Review Article

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VIRTOPSY: NEW PHASE IN FORENSIC ODONTOLOGY

Yogish.P [1], Asha Yogish [2]
1.Assisstant Professor in Department of Oral Pathology and Microbiology, Sharavathi Dental College and Hospital, Shivamogga.
2.Postgraduate student in Department of Oral Medicine and Radiology, Coorg Institute of Dental Sciences, Virajpet.

ABSTRACT:

Nowadays, technological advances are becoming more and more important in forensic sciences. Yet autopsy is still one of the very traditional methods. This also applies for dental autopsies, in which visual, photographic and radiological evidences are collected. Virtual Autopsy appears as a helpful and complementary tool for dental and medical cadaveric examination. Using high-tech radiological approaches, Virtual Autopsy may provide, through images, an efficient and more accurate view on the individual case. This critical review aims to update on the origin, applications of virtopsy and also the role of dentists in this field.

Keywords: Autopsy; Radiology; Forensic Odontology

INTRODUCTION:

Death is an inevitable part of life and at few occasions scientific examination of bodies after death becomes mandatory. Modern day investigations have reached a point of sophistication interconnecting the involvement of many different disciplines to serve problems including establishing reasons for death. The contribution of Forensic science in achieving this is noteworthy.

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. It involves 10 disciplines which include Crimanilistics, engineering science, general, jurisprudence, odontology, pathology/biology, psychiatry and behavioural science, questioned documents, toxicology and physical anthropology.

Forensic pathology is a discipline of Forensic science which deals with pathologic and physiologic changes of a body before and after death wherein autopsy plays a significant role which deals with establishing the circumstance leading to death by scientific examination of the whole surface of the body as well as body cavities.[1]

The main aim of this review article is to update on the origin, applications of virtopsy and also the role of dentists in this field.

HISTORY OF AUTOPSY

Greek physicians Erasistratus and Herophilus dissected cadavers to study the working of organs and nerves.[2] It was in 1700 when Giovanni Morgagni –

*Corresponding Author Address: Dr Yogish.P Email: pyogish@yahoo.com

the founder of today's autopsy wrote a book on “The seats and causes of Disease" investigated by anatomy and published it in 1761 in which he described 700 autopsies that he performed. Susequently Matthew Baillie, in 1793 wrote a textbook on Morbid Anatomy of the Human Body and its accompanying atlas, 6 years later.[2] In 1800, William Osler who taught medicine placed autopsy at the centre of the medical education.[3]

AUTOPSY VS VIRTOPSY

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.[4] The traditional internal autopsy procedure consists of body mutilating techniques. Due to the emotional aspects of the victim’s relatives, their knowledge of these mutilation forms the major objection against autopsies.[5] The arguments justifying the autopsy, namely the need to know the cause of death or the identity of an unknown deceased individual overrules this emotional involvement. Therefore, the families and relatives of the victim often remain in a conflicting situation with the forensic examiners.[6] Parallel to that, some religious and cultural aspects represent relevant objections for the autopsy procedure. 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.[7]

Martin and Arroio showed the applicability of post-mortem radiographic techniques in order to identify bodies through comparative analysis of the cranial sinuses.[8] Besides, numerous cases were reported in which liver, heart, brain and bone injuries were investigated radio graphically revealing the possible death cause. Furthermore, X-ray examinations were valuable to perform guided autopsies based on the acquired skeletal information. More specific in detecting(healing) bone fractures, which in many cases are indistinguishable during traditional autopsy.[8] A new autopsy technique consists of the internal examination of death bodies using computed tomography (CT) and magnetic resonance imaging (MRI), without opening the body or body parts. Besides, it allows the reconstruction of a 3D view of the analyzed cadaver. This procedure was called “Virtopsy.[9]

The term Virtopsy coined by Thali M.. et al is created from the terms Virtual and Autopsy where Virtual is derived from the latin word “Virtus” which means „useful, efficient and good“ and elimination of autos ie, self thus leading to the scientific umbrella Virtopsy. Virtopsy is a transdisciplinary technology that combines Forensic medicine, pathology, radiology, image processing, physics and biomechanics.[10] Because the dentition contains multiple identifiers teeth often play a major role

in human identification processes. These processes allow for dental identification:

The comparison between post mortem (PM) and ante-mortem (AM) data, the development of dental PM victim profiles and the dental DNA techniques.[11]

The collection of all PM dental data is indispensable for dental identification. These are obtained by direct visual observation and related recording of the available evidence. Additional information is collected after photographic and radiographic imaging of the dentition and the oral cavity. In certain cases the PM photographic and radiological exam is difficult because the access to the oral cavity is hindered (e.g. bodies in rigor mortis condition).In contrast to the classical dental autopsy the virtual autopsy process allows dental identification in an accurate and quick way without damaging the body to access the available dental data. 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.[12]

ORIGIN AND MECHANISMS

Drugs Aiding in Cessation: The most common line of drugs indicated to be aiding in tobacco cessation are the anti-depressants. Amongst the majority, the basic drug used is Bupropion Hydrochloride. A placebo trial of bupropion was conducted and the analysis concluded that the effective relative to the use of placebo was about 2.1 (95% confidence interval 1.5-3.0) [5]. The basic effect of bupropion is to elevate the levels of dopamine in the brain. Increase in the levels of dopamine are associated with the use of nicotine, so the use of bupropion mimics the use of nicotine. This mechanism helps to quit tobacco faster relatively then other drugs. Also it helps in maintaining the diet and weight of the patient. Some studies have also suggested that the conjugation of bupropion and nicotine patch is more effective than either of them being used alone [6].

Another important drug very commonly used in the treatment of tobacco abuse is Clonidine. Clonidine has been widely used in opium and alcohol withdrawal but recent studies suggest its efficacy in tobacco withdrawal as well [7]. Also drug named nortriptyline can also be used in the tobacco cessation therapy but only as a second line therapy.

Imaging techniques was supported by the creation of organizations like the Institute of Forensic Medicine (Denmark), the Victorian Institute of Pathology (Australia), the Society of Imaginological Autopsy (Japan) and the Headquarters of Medical Examinations of the Armed Forces of the United States of America.[13] In the nineties, the Institute of Forensic Medicine of the University of Bern, Switzerland, began to document on the characteristics of the human body in a concrete, objective and non-invasive way. This resulted in the

creation of a new discipline, denoted as "Virtopsy", a virtual project of autopsy.[14] In this context, the concept of the objective and noninvasive documentation of the body consists in the observation of the anatomical structures through computed tomography (CT), magnetic resonance (MRI) and micro radiology devices. Specific software (e.g. Tera Recon Aquarius NET®, Foster City, California, United States of America) allowed for 3D reconstructions of the computed tomography images from the observed structures. Another part of the documentation concerns the body surface recording, performed by forensic photogrammetric and 3D optical scanning.[13] Due to the need of getting quick and accurate information about forensic cases, international researches increasingly indicate Virtual Autopsy as a useful tool for forensic exams. 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.[15]

Aiming the CT exam, the body can remain wrapped in an artifact-free body bag and several exam protocols can be chosen considering the area to be analyzed. For soft tissue investigation the magnetic resonance is the best choice due to its dependence from the hydrogen molecules. The internal image collection is carried out on radiological units, e.g. the Leonardo® workstation (Siemens Medical Solutions®, Erlangen, Germany).[16] The external examination is performed using the GOM TRITOP/ATOSIII® system (GOM®, Braunschweig, Germany).[15] The TRITOP portion is based on photogammetry, therefore digital images are taken by a Nikon D2X® camera (Nikon Corp.®, Tokyo, Japan) and submitted wirelessly to the main system.[15] Through these images the photogammetry 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 to scan for example both jaws with high image quality takes, depending on the used protocol, around 1 minute. Aiming the management and organization of the Virtual Autopsy data, several software packages are implemented during the data acquisition. Such as the navigation software for Muti-slice CT analysis and the TRITOP/ATOS® software for surface scanning and photogammetry. These packages are controlled remotely by the Virtopsy Control Centre – VCC® (PROFACTOR Gmbh®, Steyr-Gleink, Austria), the main single software which sets all the robotic positions, guides the operator and stores the entire patient's information. Another complementary system is the Virtopsy Robot Control – VRC® (PROFACTOR Gmbh®, Steyr-Gleink, Austria), which is responsible for executing the commands related to

mobile tools, such as the robotic arms which perform scanning procedures.[15]

APPLICATIONS

The Virtual Autopsy can be applied in a broad number of forensic situations, such as thanatological investigations; carbonized and putrefied body identifications; mass disaster cases; age estimation; anthropological examinations and skin lesion analyses.

In drowned bodies the CT information about the volume, density, size of the lungs and the amount of liquid observed in them is helping in diagnosing the cause of death.[17]

Cases of firearm projectile injuries are often difficult to examine because either sometimes the bullet is not in the body, or diverted by an anatomical structure, or it can be in unknown body parts. Therefore, knowing the location of the projectile before the autopsy is performed facilitates the examination.[18]

In mass disaster cases Dirnhofer et al. describe for human identification purposes the use of adapted vehicles with imaging machines allowing for PM data collection on the disaster field. The author states that mobile CT imaging could provide a high level of positive identifications.[13]

In the odontology field, Oesterhelweg et al. describe a case where the victim was struck by respiratory obstruction from a foreign body (food bolus). The differentiation of the obstructive structure was performed with combined computed tomography and magnetic resonance imaging. In conventional autopsy examinations the greatest difficulty is to predict the depth of the foreign body. The virtual autopsy provides this information accurate and clear. Health professionals must be aware of these complementary exams because over 90% of these emergency cases were misdiagnosed.[19]

Another specific odontological application for the Virtual Autopsy is on the comparison between AM orthopantomograms and 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. Birngruber et al. reported a positive identification case based on the superimposition of post-mortem CT reconstructed images on ante-mortem radiographies.[20]

Dedouit et al. stressed the importance of the presence of dentists in the forensic identification team in particular to determine the age of charred bodies. In traditional medical examinations the decomposition of the body is a limiting factor for age assessments. Therefore, the author cites the performance of dentists to examine dental and anthropological data.[21]

Studies on restorative materials are also related on the virtual technique. Through the analysis of the restoration materials density, Jackowski et al.

performed pioneering researches on Odontology in Virtual Autopsy. These authors expressed in Hounsfield Units the different density of restoration materials, such as composites, temporary fillings and ceramics, by ultra-high-resolution CT imaging.[12] Furthermore, the author verified the course of restoration materials under high temperatures by CT images, simulating a fire mass disaster.[22]

BENEFITS AND PITFALLS

Advantages

1.It is a Scalpel free non invasive imaging technology.

2.It is digitally storage over years or decades and even transferrable over the web for second opinion.

3.It is an ethical evolution which serves better acceptance for the relatives of the deceased and also by certain religious ustoms where incisions are not recommended after death.

4.Since there is no mutilation of the body no hazard of infections from the blood or other tissue fluids.

5. It is less time consuming and body can be released immediately after the scanning.

Disadvantages

1. It is not possible to distinguish all the pathological conditions with this technique and it is associated with insufficient data base when compared to conventional autopsy.

2. It exhibits dilemma in differentiating ante mortem/postmortem artifacts; color changes and establishment of infection status.

3. Occasionally small tissue injury may be missed.[23]

CONCLUSION:

Virtual autopsy emerges as a useful tool for forensic investigations. Its main benefits are related to the improved collection of data compared to the traditional technique. The feasibility of visualizing 3-D anatomical structures thoroughly, in real time, without damaging the body is an important gain. The absence of contamination from cadaver's substances is an additional advantage. The main objection observed in the application of virtual autopsy, is its support to be performed in less developed countries, in which high-technological imaging devices are not easily feasible for scientific purposes. However, as any other new trend in science, the virtual autopsy is still developing and getting space among the commonly used methods. This review allows concluding that the virtual autopsy favours the development of forensic autopsies and stresses the role of forensic Odontologists in this field.

REFERENCES:

1. Phillip E.O. Shaughnessy. Introduction to Forensic science. DCNA. 2001;45(2).
2. Bay NS, Bay BH. Greek anatomist herophilus: the father of anatomy. Anat Cell Biol. 2010; 43(4):280-3.
3. Ellis H. Matthew Baillie: pioneer of systematic pathology. Br J Hosp Med (Lond). 2011; 72(10):594.
4. Almeida JR A, Costa JR JBO. Lições de medicina legal. 20ª ed. São Paulo: Editora 3. Nacional; 1991
5. França GV. Medicina legal. 5ª ed. Rio de Janeiro: Guanabara Koogan; 1998.4.
6. Maldonado MT. Psicologia da gravidez. 17ª ed. São Paulo: Saraiva; 2009.6.
7. Lamm M. Autópsia e embalsamento segundo a lei judaica. [Online News]. [Accessed on 7. 2011 April 17]. Available at http://www.dihitt.com.br/n/religiao/2011/03/29/autopsiae-embalsamamento
8. Martin A, Arroio J. La radiologia cadavérica. Rev Esp Med Legal 1986;1:46-7
9. Pomara C, Fineschi V, Scalzo G, Guglielmi G. Virtopsy versus digital autopsy: virtuous 8. autopsy. Radiol Med 2009;114:1367-82.
10. Thali MJ, Jackowski C, Oesterhelweg L, Ross SG, Dirnhofer R. Virtopsy – the Swiss Virtual autopsy approach. Leg Med (Tokyo) 2007;9(2):100-4
11. Girish KL, Rahman FS, TIppu SR. Dental DNA fingerprinting in identification of human remains. J Forensic Dent Sci 2010;2:63-8.
12. Jackowski C, Wyss M, Persson A, Classens M, Thali MJ, Lussi A. Ultra-high-resolution dual-source CT for forensic dental visualization – discrimination of ceramic and composite fillings. Int J Legal Med 2008;122:301-7.
13. Dirnhofer R, Jackowski C, Vock P, Potter K, Thali MJ. Virtopsy – minimally invasive, imaging guided virtual autopsy. Radio Graphics 2006;26:1305-33.
14. Cha JG, Kim DH, Kim DH, Paik SH, Park JS, Park SJ et al. Utility of postmortem autopsy via whole-body imaging: Inicial observations comparing MDCT and 3.0T MRI findings with autopsy findings. Korean J Radiol 2010;11:395-406.
15. Ebert LC, Ptacek W, Naether S, Fürst M, Ross S, Buck U et al. Virtobot – a multi-functional robotic system for 3D surface scanning and automatic post mortem biopsy. Int J Med Robotics Comput Assist Surg 2010;6:18-27.
16. Ampanozi G, Ruder TD, Preiss U, Aschenbroich K, Germerott T, Filograna L et al. Virtopsy: CT and MR imaging of a fatal head injury caused by hatchet: A case report. Legal Med 2008;12:238-41.

17. Levy AD, Harcke HT, Getz JM, Mallak CT, Caruso JL, Pearse L et al. Virtual autopsy: Two and three dimensional multidetection CT findings in drowning with autopsy comparison. Radiology 2007;243:862-8.
18. Levy AD, Abbott RM, Mallak CT, Getz JM, Harcke HT, Champion HR, Pearse LA. Virtual autopsy – Preliminary experience in high-velocity gunshot wound victims. Radiology 2006;240:522-8.
19. Oesterhelweg L, Bolliger SA, Thali MJ, Ross S. Postmortem imaging of laryngeal foreign bodies. Arch Pathol Lab Med 2010;133:806-10.
20. Birngruber CG, Obert M, Ramsthaler F, Kreutz K, Verhoff MA. Comparative dental radiographic identification using flat panel CT. Forensic Sci Int 2011;209:31-4.
21. Dedouit F, Telmon N, Costaglioga R, Otal P, Joffre F, Rougé D. Virtual anthropology and forensic identification: Report of one case. Forensic Sci Int 2007;173:182-7.
22. Woisetschläger M, Lussi A, Persson A, Jackowski C. Fire victim identification by post-mortem dental CT: Radiologic evaluation of restorative materials after exposure to high temperatures. Eur J Radiol 2011;80:432-40.
23. Patowary A.J. Virtopsy: One step forward in the field of forensic medicine – a review. J. IndianAcadForensicMed.2008;30(1):32- 36