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VIRTUAL AUTOPSY-An Overview and Use in the Diagnosis of Drowning

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Abstract
Virtual Autopsy or Virtopsy is a growing alternative method for a conventional autopsy that is performed by various imaging techniques for various purposes such as clinical, medico-legal, anatomical. In a conventional autopsy, the dead body is dismembered which is difficult for the remembrance of that person by their family which can be prevented by the use of virtual autopsy. A medico-legal autopsy is done in case of unnatural death of a person, one of which is drowning, it is very difficult to diagnose even with conventional or traditional autopsy but there have been several experiments and findings to diagnose drowning with imaging techniques. Computed tomography was one of the first imaging technique to be used for virtual autopsy, however, over the period various techniques were being used like multi-section computed tomography, micro-computed tomography, magnetic resonance imaging, magnetic resonance microscopy, magnetic resonance spectroscopy, post mortem biopsy, 3 D photogrammetry-based optical surface scanning, ultrasonography, maximum intensity projection. In this paper, we will see an overview of the virtual autopsy sharing its history, various imaging techniques, working procedure of virtual autopsy, its use in the diagnosis of drowning, and the feasibility, advantages, disadvantages of virtual autopsy along with its future advances.

Key Words: *Virtual Autopsy, Drowning, Imaging Techniques, Virtopsy.*

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I. Introduction

Autopsy signifies "Self" (autos) and "I will see" (opsomei) in Greek "to witness firsthand". It is the foundational and logical assessment of a dead body to decide or affirm the reason for death. They are of three sorts specifically clinical or pathological, medicolegal, and anatomical**. Clinical/Pathological autopsy** is done to decide the ailment causing passing and a pathologist performs it with the assent of family members of the expired. **A medico-legalautopsy**is done to understand the secretive unnatural passing and is finished by a Forensic pathologist or medico-legal expert preferably, a medico-legal post-mortem examination has numerous targets, including recognizable proof, estimation of the hour of death, investigation of the wounds (distinguishing identity, documentation, and appraisal of their significance), Identification of characteristic illnesses, recognition of toxic substances, just as recognition of clinical medicines. **An anatomical autopsy** is completed to gain proficiency with the ordinary structure of the human body by clinical understudies. Forensic pathology is a field inside which doctors are for the most part distracted by inspecting what at first are casualties of conceivable, suspected, or evident brutality. Clinical Forensic Medicine does likewise however with living casualties.

An essential part of a post-mortem examination is the dismemberment of a body, which not exclusively can all the time be horrible for the group of the perished, yet also can be unwanted or even illegal in various social and strict settings like in Judaism, it is totally restricted to allow an autopsy on the dead. So post-mortem examination is typically a clashing circumstance for scientific analysts. In certain circumstances, an examination is performed when there is no target requirement for performing it, though, then again, some of the time it is vital however not adequate to just play out a post-mortem to get all data required. Along these lines, numerous nations in current occasions utilize progressed nondestructive imaging strategies generally utilized inconsistently demonstrative techniques that can give some of the extra information and now and then even supplant the traditional post-mortem examination [1].

The most significant kind of after-death imaging is "virtual autopsy" (otherwise called Virtopsy), instituted by Prof. Richard Dirnhofer from Bern University. Virtual autopsy utilizes 3D imaging rather than the visual assessment of the body. To achieve inside assessments of the body, the virtual post-mortem examination utilizes magnetic resonance imaging and additionally surface scanning techniques or potentially multi-cut computed tomography, while for different kinds of testing it can utilize after death angiography or biopsy utilizing the robot. Like conventional post-mortem, the point of virtopsy examination is to evaluate wounds, the

reason and way of death, and identify the person. In any case, it has a conceivably expansive application in the cutting-edge period where various issues with conventional, intrusive autopsy are held up on legitimate, moral, and strict religious grounds [2,3].

As assessments are commonly performed under the legitimate limitations of insightful specialists, for example, courts, examiners, lead prosecutor, or police, there are requirements as to cost, time, objectivity, and errand detail contingent upon neighborhood law. Advanced Autopsy or Imaging examination can be characterized as the utilization of top-notch CT and additionally MRI output to decide the reason for death notwithstanding or in place of a conventional autopsy [4,5].

HISTORY OF AUTOPSY

In antiquated Egypt and Mesopotamia, after death dismemberments were much of the time performed during the way toward preserving. In India, examination and analyzation were drilled by Sushruta, an early pioneer of Ayurveda in the 6th century BC. In the third century BC, Greek researchers utilized examination to upgrade their comprehension of life structures and sickness. Similar methodologies rose in Europe during the medieval times and the Renaissance with crafted by Vesalius and others [6].

The main sorted out treatise on the obsessive finding of post-mortem examination was "The seats and the uses of disease investigated by anatomy", distributed in 1761 by Giovanni Batista Morgagni. This book portrays about 700 examinations performed by the writer and is the establishment of present-dayautopsyscience. At the finish of the nineteenth century, Osler built up the post-mortem examination as one of the foundations of his way to deal with both clinical training and the clinical technique. In the first 50% of the twentieth century, post-mortem rates consistently expanded. The second 50% of the twentieth-century and the start of the 21st century saw proceeded with a decrease in post-mortem examination rates. The most normally credited factor representing this circumstantial distress of the doctor for mentioning consent from family cost regulation measures and danger of bloodborne pathogen transmission, cultural and social convictions [6].

HISTORY OF VIRTUAL AUTOPSY

Propelled imaging strategies have been being used for a long while during Forensic examinations. In 1977, Wullenweber et al revealed one of the soonest Forensic utilization of computed tomography to portray radiographic examples of shot wounds to head [7]. In 1980, Flodmark et al played out a correlation investigation of pre-mortem CT discoveries and ensuing post-mortem outcomes in neonates who endured perinatal asphyxia [8]. Kalender et al in 1990, trailed by creating procurement and handling of 3D advanced radiographic imaging information [9]. The 1990s saw the initiation of huge scope inquire about projects committed to imaging autopsy. The most conspicuous program was the Virtopsy Project headed by Prof. Michael Thali which was started by Prof. Richard close to the completion of the twentieth century and has been working out of the Institute of Forensic Medicine at the University of Zurich, Switzerland since 2011 [10,11]. The point was to improve the objectivity of discoveries made in forensic post-mortems. The establishment stone of the business idea of computerized post-mortem examination was laid during the exposure created for the investigation of the "Virtual Mummy" at the British Museum in the year 2004[1]. The utilization of virtopsy in dentistry was additionally portrayed by Oesterhelweg et al.in a victim experiencing respiratory difficulty from a foreign body for which CT and MRI were utilized to separate the obstructive structure [12]. The data given by virtopsy was increasingly precise and clear. Birngruber et al. revealed a positive recognition of a person following contrasting antemortem radiographs and postmortemCT pictures [13].Jackowski et al. performed spearheading analysis on virtual post-mortem examination [14].Ampanozi et al. depicted the upside of virtopsy to get data about the profundity of injury from sharp instruments [15].While the way of death, the reason for death, time of death, recognizable proof of dead person and scope of pragmatic and reconstructive applications are clearly identified with the medicolegal examination of death, Virtopsy techniques were momentous in that they have set up another cutting edge tool compartment into both research and functional parts of current Forensic pathology [6].

HISTORY OF DROWNING

The determination of the reason and the foundation of the way of death in submersion cases are viewed as a test for forensic pathologists. It is commonly acknowledged that not all people whose bodies are recuperated from water have suffocated by water or drowned. All bodies recovered from water may give indications of submersion on assessment, yet this just affirms they had surely been inundated. It is imperative to appropriately characterize the terms immersion, submersion and drowning. Immersion relates to being layered with fluid. Submersion correlates to inundating the entire body in a fluid. Drowning is then characterized as a procedure bringing about essential respiratory impedance from submersion or inundation in a fluid medium. By and large, bodies recovered from water may have: (1) perished of intrinsic illness before falling into the water, (2) passed on of regular illness while in the water, (3) expired from injury before being tossed into the water, (4) passed on of injury while in the water, (5) passed on of impacts of immersion otherwise ofdrowning, (6) expired

due to drowning (genuine drowning). As per the World Health Organization, the yearly overall occurrence of death by drowning is around 320,000. Drowning is the third driving reason for accidental injury passing around the world, representing 7 % of all wound related deaths [16]. Dying from drowning is increasingly normal in small kids, males, and people living near water. In grown-ups, suicide is a regular reason for drowning, which is frequently connected with past psychological events. Drowning has particularly been identified with the younger generation who are affected by liquor and different medications while being close to water. The pathophysiological parts of drowning are compounded. 10% of drownings occur without the intake of liquid in the lung; this is the purported "dry drowning" because of a laryngospasm as a result of hypoxia and the presence of water in the upper respiratory manners (larynx). The staying 90% of drownings are alleged "wet drowning" [17].

Drowning is a troublesome reason for death to decide by a traditional post-mortem, due to the vague posthumous discoveries. Just the presence of diatoms somewhere down in the blood flow (e.g., bone marrow) is thought of, a clear, positive evidence of drowning, yet the specialized method to identify these microorganisms is intricate and fragile, and faulty positive outcomes because of defilement can happen. Negative outcomes don't bar drowning. Different reasons for death must be rejected to determine drowning with a degree of conviction, and fortuitous proof (e.g., police investigation, crime scene examination) may be critical for a definitive analysis. The fundamental positive post-mortem examination discoveries for drowning are identified with the drowning medium which is aspired into the respiratory passage. Notwithstanding, these discoveries are not explicit as they can be seen in different circumstances. Besides, their nonappearance can't avoid the chance of drowning, especially if laryngospasm happened. Since the separation of the cause of death is a challenge in forensic medicine, it is essential to separate “typical drowning” and “atypical drowning” where drowning is integrated with another reason for death (cerebral or vascular strokes for instance) or happens to an oblivious casualty. Atypical suffocating needs further assessments [17].

Drowning is viewed as an unnatural reason for death and is in this manner subject to measurable examinations, ordinarily including a full dissection. Progressively, in medico-legal posthumous assessments, a supposed virtual dissection or virtopsy is utilized by applying clinical imaging strategies to look at a dead body in a non-obtrusive way. Hence, determinants of drowning PMCT have been inspected and proposed in different examinations. A few symptomatic strategies are utilized to find drowning cases: postmortem CT, anatomopathological study, identification of diatoms, and serum strontium estimation. These strategies are frequently disputable, and we don't have the foggiest idea about their actual incentive for analysis. Ongoing investigations utilizing PMCT propose that this imaging methodology is valuable for the analysis of drowning. For "near-drowning patients", discoveries are known; intake of sand happens, and pulmonary changes can be found in CT. Below we sum up the information from the writing concerning the indicative estimation of CT in instances of drowning [17].

IMAGING TECHNIQUES

Over the timeframe, different techniques, for example, posthumous biopsy and angiography were executed on the autopsy of the dead. It was not an accomplishment in the underlying stage but rather after at some point its significance was acknowledged among the radiologists and pathologists and instructing seminars on the utilization of the Virtopsy strategies started in 2006 [18].

It very well may be helpful in the nations where crime percentage is immense and is continually expanding gradually like in India, and different other nations. It can help in giving reports in a couple of moments as opposed to hours. Along these lines, it won't just assist in getting the inside discoveries however will likewise help in expanding the pace of legal executive to serve equity of the nation. This can be the most significant change in the everyday schedules of numerous pathologists, radiologists, researchers, and so forth. This rising strategy has increased in notability as of late and individuals around the globe are interested to discover increasingly about its noteworthiness [18,19].

Currently, imaging techniques contains cross-sectional strategies for example Computed Tomography, Multi-section Computed Tomography, Micro Computed Tomography, Magnetic ResonanceMicroscopy, Magnetic Resonance Spectroscopy, Magnetic Resonance Imaging and so forth, which are joined with negligibly intrusive strategies, for example, after death angiography and biopsy, and 3D photogrammetry which depends on optical surface checking by Computed Tomography or Magnetic Resonance Imaging. These techniques are portrayed quickly beneath [18].

COMPUTED TOMOGRAPHY(CT): Computed tomography is the most regularly utilized imaging instrument in forensic pathology except X-ray. With current scanners, 2D and 3D establishment dependent on cut thicknesses of 0.5 mm are conceivable and have become routine measures. Aside from the assessment of the delicate tissues, the chief edge is in the discovery and study of a strange element, fracture lines, gas and liquid aggregations, and so forth. It can likewise show calcifications, for example, coronary sclerosis and vessels

without any problem. Besides, CT is utilized to perform angiography called postmortemCT-angiography to envision horrendous vascular pathologic conditions, just as to recognize and analyze different cardiovascular illnesses, and can uncover various common reasons for death also [20].

MULTISECTION CT: CTwas performed on a 4 or 6 detector row scanner. The entire body examinationwas performed with a collimation of 1 or 1.25 mm which gives 1200 axial pictures an area thickness of 1.25 mm and an augmentation of 0.7 mm in delicate tissue and rigid pieces. For territories of exceptional forensic significance which incorporates uncommon fracture frameworks, teeth, remote bodies, and so forth extra crude information was obtained with collimation of 0.5 mm, and 0.625-mm-thick areas were determined. Scan acquisition time was around 10 minutes [3,21,22].

MICRO CT: In uncommon circumstances, bone-tissue samples were analyzed on a micro CT framework which was created and worked at the Institute of Medical Physics in Erlangen, Germany. This scanner can picture a 3D volume with an isotropic goal extending from 10 to 100 μm. The framework permits the assessment of tests with distances across extending from 4 to 40 mm [18].

MAGNETIC RESONANCE MICROSCOPY: Magnetic ResonanceMicroscopic investigations were performed at room temperature and gives high spatial resolution images and helps to examine injury patterns in soft tissues. This helps in understanding pathological, toxicological, and phenotyping studies. This is useful in finding electrical injuries on the victim[3,21].

MAGNETIC RESONANCE IMAGING: MRI can be utilized in circumstances where CT has certain inalienable constraints, for example, to portray delicate tissue wounds and pathologies distinctly. Being non-ionizing in nature, it is moreover the solution to use imaging techniques for analyzing alive victims of the attack, for example, in the instances of manual strangulation. After death, MRI can be utilized to analyze delicate tissue injury, injuries, hematoma, and neurological injuriesas well as non-neurological injuries. Time to take scan vary from 1.5 to 3.5 hours [3,20-22].

MAGNETIC RESONANCE SPECTROSCOPY (MRS):MRS is another valuable procedure in Virtopsy which helps in deciding the metabolic fixations in the tissues and helps in evaluating the hour of death. MR microscopy is a miniaturized scale imaging strategy which is additionally used to contemplate the delicate tissue wounds like retinal bleeding, and so on [3,21].

POST MORTEM BIOPSY: The word posthumous biopsy has the part 'bios' which is from the old Greek signifying 'life' and is thus, not pertinent for anautopsy technique, this phrasing has built up itself in forensic medical science in relationship to biopsies acted in clinical treatment. With a biopsy needle and gun, tests of organs of interest or explicit pathologies seen at CT or MRI and can be taken and inspected through histological arrangements. Tissue and liquid samples can be gathered for toxicological and microbiological assessments. Other than the manual examining, picture guided testing with a committed robot has been acquainted as of late with a decline in the chances of samples being contaminated [18].

3 D PHOTOGRAMMETRY-BASED OPTICAL SURFACE SCANNING: With a surface-filtering unit, which extends a fringe design onto a surface and is recorded with the assistance of two cameras, a 3D picture in genuine shades can be acquired utilizing unique programming. Advanced photography of the surface from different points would then be able to be added to the information&subsequently empowering a real nature 3D surface remaking. This extremely precise documentation, which relies upon the applied goals, can record structures below 1 mm in size [18].

ULTRASONOGRAPHY: helps in the assessment of different organs, effusions, pleural air, heart, and pericardial variations from the normal structure, hemoperitoneum, and even skeletal wounds. The resulting information can be chronicled and imitated without misplacement, broke down somewhere else, or given or distributed to experts for further examination [18].

MAXIMUM INTENSITY PROJECTION (MIP): is a quick imaging procedure that takes only a few minutes to make a radiographic model of the dead bodies be researched [18].

VIRTOBOT: this machine combines four imaging methods, MSCT, MRI, MRM, MRS. With virtobot we are able to access surface and body volume data in a single 3D space [3,21].

VIRTOMOBILE: This is a machine useful in mass disaster situation. This is a compact and transferable version of virtobot[3,21].

WORKING PROCEDURE OF VIRTUAL AUTOPSY

In Virtopsy, there is the blend of the advancements of 3D imaging strategies and 3D surface scanning techniques which records and reports the 3D picture of the body surface region in detail [23].

The initial phase in playing out a Virtopsy includes the corpse to get ready for imaging. It is practiced by setting little discs by the workforce along the outside of the body, with the goal that the surface and the inside scans could be adjusted without any problem. These discs mark points that are utilized for getting the pictures into one single picture. Virtibot which is an automated machine helps in achieving this assignment. In this way, making the consequences of Virtopsy progressively normalized and exact. The markers are utilized by the PC

processors to adjust the outside scan of the dead body and afterward coordinate with the interior imaging forms [23].

After the putting of markers by the virtibot, it makes a 3D colored model of the dead body. The scanner uses stereoscopic cameras with a resolution of 0.02 mm to catch the shades of pictures alongside; the projector is utilized to cast a mesh design on the body. The robot moves over the body making a 3D picture and the complete time taken in this procedure is about 10s [23].

After the surface sweep, the body is brought to the CT and MRI station which is normally twofold secured inside a blue bagvia which X-rays pass through. It is done to forestall any pollutant or contamination; at that point, the body is laid on the sliding table of the CT, MRI, and MRS gear one by one. The sack will stay shut while the body is examined from both sides. It is essentially done to regard the security of the dead, to keep up cleanliness, and to stay undisturbed by any lay-man or non-forensic individual present inside the room. The body at that point experiences a CT filter which is a technique that completes in 20 s and gains up to 25,000 pictures; each picture is a cut or slice through the body. At that point, the body is likewise exposed to MRI and MRS filters. The data from the inside and surface sweeps are put away in incredible PCs wherein information is joined, further rendered utilizing PC supported drafting-style programs and ultra-robust graphics processors. In a limited period to focus 10 min detail pictures of bone and tissue are recreated utilizing those PCs, from the information which shows thin X-ray cuts of the body. Various tissues, remote materials, and bodily material retain the scanner's X-rays in various sums and the distinctive assimilation levels are introduced into a 3D visual of various hues. The PC can likewise appoint the thickness contrasts of any color; however, this is typically normalized as blue for air pockets, beige for delicate tissues, red for veins, and white for bones. A pathologist isn't confined by any limitation to strip through the layers of virtual skin and muscle with only a click of the PC mouse [23].

Pathologists and radiologists can illustrate and examine the various patterns. Simultaneously, pictures can be controlled all over and pivoted at different edges, giving moment adaptability that is missing in a traditional autopsy. After investigation of the 3D model, interior and surface results, a needle biopsy should be possible if internal body specimens are required. Virtibot, when utilized, eases the need to uncover somebody's hand under the CT scan to separate the biopsy. All the information filtered is then recorded and saved on computer drive or discs [23].

The Imaging Autopsy can be applied in anextended number of fields in forensic sciences, for example, thanatological investigation; identification of carbonized and decomposed body, mass catastrophe cases, age evaluation, skin wound investigations, and so forth [23].

For example, in instances of gunshot wounds, the area of the shot can be known before the autopsy is performed encourages the assessment [23].

Indeed, even in the instances of odontology field, Oesterhelweg portrayed a situation where the separation of the obstructive structure in air passage from food bolus was performed with joined CT and MRI. Virtopsy is also a reliable source to examine victims with damaged oral cavities and charred bodies [12].

Thus, in the instances of drowned corpses, the CT data about the volume, thickness, size of the lungs, and the measure of fluid in them which can help in diagnosing the reason for death [23].

USE OF VIRTUAL AUTOPSY IN DROWNING CASES

- In 2007 Christe et al. found all the typical findings of drowning, except Paltau's spots, were detected using post-mortem MSCT, and a good correlation of MSCT and autopsy was found. The advantage of MSCT was the direct detection of bronchospasm, haemodilution, and water in the paranasal sinus, which is rather complicated or impossible at the classical autopsy [24].
- Levy et al. (2007) discovered that multidetector CT findings of pan sinus fluid, mastoid cell fluid, subglottic tracheal and bronchial fluid, and ground-glass opacity within the lung at multidetector CT are supportive of drowning in the appropriate scenario [25].
- In 2012 kawasumi et al. concluded fluid accumulation in the maxillary or sphenoidal sinuses is more common in drowning victims. However, as it is present in 65% of the non-drowning victims as well, the presence of fluid can not be used to diagnose drowning. The absence of fluid can be used to virtually exclude drowning [26].
- In 2013 kawasumi et al. discovered that the volume and density of fluid accumulation in the maxillary or sphenoid sinuses differed significantly between the drowning and non-drowning cases [27].
- In 2013 Ambrosetti et al. found that blood density in all cardiac chambers was lower in group A (freshwater drowning) than in group B (deaths by other causes). The difference was statistically significant within the left atrium and ventricle and was significantly lower in the left than in the right heart chambers in group A only [28].
- In 2014 Usui et al. classified postmortem CT images of drowning cases into three major types with a few exceptions, ground-glass opacities with thickened pulmonary interstitium (n = 31), and a centrilobular

distribution of ill-defined nodules along the airways (n = 38). Some cases were mixed type (n = 10). The remaining three types were consolidation (n = 5), emphysema and/or fibrosis (n = 4), and unclassifiable (n = 4) [29].

- In 2014 Raux et al. examined the presence of fluid and sediment in paranasal sinuses (sensitivity of 100%) appear to be the determinants of the diagnosis of drowning. Haemodilution was present in cases of drowning ($p < 0.001$) [30].
- In 2014 Van Hoyweghen et al. results indicate that it is not possible to reliably distinguish drowning from non-drowning asphyxiation on CT, because many findings in drowning were also present in non-drowning asphyxiation [31].
- In 2015 Giuseppe Lo Re et al. All the cadavers showed fluid in the airways and patchy ground-glass opacities in the lung. This study proves that a virtopsy is a useful tool in the diagnosis of drowning in that it allows us to understand if the victim was alive or dead when he entered the water and if the cause of death was drowning [32].
- In 2015 Kawasumi et al. founded the average density of sinus fluid in cases of saltwater drowning was significantly higher than in freshwater drowning cases; there was no significant difference in the sinus fluid volume [33].
- In 2015 Plaetsen et al. found excessive fluid in the paranasal sinuses (98%), nasal pharynx (98%), oropharynx (95%), trachea (83%), ground-glass opacities in the lung (89%), pleural fluid (71%), pericardial fluid (59%), esophageal fluid (81%), stomach fluid and distension (71%), duodenal (34%) and jejunal distension (31%) were the most frequent drowning related imaging findings which significantly differed from the group of mechanical asphyxia by hanging. In cases of freshwater drowning, hemodilution was present in 79% [34].
- In 2016 Hyodoh et al. evaluated the drowning lung appearances on postmortem CT and found a uniform pattern of ground-glass opacity in seawater and freshwater without statistically significant difference. An understanding of the typical appearance and knowledge of its limitations could improve postmortem CT image interpretation [35].
- In 2017 Leth et al. The lung density (g/liter) measured by a combination of the PMCT measured total lung volume and the autopsy-measured total lung weight is decreased in drowning cases as a result of emphysema aquosum. It is not possible to separate fresh and saltwater drowning cases by comparing the radio densities of the blood in the heart chambers or the great vessels or by comparing the radio densities of blood between cases and controls [36].
- In 2019 Jian et al. discovered that thoracic PMCT is helpful for the forensic medical diagnosis of drowning. Lung volume ratio and lung CT value distribution are potential indicators to distinguish between drowning and CAD [37].

FEASIBILITY OF VIRTUAL AUTOPSY

The virtual examination is achievable up to an extraordinary degree as it gives a 3D outline which is anything but difficult to decipher and effectively open. It permits a computerized reconsideration of the body and even of rotten cadaver decades later. It requires little time (nearly a couple of seconds) than the conventional examination and subsequently gives better analysis by giving admiration to a religious point of view. These make it a dependable strategy to get the pathological records of the victim. The outcomes are profoundly delicate, explicit, and exact. It is non-intrusive and non-ruinous in nature. It streamlines the work as it distinguishes the person, recognizes remote bodies, and simple exhibits for the official courtroom [20].

Even though it has numerous adjustments, yet it does have its escape clauses which should be fixed, for example, the absence of physiological abilities of pathologist or an expert like touch, feel, appearance, and smell perception. It is costly and the concerned staff are confined as there is no immediate contact with the dead body. Thus, making it is less doable in the immature and evolving nations [23].

In some developed nations by associating a customary CT or MRI scanner to a 3D imaging programming device that can show and analyze dead bodies in a much-sophisticated design than traditional surgical tool-based techniques permit. Utilizing a huge touch screen to show the body's 3D picture, one can zoom into regions of the body they need to concentrate in more prominent detail and take off layers of garments and tissues without cutting them. Each time a coroner requires a post-mortem to be performed on a body, family members of the expired will be given an alternative of either exposing the body to a customary method complimentary or select the computerized autopsy for £500 [25].

ADVANTAGES OF VIRTUAL AUTOPSY

1. Virtual imaging can exhibit discoveries that are not promptly perceived during the conventional post-mortem, for example, quick and precise recognizable proof of remote articles (slugs or bullet) in putrefied bodies, documentation, and assessment of neck muscle hemorrhages in Forensic cases, perception and measurement of venous air embolism mass. Imaging autopsy offers incredible accuracy, including a close

estimation of organ mass and the capacity to coordinate decedent-condition connections in deadly horrendous wounds. Imaging Autopsygives a representation of delicate tissue designs in instances of serious degradation. This is particularly significant when basic examples are not in any case recognizable on conventional examination [5].

2. Imaging Autopsy produces complete records that show indisputably the reason or way of death which can be kept unblemished and liberated from human mediation [5].
3. It facilitates the wayto recognize the person and reason for death in survivors of mass cataclysmic events, especially in an enormous number of seriously disintegrated bodies [5].
4. Digitized bodies can be sent to legal pathologists who can supervise post-mortems remotely[5].
5. In the wake of an organic defilement or biological militant or terrorist assault, virtopsy can be incredibly important in deciding further examination that is important to distinguish the pathogenesis while simultaneously shielding forensic pathologist from coincidental introduction to the organic contaminant[5].
6. Computerized post-mortem examination smoothes out the correspondence between forensic specialists just as pathologists to look for a proficient second opinion with specialists abroad through a procured digital channel[5].
7. It can reproduce reasonable 3D anatomic recreations of wounds which are valuable while relating the examples of wounds to different natural elements at the time of death[5].
8. It can lessen the negative effect of displaying upsetting photographs on the family, members of the jury, and judges. Bilateral images are frequently simpler for juries, attorneys, and other court officials with a clearer comprehension of the post-mortem examination process, which can be imperative when the way of death must be built up in a legal dispute[5].
9. From the cultural or religious perspective, it gives a choice to treat the perished with respect while simultaneously accomplish the medico-legal necessity. The traditional examination might be rejected due to personal or religious or social or cultural convictions. Imaging examination offers a non-obtrusive and non-dangerous option of finding the reason for death in such cases[5].
10. Computed tomography might be more appropriate to body packer identification than customary or plain stomach X-Rays[5].
11. It gives a clean bloodless representation of the documentation with high accuracy, infection-free specimen (venoms, contaminations, tissue, and so forth) precise to the millimeter[5].
12. Virtopsy gives a quick and noninvasive bloodless representation of an area of interest with astounding precision regarding the size, volume, and direction of a harmed organ or remote body[5].
13. Rather than the conventional post-mortem examination, utilization of virtual post-mortem examinationconsiders the securing of information that isn't needy upon one assessment and analyst, i.e., on the experience and system of dismemberment methods[5].
14. The utilization of virtual autopsyconsiders the gathered information to be systematized[5].
15. In supplement to opening the opportunities for universal collaboration for different specialists in the field, virtual post-mortem likewise takes into consideration the chance of reviving the situation when the body is covered or incinerated.
16. Virtual post-mortem examination can be valuable for other scientific purposes, as it very well may be halfway applied additionally on the living casualties. A virtual post-mortem examination is especially valuable for examinations when the wounds are mended.

DISADVANTAGES OF VIRTUAL AUTOPSY

1. Virtual autopsy can't give data about the status of contamination, tissue surface and texture, and color changes in the body[5].
2. It is still less useful than the customary intrusive post-mortem examination as it relies on radiographic translation and in some cases, minor tissue wounds may get missed[5].
3. This procedure is delicate and requires profoundly talented radiologists[5].
4. It has constrained plausibility and legal executive acknowledgment among experts[5].
5. While annihilating awful wounds might be clear on a "virtual" autopsy, reasons for death because of certain ailments (i.e., metabolic disarranges) may evade even the most specific and touchy imaging strategies[5].
6. Significant inquiries should be replied before increasingly boundless utilization of imaging autopsy is founded, including its medico-legal repercussions, medico-economic intimation, and issues encompassing imaging autopsyelucidation[5].
7. Imaging or virtual autopsy contemplates include various disputable issues, for example, who ought to be liable for acquiring and deciphering these examinations, who will cover the cost of performing and deciphering them and medico-legally who will be held at risk for these post-mortem examinations[5].
8. The comparatively moderate acknowledgment of Imaging Autopsy is likely identified with certain medico-legitimate viewpoints, vulnerability over who ought to be liable for deciphering such examinations, just

as the expense and compensation related to these investigations keep imaging autopsy from being acknowledged generally as an option in contrast to a conventional post-mortem examination[5].

II. Future Advancement Of Virtual Autopsy

At present, there are just hardly any organizations on the planet who have perceived the practicality and conceivable effect of cross-sectional imaging in the posthumous examination and that have put endeavors in its usage. For instance, the Office of the Armed Forces Medical Examiner (Washington, DC; Dover, Del), the Institute of Forensic Medicine (Copenhagen, Denmark), and the Victorian Institute of Pathology (Sydney, Australia) has just introduced their own CT scanners, and in Japan, the Society for Autopsy Imaging was established in 2003. In the future, the utilization of CT innovation will turn out to be progressive across the board at recognizing foundations of crime scene investigation and pathology [2,6].

The innovation right now utilized for directing a virtual post-mortem examination includes: Robot guided surface filtering for three-dimensional documentation of the outside of the body, to scale and in color. This augments the exterior posthumous assessment of the body that is done in the customary or traditional examination. Multi-slice spiral CT and MRI enhance the interior posthumous assessment of the body in the autopsy. Picture and robot-guided, infection-free specimen for a wide scope of additional Forensic investigation, for example, histology, bacteriology, virology, toxicology, and diatomology [3].

Robotic virtopsy is a multifunctional framework that can perform a programmed autopsy and 3D surface scanning which subjectively increment the improvement in the result of scientific examinations. The robotic virtual examination likewise helps in recognizing the adjustment in the color of the tissue. Indeed, even an automated machine called Virtobot will utilize all the strategies by melding surface and body volume information securing inside a solitary 3D space. Mechanical arms will do an exact and programmed arrangement of infusion instruments or biopsy needles [4,5].

Posthumous angiography is a virtopsy strategy that is useful in the representation of the cardiovascular framework that incorporates a mixture of balance medium with the guide of the peristaltic pump [2].

Volume-investigation programming utilized in virtopsy helps in the precise estimation of the mass of interior organs [2].

Late advancements in MR imaging innovation, for example, entire body or equal imaging (complete imaging grid) will likewise altogether decrease assessment times for forensic MR imaging assessments, which can at present require 3 hours or more for each cadaver [3].

If different nations likewise step up to the plate and adjust this innovation, at that point it very well maybe ends up being an achievement in the field of forensic science.

III. Conclusion

In this article, we explained upon the potential outcomes and focal points of executing strategies for virtual post-mortem; investigated the origin of autopsy and virtopsy and pragmatic use of imaging techniques currently present; and, introduced all means of the virtual post-mortem examination and their working procedure with advantages and disadvantages. The feasibility and future advancement were also discussed here. Through this expansive investigation, we empowered a more extensive crowd, including forensic, legal, and clinical specialists to acclimate themselves with the study of forensic imaging and virtopsy.

Virtopsy is a non-obtrusive strategy of envisioning the internal parts of an individual without harming the social, cultural, and religious convictions that guarantee a noble end to an individual's life. With the progression, one can hope for a less expensive, quicker, and proficient post-mortem. However, there is a comparatively moderate acknowledgment of Imaging or virtual autopsy over conventional post-mortem. While imaging dissections are improbable to compeer or complement a portion of the histological and metabolic data accessible from conventional post-mortem examinations (smell, surface, poison investigation), it might be that for specific illness acknowledgment radiographic autopsy assessment is prevalent. They take just a couple of moments and might be seen remotely without loss of imaging point of interest with uncomplicated sharing of the information among specialists. The normal execution of Imaging Autopsy could likewise help assemble a tone of interdisciplinary collaboration between radiologists, pathologists, and essential doctors engaged with clinical consideration of the decedent before their demise.

A virtual post-mortem examination is especially valuable in cases including catastrophes, degradation, or complex shattering of bones since this strategy protects the trustworthiness of anatomical structures. In cases of drowned bodies CT scan helps us to know about the amount of liquid, size, density, volume of lungs [38].Utilization of Imaging Autopsy will likewise end up being a phenomenal instructive apparatus that can give genuinely necessary posthumous data during the time of declining post-mortem examination rates. Improvement of Forensic telemedicine conferences will take care of a significant number of the issues related to the understanding of IA concentrates during odd hours or at areas that don't have the essential assets to perform such procedures. Thus,imagingor virtual autopsy or computerized post-mortem is quick moving ceaselessly

from being a fiction to be utilized as pre dissection screening instrument or corresponding investigation or study to another type of conventional autopsy assessment.

References

[1]. Kružić I, Jerković I, Mihanović F, Marušić A, Anđelinović Š, Bašić Ž. Virtual autopsy in legal medicine: literature review and example of application on the mummified remains. Medicine, Law & Society. 2018 Oct 22;11(2):67-90.

[2]. Aggarwal K, Chauhan A, Shukla SK. Implementation of Virtual Autopsy in Forensic Medicine. Indian Journal of Forensic Medicine & Toxicology. 2019;13(2):68-72.

[3]. Pathak MK, Jha SS. Virtopsy: a recent advancement in traditional necropsy. IJHRMLP.:74.

[4]. Kaur N, Chaudhary RK, Gupta P, Singh B. Digital autopsy: Moving from fiction to reality. Journal of Indian Academy of Forensic Medicine. 2014;36(2):195-8.

[5]. Cirielli V, Cima L, Bortolotti F, Narayanasamy M, Scarpelli MP, Danzi O, Brunelli M, Eccher A, Vanzo F, Ambrosetti MC, El-Dalati G. Virtual autopsy as a screening test before traditional autopsy: The verona experience on 25 Cases. Journal of pathology informatics. 2018;9.

[6]. Hill RB, Anderson RE. The recent history of the autopsy. Archives of pathology & laboratory medicine. 1996 Aug 1;120(8):702.

[7]. Wüllenweber R, Schneider V, Grumme T. A computer-tomographical examination of cranial bullet wounds (author's transl). Zeitschrift fur Rechtsmedizin. 1977;80(3):227-46.

[8]. Flodmark O, Becker LE, Harwood-Nash DC, Fitzhardinge PM, Fitz CR, Chuang SH. Correlation between computed tomography and autopsy in premature and full-term neonates that have suffered perinatal asphyxia. Radiology. 1980 Oct;137(1):93-103.

[9]. Kalender WA, Seissler W, Klotz E, Vock P. Spiral volumetric CT with single-breath-hold technique, continuous transport, and continuous scanner rotation. Radiology. 1990 Jul;176(1):181-3.

[10]. Thali MJ, Jackowski C, Oesterhelweg L, Ross SG, Dirnhofer R. VIRTOPSY–the Swiss virtual autopsy approach. Legal Medicine. 2007 Mar 1;9(2):100-4.

[11]. Bolliger SA, Thali MJ. Imaging and virtual autopsy: looking back and forward. Philosophical Transactions of the Royal Society B: Biological Sciences. 2015 Aug 5;370(1674):20140253.

[12]. Oesterhelweg L, Bolliger SA, Thali MJ, Ross S. Virtopsy: postmortem imaging of laryngeal foreign bodies. Archives of pathology & laboratory medicine. 2009 May;133(5):806-10.

[13]. Birngruber CG, Obert M, Ramsthaler F, Kreutz K, Verhoff MA. Comparative dental radiographic identification using flat panel CT. Forensic science international. 2011 Jun 15;209(1-3):e31-4.

[14]. 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. International journal of legal medicine. 2008 Jul 1;122(4):301-7.

[15]. Ampanozi G, Ruder TD, Preiss U, Aschenbroich K, Germerott T, Filograna L, Thali MJ. Virtopsy: CT and MR imaging of a fatal head injury caused by a hatchet: a case report. Legal medicine. 2010 Sep 1;12(5):238-41.

[16]. World Health Organization. Newsroom / Fact Sheets/ Detail/Drowning. Available online at: https://www.who.int/news-room/fact-sheets/detail/drowning

[17]. Armstrong EJ, Erskine KL. Investigation of drowning deaths: a practical review. Academic forensic pathology. 2018 Mar;8(1):8-43.

[18]. Rai S, Misra D, Tyagi K, Prabhat M, Gangwal P. Image Guided Virtual Autopsy: An Adjunct with Radiographic and Computed Tomography Modalities-An Important Tool in Forensic Identification. Journal of Indian Academy of Oral Medicine and Radiology. 2017 Oct 1;29(4):368.

[19]. Timonov P, Novakov S, Sivkov S, Fasova A, Novakov I, Spasov S. The advantage of the virtual forensic autopsy-A new approach which could benefit forensic expertise. Journal of forensic and legal medicine. 2019 Feb 1;62:69-71.

[20]. Dirnhofer R, Jackowski C, Vock P, Potter K, Thali MJ. VIRTOPSY: minimally invasive, imaging-guided virtual autopsy. Radiographics. 2006 Sep;26(5):1305-33.

[21]. Surabhi TM, Bhateja S, Arora G. Virtopsy: an aid in forensic investigation.

[22]. Thali MJ, Yen K, Schweitzer W, Vock P, Boesch C, Ozdoba C, Schroth G, Ith M, Sonnenschein M, Doernhoefer T, Scheurer E. Virtopsy, a new imaging horizon in forensic pathology: virtual autopsy by postmortem multislice computed tomography (MSCT) and magnetic resonance imaging (MRI)-a feasibility study. Journal of forensic sciences. 2003 Mar 1;48(2):386-403.

[23]. Badam RK, Sownetha T, Babu DG, Waghray S, Reddy L, Garlapati K, Chavva S. Virtopsy: Touch-free autopsy. Journal of forensic dental sciences. 2017 Jan;9(1):42.

[24]. Christe A, Aghayev E, Jackowski C, Thali MJ, Vock P. Drowning—post-mortem imaging findings by computed tomography. European radiology. 2008 Feb 1;18(2):283-90.

[25]. Levy AD, Harcke HT, Getz JM, Mallak CT, Caruso JL, Pearse L, Frazier AA, Galvin JR. Virtual autopsy: two-and three-dimensional multidetector CT findings in drowning with autopsy comparison. Radiology. 2007 Jun;243(3):862-8.

[26]. Kawasumi Y, Kawabata T, Sugai Y, Usui A, Hosokai Y, Sato M, Saito H, Ishibashi T, Hayashizaki Y, Funayama M. Assessment of the relationship between drowning and fluid accumulation in the paranasal sinuses on post-mortem computed tomography. European journal of radiology. 2012 Dec 1;81(12):3953-5.

[27]. Kawasumi Y, Kawabata T, Sugai Y, Usui A, Hosokai Y, Sato M, Saito H, Ishibashi T, Hayashizaki Y, Funayama M. Diagnosis of drowning using post-mortem computed tomography based on the volume and density of fluid accumulation in the maxillary and sphenoid sinuses. European journal of radiology. 2013 Oct 1;82(10):e562-6.

[28]. Ambrosetti MC, Barbiani C, El-Dalati G, Pellini E, Raniero D, De Salvia A, Mucelli RP. Virtual autopsy using multislice computed tomography in forensic medical diagnosis of drowning. La radiologia medica. 2013 Jun 1;118(4):679-87.

[29]. Usui A, Kawasumi Y, Funayama M, Saito H. Postmortem lung features in drowning cases on computed tomography. Japanese journal of radiology. 2014 Jul 1;32(7):414-20.

[30]. Raux C, Saval F, Rouge D, Telmon N, Dedouit F. Diagnosis of drowning using post-mortem computed tomography–state of the art. ArchiwumMedycznySądowejiKryminologii/Archives of Forensic Medicine and Criminology. 2014;64(2):59-75.

[31]. Van Hoyweghen AJ, Jacobs W, de Beeck BO, Parizel PM. Can post-mortem CT reliably distinguish between drowning and non-drowning asphyxiation?. International journal of legal medicine. 2015 Jan 1;129(1):159-64.

[32]. Re GL, Vernuccio F, Galfano MC, Picone D, Milone L, La Tona G, Argo A, Zerbo S, Salerno S, Procaccianti P, Midiri M. Role of virtopsy in the post-mortem diagnosis of drowning. La radiologia medica. 2015 Mar 1;120(3):304-8.

[33]. Kawasumi Y, Usui A, Sato Y, Sato Y, Daigaku N, Hosokai Y, Hayashizaki Y, Funayama M, Ishibashi T. Distinction between saltwater drowning and freshwater drowning by assessment of sinus fluid on post-mortem computed tomography. European radiology. 2016 Apr 1;26(4):1186-90.

[34]. Vander Plaetsen S, De Letter E, Piette M, Van Parys G, Casselman JW, Verstraete K. Post-mortem evaluation of drowning with whole body CT. Forensic science international. 2015 Apr 1;249:35-41.
[35]. Hyodoh H, Terashima R, Rokukawa M, Shimizu J, Okazaki S, Mizuo K, Watanabe S. Experimental drowning lung images on postmortem CT–difference between sea water and fresh water. Legal Medicine. 2016 Mar 1;19:11-5.
[36]. Leth PM, Madsen BH. Drowning investigated by post mortem computed tomography and autopsy. Journal of Forensic Radiology and Imaging. 2017 Jun 1;9:28-30.
[37]. Jian J, Wan L, Shao Y, Zou D, Huang P, Wang Z, Liu N, Chen Y. Postmortem chest computed tomography for the diagnosis of drowning: a feasibility study. Forensic Sciences Research. 2019 Feb 20:1-7.
[38]. Junior R, Souza PH, Coudyzer W, Thevissen P, Willems G, Jacobs R. Virtual autopsy in forensic sciences and its applications in the forensic odontology. RevistaOdontoCiência. 2012;27(1):5-9.

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