanging. (8)

The external examination is performed using the GOM TRITOP/ATOSIII® system. The TRITOP portion is based on photogrammetry, which calculates the position of the body and the texture of the surface model. The surface scanning is performed by the ATOS component, and it is based on the principle of triangulation. The sensor head has one camera on each side and a projection unit in the middle, the images taken are transferred to the computer and the 3D surface points are calculated. The whole procedure of scanning is completed in very short duration of time. Ebert et al. specified that 3D reconstructions made the examination processes more efficient and could be carried out and interpreted by a single specialized examiner and thus can augment and even partially replace a

traditional autopsy. (9) . Forensic scientists are preferring this technique owing to the need of getting quick and accurate information about forensic cases

Applications of virtopsy in Forensic Odontology :

When a forensic odontologist is involved in the forensic team the PM photographic and radiological examination is difficult because the access to the oral cavity is hindered (e.g. bodies in rigor mortis condition). In these cases the virtual autopsy process allows dental identification in an accurate and quick way without damaging the body to access the available dental data. (6)

Dental age estimation methods based on tooth development can be applied during the virtual autopsy, allowing the examiner to include or exclude individuals based on age related victim lists (6) Another specific odontological application for the Virtual Autopsy is on the comparison between antemortem (AM) orthopantomograms and Post mortem (PM) reconstructed panoramic overviews of cranial CT images. This way PM dental evidences can easily be related to the AM data of the expected missing person. (6)

Studies on restorative materials are also related on the virtual technique. Through the analysis of the restoration materials density, authors expressed in Hounsfield Units the different density of restoration materials, such as composites, temporary fillings and ceramics, by ultra-high-resolution CT imaging. The course of restoration materials under high temperatures by CT images, simulating a fire mass disaster is tested there by applying this in the field of forensics.(8)

Forensic dentist can improve the forensic examinations analyzing detailed morphological structures of the teeth, e.g. pulp chamber shapes, roots arrangement and periodontal status.(6) In mass disaster cases Dirnhofer et al. described the use of adapted vehicles with imaging machines which allows for the collection of postmortem data at the disaster site. The author states that mobile CT imaging could provide a high level of positive identifications. (4)

Thus, Virtopsy revealed a cutting edge in determining the cause of death, eliciting relevant

traumatological and pathological findings, vital reactions, reconstruction of injuries and visualization of forensic cases. Thus virtopsy helped forensic odontologist to utilize the data for expert witness reports, teaching, quality control and telemedical consultation. (3)

The potential advantages of this technique are (6) ,(3), (10)

- presence of fracture lines can be noted, which is not commonly found in traditional autopsy.
- magnetic resonance imaging in virtopsy can locate the primary and secondary traumas.
- In conventional autopsy examinations the greatest difficulty is to predict the depth of the foreign body which is overridden in virtopsy.
- Since there is no mutilation of the body there is no hazard of infections from the blood or other tissue fluids. {3}{6}{3} (10)
- review of the case can be even after several years of death, the disposal of radiological chemical processing and the improved data organization and communication are benefits provided by the computed approach present in the virtual autopsy.

Though the technique is advancing there are few limitations as to: (6,10,11)

- precision of virtual autopsy on detailing anatomical structures depends, mainly, on the equipment and settings used .
- information about color, smell and sometimes texture can be lost on restricted virtual examinations
- Ethical objections against the virtual technique advocate the data privacy of the examined corpses.
- the bioethical issue related to the digital imaging transferring is another objection for the use of virtual autopsy.

CONCLUSION

As virtopsy favors the development of forensic autopsies, forensic odontologists should get updated on the virtual autopsy process and more specific on the applications of this technology related to dental Identification and associated dental age estimations. There is a wide scope for multidisciplinary research in this field to develop

improved tools and protocols for virtual autopsy and thus opening avenues for forensic Odontologist.

CONFLICTS OF INTEREST

The authors declare they have no potential conflict of interests regarding this article.

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