Review Article

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Current Scenario of Virtopsy of Head and Neck.

[1]Parul K. Sinha, [2]Rakesh K. Gorea, [3]Parul Kumar
[1]Department of Oral Pathology, Jiao Tong University, Shanghai, China
[2]Forensic Medicine Gian Sagar Medical College, Ram Nagar, Punjab
[3]Shine Family Dental Surrey, BC, Canada

Abstract:
Virtopsy has been discussed lately as a new era over the traditional autopsy. In numerous published literatureVirtopsy has been reviewed. Authors have discussed different techniques used, advantages and disadvantages. But only a few cases have been reported using this technology and limited studies have been done predominantly related to the virtopsy of head and neck (VHN). This paper focuses on the cases particularly related to head and neck region that have been actually elucidated through virtopsy around the world and the studies were particularly done in head and neck region. In this paper, possibilities have been looked to replace the buccal autopsy, by virtopsy, in the times to come. Furthermore, the status of VHN in India is discussed. The real scenario of this latest advancement

Keywords: Autopsy, CT, virtopsy, postmartum, forensic

Introduction:

Forensic Medicine is the branch wherein experts thoroughly examine deceased for the cause of death. During the autopsy, they look for what primarily are victims of probable, suspected or evident violence that ultimately die. In cases of mutilation, severe burn wherein skull and teeth are available for identification, collection of PM dental data becomes very important for dental identification. This can be attained by direct visual investigation and associated recording of the available evidence. Supplementary information is collected with photographic and digital imaging of the dentition and the oral cavity. Virtopsy of head and neck (VHN) plays a crucial role over traditional dental autopsy in particular cases where PM photographic and radiological examination is difficult because the access to the oral cavity is obstructed (e.g. bodies in rigor mortis condition). Additionally VHN also allows dental identification in a precise and quick way without damaging the body to access the available dental data.[1] Furthermore dental age estimation methods based on teeth development can be applied during the virtual autopsy, letting the examiner include or exclude deceased based on age-related victim lists.

History of autopsy goes way back to around 3000 BCE, the ancient Egyptian civilization practised mummification, the removal and examination of internal organs of humans for a religious cause.[2] In 44 BCE famous Julius Cesar's official autopsy was conducted after his murder by rival senator by stabbing him 23 times.[3] By 150 BC ancient Romans had established parameters for the legal practice of autopsy.[2] In

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Address for Correspondence : Dr. Parul K. Sinha
Department of Oral Pathology, Jiao Tong University, Shanghai, China
Email- parulsinha02@gmail.com

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1769 Italian anatomist Giovanni Battista Morgani also known as Father... of anatomical pathology wrote a book "The Seats and Causes of Diseases Investigated by Anatomy."[2] In 19th century standard protocol of autopsy was established and published by Rudolf Virchow, he also developed the concept of pathological processes. During the turn of the 20th century, the beginning of the latest era in forensic medicine started with the introduction of radiological techniques for performing an autopsy, the concept of "virtopsy." Which is an amalgamation of surveying technology, pathology, radiology, image processing, computer sciences, telematics, physics, and biomechanics.[4]

The term virtopsy is a combination of "virtual" and "autopsy." Wherein the word virtual is derived from the Latin word virtus, which means "useful, efficient, and good."[5] In 1977 the first forensic application of the radiological technique of computed tomography (CT) was used for the depiction of gunshot injury to the head, by Wullenweber et al.[6] In 1989 spiral CT was used by Kalender *et al*, for three-dimensional (3D) data acquisition and processing.[7]

Currently, virtopsy employs imaging methods that are also used in clinical medicines like computed tomography (CT), magnetic resonance imaging (MRI), and three-dimensional (3D) imaging for the examination of dead bodies.[8] The choice of methods are further enhanced with 3D imaging-guided biopsy systems[9] and post mortem angiography.[10] These non-invasive and less time-consuming techniques can be used for broad and systemic examination of the whole body as they are not only adjuring method for better diagnosis but also respect the religious sentiments.[8]

VHN can be employed for a large spectrum of forensic situations. To enlist few of them, thanatological investigations; carbonized and putrefied body identifications; mass disaster cases; age estimation; anthropological examinations and skin lesion analyses.[11] Particularly distinctive cases related to forensic odontology wherein sometimes it gets difficult to open the jaws because of lockjaw situations caused due to certain reasons or skulls that are highly mutilated (case 1). In such a scenario, VHN has an added advantage over traditional technique as the possibility of visualizing 3-D anatomical structures systematically, in real-time, without damaging the body is an important improvement.[11] Moreover, the data can be stored and fully re-interpreted at any time.[12]

Death because of corpora aliena in the larynx is a well-known entity in forensic pathology. In these typical cases, it is difficult to identify the precise reason of death without conducting an autopsy. Therefore the likelihood of misdiagnoses increases by solitary doing the external examination.[13] In such cases VHN plays an important role(case 2-4).

Other situations where the examination of the cases has to be done even after several years of death, the disposal of radiological chemical processing and the enhanced data organization and communication is the advantages provided by virtopsy[11](case 5).

CASE 01: France (2007) a house constructed of wood and thatched roof in the mountainous region caught fire and the roof collapsed. The remains of a charred body were brought for investigation. Experts conducted multislice computed tomography (MSCT) before bone preparation and after autopsy concludes as accurately as possible the sex, age, antemortem stature and ethnic of the victim. 2D and 3D Axial MSCT images were interpreted for all four basic questions mentioned above. It was illustrated that this technique is not only rapid for identification of deceased in a medicolegal context but also extremely useful in cases where charred or fragile bones are obtained for examination. Furthermore, there is no manipulation or treatment of the bones and there is no loss of information.[12[

CASE 02: Germany (2009) A 60-year-old man with known dementia collapsed unexpectedly. Resuscitation was tried, but the man was declared dead by the doctors when reached emergency. MSCT including postmortem computed tomography– angiography was performed, a laryngeal mass, causing stenosis of the larynx, could be seen with the help of

contrast agent. Beside this foreign material could also be identified in the remaining lumen. It was concluded from this case that in addition to the postmortem MSCT, the combination of MSCT with post-mortem angiography can give more valued evidence because of enhancement in neoplastic tissue.[13]

CASE 03: Germany (2009) A 70-year-old man while eating a piece of meat in dinner, got chocked and collapsed immediately. Attempts of Resuscitation were carried out but were unsuccessful. The deceased had history of hypertension, minor cerebral strokes, alcoholism and skeletal deformation of the right leg. In the post-mortem multislice computed tomography (MSCT) and magnetic resonance imaging (MRI), a foreign body in the larynx was evidently .
Also, could appreciate findings like cerebral atrophy and small stroke residues by these imaging procedures. Importantly by performing PM VHN using MRI the differentiation between neoplasm or soft foreign bodies was easily possible but was difficult by MSCT alone.[13]

CASE 04: Germany (2009) A 90-year-old woman was getting fed by a nurse her breakfast at a nursing home, she choked, coughed and collapsed immediately. Heimlich manoeuvre was performed but was not successful. The deceased had a history of Parkinson's disease. By post-mortem MSCT it was is possible to eliminate the accusation of maltreatment without an autopsy. So MSCT was performed and foreign body in the larynx was evidently visible, other organs like trachea and the bronchi were free of any foreign material.[13]

CASE 05: Germany (2011) Skull with only upper jaw intact, of a missing person from the past 5 years was reported for identification. The skull was scanned with a multislice computed tomography (MSCT) scanner and virtual radiographs with the desired angulation were generated from the data with the maximum intensity projection (MIP) technique. To compare with an antemortem dental chart and two dental films of the 1st and 2nd dental quadrants. The upper jaw was scanned with a high-resolution eLU-CT (eXplore Locus Ultra-flat panel CT). The result obtained from CT datasets were then analysed with the MIP technique and generated virtual radiographs that could be compared with the antemortem radiographs. Positive identification was anticipated with proximate certainty after dental features possibly be matched in the superimposition of antemortem and postmortem radiographs.[14]

Study 01: Washington, DC (2006) A special report was published by Levy *et al*. from the Department of Radiologic Pathology, Armed forces Institute of Pathology, Alaska on virtual Autopsy with CT in Gunshot Wound Victims. Eight male victims with gunshot wounds in the head and neck region (age range, 19–49 years; mean age, 27 years) were assessed retrospectively. All of the subjects sustained lethal injuries fromAK-47 assault weapons and some machine guns. Victims were imaged with total-body multidetector CT within 2–5 days of death. Findings revealed gunshot wound trajectory entry to exit defects recognised by the presence of gas and metallic fragments along the bullet paths. Both multidetector CT followed by autopsy didn't show injury to the neck vessels.[15

Study 02- Switzerland (2008) The study investigated, presently used restorative materials using ultra-high-resolution dual-source CT and the extended CT scale to analyse for colour-encoded, in scale, and artifact-free visualization in 3D volume rendering. 220 cavities were prepared in 122 molars of 2-5mm diameter with currently used filling materials (different composites, temporary filling materials, ceramic, and liner), these cavities were restored in six teeth for each material. Further images were reconstructed using an extended CT scale on CT scan and filling material was examined in terms of resulting in Hounsfield units (HU). These values helped to easily visualize the position of restorations, the shape (in scale), and the material used which is colour encoded in 3D. Different restorative materials showed distinctively differing radiopacities allowing for CT-data-based discrimination, predominantly, ceramic and composite fillings could be differentiated. Researchers concluded that CT of dentition could facilitate routine forensic work and specifically support disaster victim identification.[16]

Study 03: Sweden (2011). A study was conducted to evaluate the use of high-resolution CT to radiologically describe teeth filling material properties after high-temperature exposure. 122molars with 10 different filling materials were examined. Using CT scan teeth were scanned before and after the exposure to different temperatures to analyse their morphology and Hounsfield units (HU). Researchers concluded that this technique along with 3D visualization improves the identification of defining filling materials in the cases of heat exposure up to approximately 600°C. Which includes the majority of fire victims like burned corpses, particularly in mass disaster catastrophes, where the identification process might be complicated by the number of victims, the weather or logistical problems. Further, this technique can also give information about the fire lapse and definite temperatures in the region of the victim's mouth.[17]

Study 04: Belgium (2013) A study was conducted to authenticate if PM dental charting could be performed on virtual reconstructions of full-body CT's using the Interpol dental codes.103 PM full-body CT's data were collected retrospectively, out of which 3 bodies were sent for dental radiography, full-body CT examination and complete dental autopsy. 3D reconstructions of images were done on axial, coronal and sagittal slices. The dental identifiers were charted on pink PM Interpol forms (F1, F2), using the associated dental codes. Study results revealed that optimal dental charting could be attained by combining observations on 3D reconstructions and CT slices. Oral identifiers,3D morphological features of dental and maxillofacial structures were observed. That is informative because of inherent spatial features, increasing preventive dental treatment, and the decreasing application of dental restorations. Therefore, VHN can give much better analysis if PM dental charting protocols and the Interpol dental codes are adapted accordingly.[18]

Study 05: Niels *et al*, proposed a guideline for PM CT for dental Identification in 2019. For their study, they collected 15 cases retrospectively from the Department of Forensic Medicine and using the functionalities and 3D reconstructions of OsiriX DICOM-viewer software they adjusted the contrast and brightness settings and developed a proposed four-step guideline for creating PMCTbased dental charts. Under the main headings of "overview" and "detailed recording of examination finding," these were further subdivided into 4 groups Step 1 (Mode: LAT and AP topograms), Step 2 (Mode: Tomogram), Step 2a (Mode: MPR to align upper and lower Jaw), Step 3 (Mode: Tomogram and/or MPR) Step 4 (Mode: 3d). For each group authors have given detailed observations and instructions, to mention few; an impression of dentition, presence of prosthetics, types of fillings, implants etc. Although further research is needed to validate the proposed guideline.[19]

Discussion:

VHN principal benefit is, it is an alternative to invasive surgical procedures and uses the latest radiological techniques imaging for the examination of cadavers, charred bodies and severely damaged oral cavities with a quick and reliable way for getting postmortem records.[20] Virtopsy can also be used to assist in both individual and general identification, including determination of gender, ethnic group and age.[21] Further, these imaging techniques are useful inability to recognize pathology in decaying tissues, ability to achieve and use information related to material composition, identification and assimilation of bone bruises into accident reconstructions, certification of medical installations, the identification of gas and utilization of digital data for reconstructive purposes.[22] Other advantages of VHN is that these digital images can be enhanced for optimal viewing thus permitting side -by -side digital comparisons of antemortem and postmortem radiographs. These radiographs provide much better information that may not be registered on clinical examination. For instance particulars like the shapes of restorations, bases under restorations, dental and radicular shapes, endodontic treatments, and anatomy of the maxillary sinuses.[21] An added advantage that digitally stored data may be recollected at any time to provide fresh, intact topographic and anatomic clinical information. Better quality control and proficient observation become possible, as do image transmission and forensic "telemedicine" consultation.[23] The limitation of VHN is its cost to install the system and its feasibility of implementation of high-technological imaging devices in the developing countries, for scientific purposes. Besides the bioethical issue related to digital imaging

transferring for the use of virtual autopsy.[11] Other disadvantages of VHN in buccal mucosa includes the absence of touch, feel, and smell senses by forensic personnel.[24] It is not possible to differentiate all the pathological conditions, infectious status, AM or PM injuries. It is also difficult to appreciate the PM artefacts, colour changes, and sometimes small tissue injury. Till date, no literature associated with the use of specific colour resolutions for image analysis in full-body CTs have been retrieved.[25,26]

December 2019 Indian government announced that "The All India Institute of Medical Science (AIIMS), New Delhi and Indian Council of Medical Research (ICMR) are working together on a technique for postmortem without incising/dissecting the body. This technique is likely to become functional in the next six months". Minister also acknowledged, "the traditional postmortem often makes members of the dead person's family uncomfortable. That, in fact, is the primary reason for the increasing use of virtual autopsies internationally. ICMR and AIIMS have studied global practices, and taken up this project for "dignified management of dead body".[27]

Conclusion :

VHN is still developing among the commonly used methods. Postmortem CT is more frequently used in developed countries worldwide for screening the cause of death, candidates for autopsy, and guidance and/ or supplemental information for autopsy as compared to India. Where this branch of forensic sciences is still in naïve stage. Even though there are differences in the AM radiological findings and PM findings, this field needs further study intensively. VHN charting has to be deliberated as a supplementary tool in the human dental identification technique as it is a new advancement in the field of investigations of death and its acceptability in the court of law is yet to be proved in India. VHN do help in differentiating especially ceramic and composite fillings that can ease daily forensic routine work and particularly support disaster victim identification teams in their work. Digital images are more reliable, in terms of collection and analysis of data, accurate with fewer errors and could not be manipulated by the third person. VHN need to be incorporated in our system and setups and experts need to be well versed in this technology by practising in the software in an effective and legal way. Future of digital forensics also relies on reduced costs of technology that will enhance their utilization of this technique in various specialities.

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