

# Virtopsy (virtual autopsy): A new phase in forensic investigation

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. Virtopsy is a word combining 'virtual' and 'autopsy' and employs imaging methods that are also used in clinical medicine such as computed tomography (CT), magnetic resonance imaging (MRI), etc., for the purpose of autopsy and to find the cause of the death. 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. Virtopsy is quickly gaining importance in the field of medicolegal cases, but still has its own disadvantages. This technique has been recently used by forensic odontologists, but yet to receive its own limelight.

## Virtual autopsy in forensic sciences and its applications in the forensic odontology

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The most important forensic expertise is the medicolegal autopsy, which is also popularly called as "the expertise of expertises". But it has emotional and ethical disadvantages as many cultures and religions do not go hand in hand in mutilating the body for the sake of autopsy.

Radiological imaging and the first time observation of the cranial sinuses by Martin and Arroio in 1896 using postmortem radiological techniques has laid a pavement for the development of a new technique that is termed as virtopsy which uses latest radiological techniques like CT, MRI, and three-dimensional (3D) imaging for the examination of dead bodies.

Dental identification procedures often include the comparison between postmortem and antimortem data, development of dental postmortem victim details, and dental deoxyribonucleic acid (DNA) techniques. Postmortem dental data is compulsory for dental identification, which is obtained principally by visual examination. But visual examination is very difficult in victims with charred bodies and damaged oral cavities. In these cases, virtopsy becomes a quick, reliable way for getting postmortem records.

In recent days, there is a decrease in invasive dental treatment making identification based on restorations more difficult. Identification based on shape of pulp chambers, root arrangement, and periodontal status is gaining importance.

In virtopsy, 3D imaging in postmortem victims is effectively performed by using principle of triangulation. Along with this, virtopsy has many advantages which are not there in conventional autopsies like 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 a greatest disadvantage of conventional autopsy. Also, the examination through virtopsy can be done without any fuss as there is no cadaver contamination.

Though virtopsy has its own advantages, it has a disadvantage that the physiological senses of an anatomical pathologist like smell, texture, and color are restricted as there is no direct contact with the dead body of the victim. Also, the main disadvantage is the feasibility in using these high technology imaging devices in less developed countries.

## Virtopsy: The Swiss virtual autopsy approach

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Virtopsy technique uses the modern radiographical aids like computed tomography (CT) and/or magnetic resonance imaging (MRI) to scan the dead bodies and obtains a more sensitive, specific, and accurate result than that of the conventional autopsy. The comparison between conventional autopsy and CT has shown that CT is a superior tool in identifying entry and exit pattern of wounds (fracture patterns), pathological gas collections,

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and gross tissue injury. The postmortem CT though has the above advantages, is less specific and sensitive in assessing intravenous contrast. Postmortem MRI is highly sensitive, specific, and mainly used for assessing soft tissue injuries, neurological/non-neurological trauma, contusions, and hematomas.

Magnetic resonance spectroscopy (MRS) is another 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. Microtomography is used to study the weapon involved and its injury patterns.

Virtual autopsy is used in cultures where conventional autopsies are not accepted. It also has advantages that the archives can be easily retrieved for medicolegal purpose and bodies that are toxic can be easily examined without any contamination.

## **Virtopsy: An alternative to the conventional autopsy**

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The progress in imagistic domains (computed tomography (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, three-dimensional examination of naturally preserved specimens.

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 autopsy were identified through imagistic methods independently. In morphopathological observations, MSCT and NMR were superior to autopsy in trauma cases, but inferior to those caused by organic diseases. In vital response studies, MSCT and NMR are superior in pneumothorax, air embolism, and subcutaneous emphysema; but inferior to autopsy in hemorrhage and fat embolism. Vascular and metabolic modifications

cannot be identified because the contrast cannot be injected. In the reconstruction of the lesion, contribution from virtopsy is significant as in case of traffic accidents where impact force can be identified for all the victims through these techniques, order of fractures, depth and orientation of wounds, direction of flames as well as tissue carbonization degree. Virtopsy role in identifying death cause is indisputable and reexamination is possible in seeking second opinion. Inconvenience in financial aspect in virtopsy should be considered, but it has an immense psychological and cultural advantage on people of certain religions and communities who believe that body and soul are inseparable and thus forbid the autopsy.

## **Virtopsy versus autopsy in unusual case of asphyxia: Case report I**

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Asphyxia is defined as the death caused by deprived supply of oxygen (hypoxia), which can be total or partial. It can also be caused by compression of nerves and vessels of the neck. This type of death is caused not only by suicides but also by obstruction of the upper respiratory tract by food materials. The food obstruction is caused by habits such as alcohol or drugs, trauma with decreased level of consciousness, and even partial or total edentulism. Particularly in elderly patients, death may be due to improperly prepared food.

An attempt was made to identify whether the death of an old woman was a suicide or homicide, but found out to be due to obstruction of food by this method of virtopsy through the inspection of the corpse and from the data received from multislice computed tomography (MSCT) where diffuse signs of periodontopathy, presence of radicular stumps, and maxillary alveolar bone resorption was evident. MSCT revealed the presence of inhomogenous hypodensity extending from the glottic region until the bronchial carina with involvement of the main bronchial branches except the right upper lobar appearing normoventilated. Findings of autopsy analyzed the masticatory and respiratory apparatus. Salivation and mastication are the two components involved in the formation of the bolus and severe periodontal diseases with partially edentulous area was noted. Similar material as in the oral cavity was found in the carinal and the bronchial seats. The histological examination showed the presence of starch fibers within the pulmonary bolus. Lung examination showed small subpleural and subepicardial petechiae. In this study, the author highlights the role of MSCT in detecting maxillofacial area disorders and presence of endotracheal foreign body. This method is repeatable and observer independent tool.

## **Estimation of sex and age of “virtual skeletons”: A feasibility study**

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The potential of multidetector tomography (MDCT) in estimating the bone age and sex of deceased persons is demonstrated in this study. Twenty-two blinded cases of the Institute of Forensic Medicine, Berne were chosen which had intact skeletal system and whose confirmed age at death was known. MDCT was performed and estimation of sex was done independently by three anthropologists. Also, estimation of age was performed using the complex method according to Nemeskeri and coworkers (parameters include endocranial obliteration of the sutures, structure of the spongiosia of the proximal humerus, the proximal femur,

and the texture of symphyseal surface of the pubic bone).

The sex of 22 cases was determined correctly by the anthropologists upon examining the virtual skull and pelvis. Results of the complex method alone and final estimation including more parameters were separately investigated. By adding additional parameters to the complex method (live state of dentition, degeneration of the spine, etc.) age estimation by all the three anthropologists improved significantly with conspicuous reduction in wrong interpretation. Bones were estimated without sampling and maceration by MDCT, also virtual skeleton can be easily handled without destruction and therefore used for infinite investigations.

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