REVIEW ARTICLE

IJETV Vol. 8, Issue 1, 2022 Print ISSN: 2394–6822 Online ISSN: 2395–4272

Establishing a Virtual Autopsy Center: The Basic Requirements–NEIGRIHMS Experience

Amar J. Patowary*

Department of Forensic Medicine, North Eastern Indira Gandhi Regional Institute of Health and Medical Sciences, Shillong, Meghalaya, India

Abstract

An autopsy is an integral part of the criminal investigation of the death of a human being, and a Virtual autopsy, Digital autopsy or Virtopsy as is called, is a new addition to it, particularly in India. India's first Virtual autopsy center was established at All India Institute of Medical Sciences (AIIMS), New Delhi, and was inaugurated in March 2021. In less than one year time, the second Virtual autopsy center has become functional at North Eastern indira Gandhi Regional Institute of Health and Medical Sciences (NEIGRIHMS), Shillong, with a computed tomography (CT) scan machine and related console panel and work stations; the system also includes one virtual dissection table, which is the first of its kind in the field of Forensic Medicine in India. There are many advantages of Virtual autopsy over conventional autopsy, and at the same time, there are limitations too. However, unlike the conventional autopsy, which is subjective and always observer depended, Virtopsy is objective and observer-independent. Moreover, it is computed tomography and magnetic resonance imaging (CT/MRI) based, so the data generated can be stored even after the disposal of the body. Till now it is, therefore, considered as a supplement to the conventional autopsy for medico-legal purposes; however, in some cases like death due to road traffic incidents, etc., Virtopsy may be considered instead of the conventional autopsy.

Keywords: Digital autopsy, Post-mortem angiography (PM), Post-mortem computed tomography (PM CT), Virtual dissection, Virtopsy in NEIGRIHMS.

Int J Eth Trauma Victimology (2022). DOI: 10.18099/ijetv.v8i01.05

Corresponding Author: A.J. Patowary, Deptt. Of Forensic Medicine, NEIGRIHMS, Shillong, Meghalaya, India, e-mail: drajpatowary@gmail.com

How to cite this article: Patowary AJ. Establishing a Virtual Autopsy Center: The Basic Requirements– Neigrihms Experience. Int J Eth Trauma Victimology. 2022;8(1):22-27.

Source of support: Nil

Conflict of interest: None

Received: 10/06/2022; **Received in revised form:** 20/06/2022; **Accepted:** 29/06/2022; **Published:** 10/07/2022

Introduction

An autopsy is the scientific examination of the body after death;[1,2] for a medico-legal autopsy, the main objective is to the determination of the cause of death, manner of death, mode of death, time since death etc. etc. It is performed in cases of sudden suspicious or unnatural deaths and many a time it becomes the very important piece of evidence in the court of law for settling different issues related to the death of an individual.[1-3]

While performing the autopsy, the autopsy surgeon explores all the body cavities and examines all the organs apart from noting the injury or any other findings in the deceased's body. While doing so, the autopsy surgeons have to dissect the body and organs for the collection of evidence; often this may be a trauma for the family members.

Virtual autopsy, virtopsy, or digital autopsy, on the other hand, is a process of examination of the body using advanced techniques like Multi-slice computed tomography (MSCT), Magnetic resonance imaging (MRI), Surface scanner, Post-mortem angiography, and Magnetic resonance spectroscope with the 3D reconstruction software. The whole body is scanned, and a three-dimensional image of the body is made using the reconstruction software, which then can be processed to examine the body externally and the internal organs without any incision on the body.[4-6]

As mentioned above, Virtopsy is a non-inessive procedure, where the body is examined without any incision in the body, and so, the acceptability of the relative of the deceased towards it is more in comparison to the conventional autopsy.

However, in all cases of medico-legal autopsy, it is of utmost essential to examine the whole body with an examination of all the organs for any injury or abnormality, which is well achieved in most cases in a conventional autopsy. Though, in some cases, the body is to be subjected to X-ray examination or CT scan for detection of any foreign object like a bullet, etc. The main objective of the medico-legal autopsy is to find out the cause, manner, mode of death as well as time since death, apart from recording the injuries and collecting data related to identification in un-identified cases as well as a collection of samples or pieces of evidence in the body.[1,2]

To achieve the above, there are a few universal steps to be followed in conventional autopsy –

- External examination
- Internal examination -
  - o Exploration of all the body cavities
  - o Examination of all the organs
- Collection of samples

Tools used in virtual autopsy:

- CT scan
- MRI scan
- Surface scanner
- MR spectroscope
- PM angiography
- 3D reconstruction software

Apart from the above, there can be micro CT, MR microscopy, CT image-guided biopsy, as well as a body bag for putting the body in the body bag to avoid contamination or soiling the CT couch. The body bag should preferably be transparent, leak-proof, and artifact-free.[4-7]

The role of the CT scan and MRI is to image the body along with the internal structures, and when it is combined with the surface scanner, there can be a 3D image of the whole body.[4,5,7]

MR spectroscopy is used for estimating time since death; using the 1H-MRI, a non-invasive technique, identification and quantification of the brain metabolites is possible, which in turn can help estimate time since death.[5,8-11]

Post-mortem angiography is another tool for examination of the vasculature in the body, including the coronary circulation and vessels in the brain.[5,7,12]

The 3D reconstruction software is the backbone of the whole procedure, which enables the autopsy surgeon to examine the body and the different organs without dissection.[4-7]

Though there is a need for the MRI and the surface scanner for the reconstruction of the 3D image of the body, it is now possible to get the 3D image of the body with the help of appropriate software from the data of the CT scan only. In a study conducted at two centers in UK way back in 2006-2008, where the whole-body CT scan and MRI were used followed by conventional autopsy to validate the post-mortem imaging as an alternative to conventional autopsy in adult death, it was concluded that CT was more accurate for determination of the cause of death in comparison to the MRI.[13]

Why Virtopsy – NEIGRIHMS Experience

In a study conducted at NEIGRIHMS, Shillong, to evaluate the perception of the relatives towards autopsy, it was found that in 49.16% of the cases autopsy was exempted by competent authority; relatives were not willing for autopsy in 63.1% of the cases, the non-willingness for autopsy on the religious ground in 97.35% of the cases and fear for disfigurement of the body in 92.04% of the cases.[14] Likewise, in many other parts of the world, an autopsy is not regularly done even though there is an indication for a medico-legal autopsy. So, it becomes difficult for the autopsy surgeon to act in such a situation.

Therefore, to address the issues related to the exemptions, NEIGRIHMS, Shillong has procured its virtual autopsy setup with a 32-slice CT scan machine, related console panel and work stations and a virtual dissection table, enabling the Department of forensic medicine NEIGRIHMS, Shillong to perform virtual autopsy. The center is the second of its kind in India after the AIIMS, Delhi.[15,16]

Set up at NEIGRIHMS

The virtual autopsy center of NEIGRIHMS is situated along with the main autopsy complex where all the cases of the autopsy are being done. All the cases coming for autopsy are first subjected to the CT scan, and the Digital imaging and communications in medicine (DICOM) images generated are then transferred to the Workstations and the virtual dissection table, where the images are analyzed. The whole process is in its very early phase, as the installation and commissioning of the setup were completed only in late February 2022. There is one study being undertaken to compare the findings of the Virtual autopsy with that of the conventional autopsy, which is a blinded study conducted in the Department of forensic medicine along with the Department of radiology NEIGRIHMS.

The requirement for such a center is similar to any CT scan center with a room for a CT scan machine and space for the console panel and the virtual dissection table. The CT room must have all the radiation safety measures and is to be certified by AERB (Atomic Energy Regulatory Board).

At NEIGRIHMS, Shillong, there is a room for the CT scan machine, one room for the console and the work station, and another room for the virtual dissection table. NEIGRIHMS is having its mortuary with almost all the facilities like ceiling

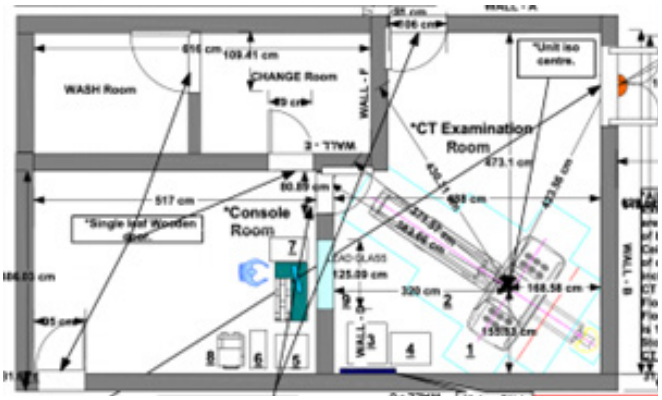

Figure 1: Lay diagram of CT room

Figure 2: Mortuary with Ceiling mounted OT light with camera and Laminar Flow system

mounted OT light having a camera facility which is connected to the monitor as well as a computer for inhouse monitoring and viewing of the autopsy from the department or the classroom. It has its laminar flow system with High-Efficiency particulate air (HEPA) filters for air purification apart from the other facilities like a portable X-ray machine, DICOM printer, suction machines, etc. (Figure 1-5)

All the bodies coming for the autopsy are first subjected to external examination to note down the findings, especially in regards to the rigor-mortis, wearing garments, any stains, or other related findings which are required as per the conventional autopsy. A photograph is taken to document the actual position of the body before going for the autopsy. The rigor mortis is then broken down if required to position the body properly in the CT machine as many a time. The position of the limbs or sometimes the state of the body itself poses a problem for putting the body in the CT scan machine. The body is then put in a transparent water-tight body bag and then put on the CT couch for a CT scan of the whole body. After the CT scanning, the body then goes for the conventional autopsy. The DICOM images generated from the CT scan machine are processed and reviewed in the workstations and then are again sent to the virtual dissection table for virtual dissection.

Figure 3: CT room

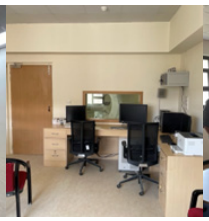

Figure 4: Console room

Figure 5: Virtual dissection table

Comparison of Virtual Autopsy and Conventional Autopsy

The whole concept of a virtual autopsy is a new development in India. The first virtual autopsy center was set up as a Circulation assimilation relaxation and elimination (CARE) project under the Indian council of medical research (ICMR) at All india institute of medical sciences (AIIMS), Delhi, which was inaugurated by the DG, ICMR in March 2021.[15,16] The virtual autopsy center at NEIGRIHMS is a very new one. The installation process was completed in the latter part of February 2022.

Since then, all the cases are subjected to the CT scan and then the conventional autopsy as mentioned above.

Based on the experience during this short period, it is

Some of the images in the CT and Virtual dissection table:

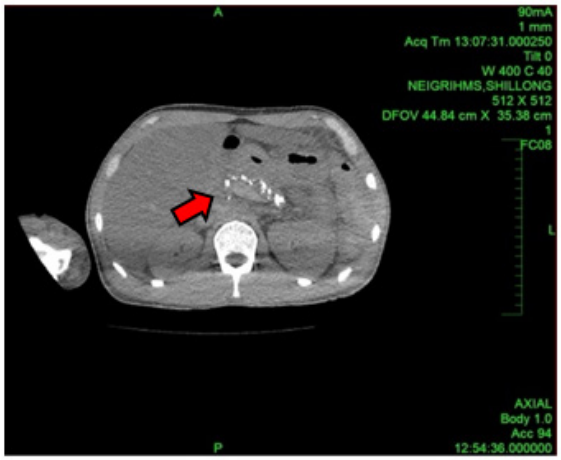

Figure 6: CT abdomen: calcified pancreas

Figure 7: 3D reconstruction with calcified pancreas in virtual dissection table

Figure 8: 3D reconstruction in virtual dissection table with calcified pancreas

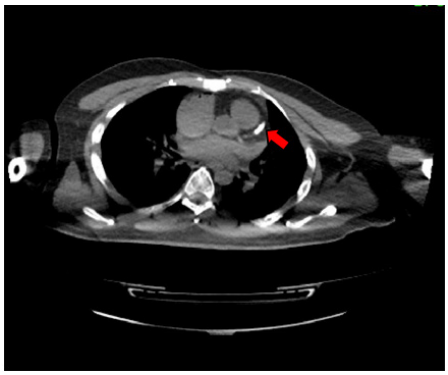

Figure 9: CT thorax with calcified LAD

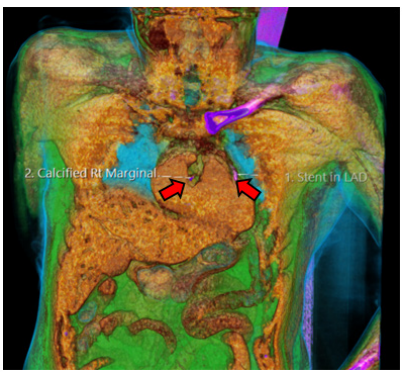

Figure 10: 3D reconstruction with calcified Rt carotid & stent in LAD in virtual dissection table

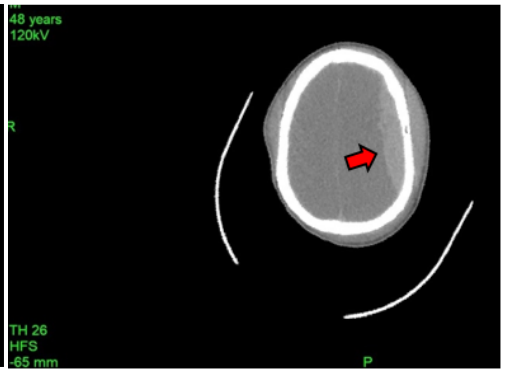

Figure 11: CT brain showing EDH with fracture of parietal bone and scalp hematoma

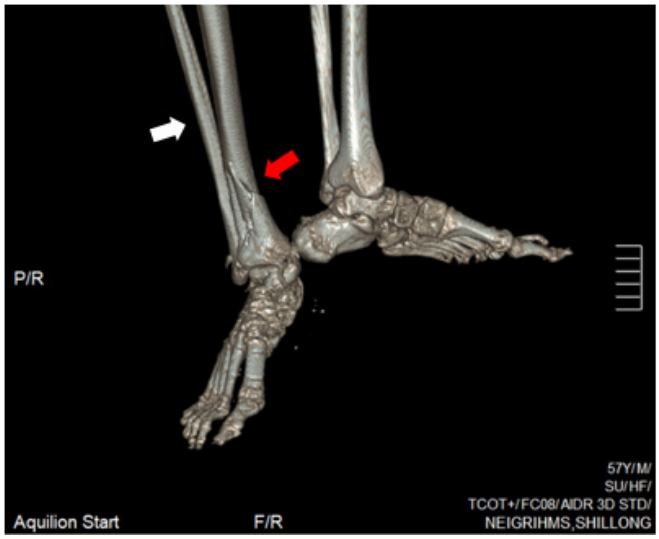

Figure 12: 3D reconstruction with fracture both bones rt leg

Fig. 13: 3D reconstruction with fracture femur with dislocation

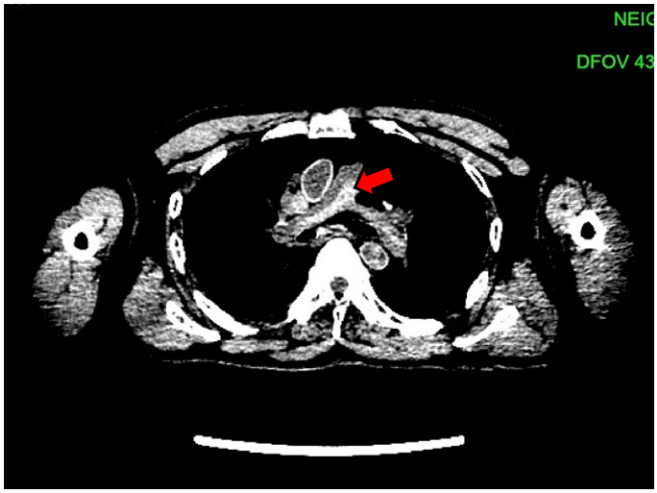

Figure 14: 3D CT Thorax showing the pulmonary embolism

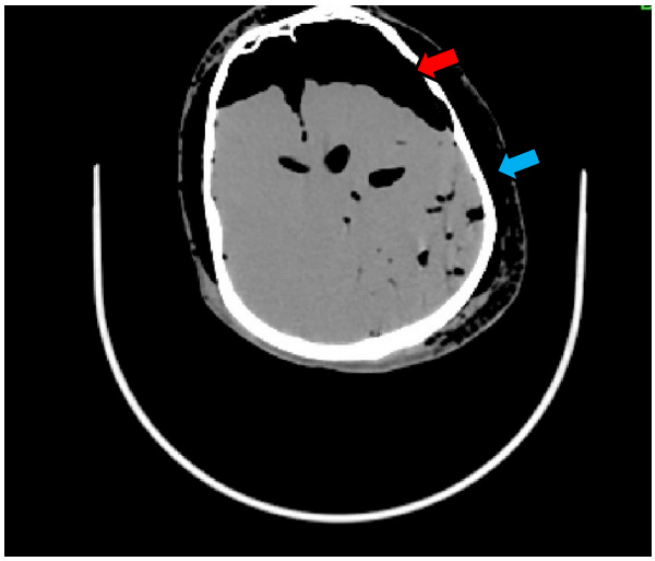

Fig. 15: CT brain showing the decomposed gas in cranial cavity (red arrow) & scalp (blue arrow)

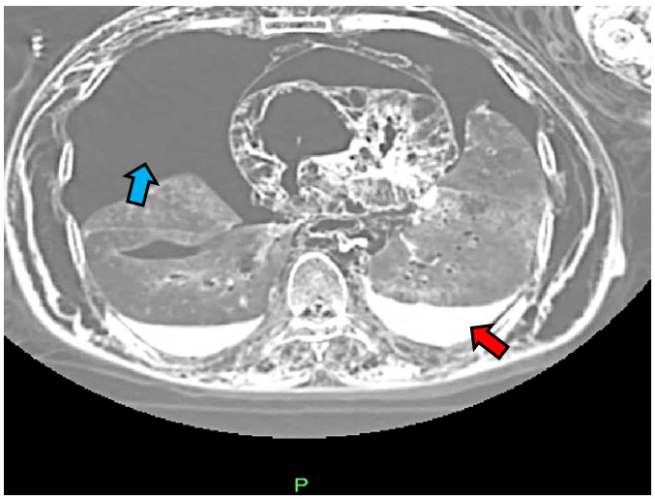

Figure 16: CT thorax showing the post-mortem fluid (red arrow) and gas (blue arrow)

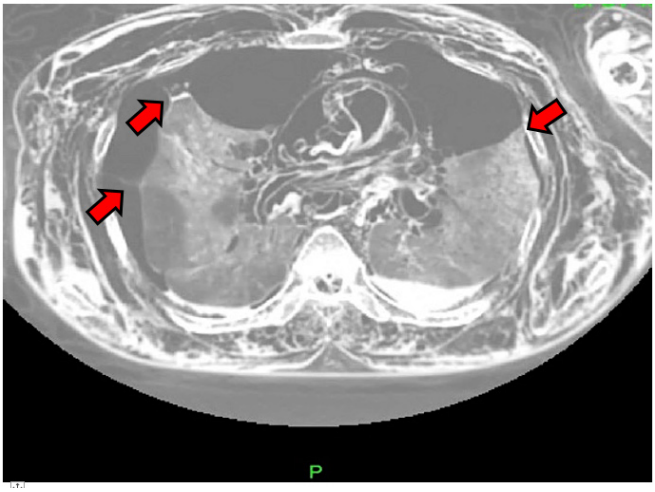

Figure 17: CT thorax showing the pulmonary fibrosis with adhesions

quite evident that there are advantages and disadvantages in both the conventional autopsy as well as virtual autopsy; many of the findings in the CT are not found or observed in the conventional autopsy. Similarly, there are some findings that are not appreciated in the CT/Virtual autopsy.

It is a fact that the virtual autopsy is far less time-consuming; the body can be released even within 15 minutes from receiving, as the CT will take hardly five minutes; moreover, the data is stored and can be processed and loaded to the virtual dissection table for further processing. In the virtual dissection table, the 3D image of the body can be generated, which can be subjected to different filters and tools to visualize the organs or the systems as per need, along with virtual dissection into the cavities. So, with the CT and the virtual dissection table, one can have almost the same kind of experience as the conventional autopsy in most cases and with more detailed findings. If along with the CT, one can get Post-mortem angio, then it will help one assess vessels more precisely.

Apart from being the easy and fast release of the body, it is also almost non-hazardous for the autopsy room staff in comparison to the conventional autopsy. So it becomes very much convenient for the autopsy surgeon as well as other supporting staff to go for it, especially in cases of hazardous autopsies.

As the data generated are in the form of DICOM images from the CT scan machine, the same can be stored with minimal effort and also can be shared and retrieved for further opinion and processing. Similarly, the 3D images generated after the reconstruction or processing can be documented and understood even by non-medical persons also, so, very informative for the court procedure, which is not possible in the case of the conventional autopsy.

Similarly, the 3D images generated are more precise and informative in regards to some of the injuries, particularly stab wounds or firearm injuries. The accumulation of air or fluid in the cavities as well in the tissue spaces or injury to some vessel and formation of hematoma also can be better demonstrated in virtopsy in comparison to conventional autopsy as many a time during dissection of the body; these findings may be masked or distorted.

However, as mentioned above, there are disadvantages in the procedure as the color and temperature are not recorded in the CT machine, so it is impossible to find the antemortem or post-mortem nature of the wounds or the time since the death based on the CT based technique. The issue can be addressed by external examination of the body as practiced at NEIGRIHMS before conventional autopsy to note down the findings, and then the body can be put for a CT scan.

Image-guided FNAC or endoscopes can well achieve the issue of collection of samples. For the collection of toxicological samples, the blood sample which can be collected from the great vessels may be sufficient; for stomach content, one can do it by aspiration from the stomach.

However, the real challenge arises when commenting on a vessel's antemortem clot or post-mortem clot. Similarly, the color changes in the organ or tissue due to time passed since injury or inflammation cannot be appreciated.

Conclusions

There is always resistance from most towards accepting any new development, particularly in the scientific field. It always had to pass through trial by fire when it concerns something related to the law and justice. Virtopsy is also no exception. For many, it cannot be an independent method for a death investigation.

Like any other scientific tool, Virtopsy also has its merits and demerits, but one should not be judgmental about it. Virtopsy can be a supplement to the conventional autopsy, and many a time, it can even be adopted as a single tool for death investigation in place of the conventional autopsy.

There are a few, even amongst the medical professionals who are sceptical about the legal acceptability of virtual autopsy; however, it is very clear from the Section 65A and 65B, Indian Evidence Act 1872, that information contained in an electronic record is printed on paper, stored, recorded, or copied in optical or magnetic media produced by a computer shall also be deemed to be a document and shall be admissible in any proceedings and as such, the findings generated in the virtual autopsy is admissible in the court; the only requirement is reporting by a forensic medicine person trained in forensic radiology/CT scan.

At NEIGRIHMS, Shillong, a study is going on to determine the cases where it will be proper to go for virtual autopsy alone, and after completion of the study, hopefully, we will come out with a protocol for virtual autopsy.

So in the near future, India will be one of the countries where the autopsy will be done with a minimally invasive procedure and also will be less hazardous for the autopsy room staff.

Acknowledgement

I am thankful to the faculty, staff and the PGs of the department

of Forensic Medicine, NEIGRIHMS, Shillong for their help in the preparation of the article by providing the images and findings of the cases.

Reference

1. Aggrawal A. Medicolegal Autopsy. In: Forensic Medicine and Toxicology for MBBS. 1st ed. Delhi: Avichal Publishing Company; 2016. p. 93–114.
2. Biswas G. Medicolegal Autopsy. In: Review of Forensic Medicine & Toxicology. 5th ed. New Delhi: Jaypee Brothers Medical Publishers; 2021. p. 113–135.
3. Patowary AJ. Autopsy in cases of torture and custodial death. In: Recent advance in forensic medicine & toxicology. 1st ed. New Delhi: Jaypee; 2018. p. 503–528.
4. Badam RK, Sownetha T, Babu DBG, Waghray S, Reddy L, Garlapati K, et al. Virtopsy: Touch-free autopsy. J Forensic Dent Sci. 2017 Apr;9(1):42.
5. Patowary AJ. Virtopsy: One Step Forward In The Field Of Forensic Medicine - A Review. J Indian Acad Forensic Med. 30(1):32–6.
6. Kumar A. Digital Autopsy (Virtopsy) in India: Steps taken and journey ahead. J Indian Acad Forensic Med. 2022 Jan;44(Suppl):S43–6.
7. Thali MJ, Braun M, Buck U, Aghayev E, Jackowski C, Vock P, Sonnenschein M, Dirnhofer R. VIRTOPSY—scientific documentation, reconstruction and animation in forensic: individual and real 3D data based geo-metric approach including optical body/object surface and radiological CT/MRI scanning. Journal of forensic science. 2005 Jan 5;50(2):JFS2004290-15.
8. Ith M, Scheurer E, Kreis R, Thali M, Dirnhofer R, Boesch C. Estimation of the postmortem interval by means of ^{1}H MRS of decomposing brain tissue: influence of ambient temperature. NMR Biomed. 2011 Aug;24(7):791–798.
9. Scheurer E, Ith M, Dietrich D, Kreis R, Hüsler J, Dirnhofer R, *et al.* Statistical evaluation of time-dependent metabolite concentrations: estimation of post-mortem intervals based on in situ 1H-MRS of the brain. NMR Biomed. 2005 May;18(3):163–172.
10. Jansen JFA, Backes WH, Nicolay K, Kooi ME. 1H MR spectroscopy of the brain: absolute quantification of metabolites. Radiology. 2006 Aug;240(2):318–332.
11. Sidek S, Ramli N, Rahmat K, Ramli NM, Abdulrahman F, Kuo TL. In vivo proton magnetic resonance spectroscopy (1H-MRS) evaluation of the metabolite concentration of optic radiation in primary open-angle glaucoma. Eur Radiol. 2016;26(12):4404–4412.
12. Ross SG, Bolliger SA, Ampanozi G, Oesterhelweg L, Thali MJ, Flach PM. Postmortem CT Angiography: Capabilities and Limitations in Traumatic and Natural Causes of Death. RadioGraphics. 2014 May;34(3):830–846.
13. Roberts ISD, Benmore RE, Benbow EW, Lee SH, Harris JN, Jackson A, et al. Post-mortem imaging as an alternative to autopsy in the diagnosis of adult deaths: a validation study. Lancet Lond Engl. 2012 Jan 14;379(9811):136–142.
14. Slong D, Ropmay AD, Marak AR, Nath A, Marbaniang RBV, Patowary AJ. Perception of relatives towards Medico-legal autopsy in a tertiary care centre of Northeast India. Panjab Acad Forensic Med Toxicol. 2021;21(1):39–43.
15. Delhi: AIIMS set to start virtual autopsy, no cuts needed | Delhi News - Times of India [Internet]. [cited 2022 May 12]. Available from: https://timesofindia.indiatimes.com/city/delhi/aiims-set-to-start-virtual-autopsy-no-cuts-needed/articleshow/81595090.cms
16. AIIMS Becomes First in South, SE Asia to Start "Virtual Autopsy" with No Cuts: What is it? [Internet]. News18. 2021 [cited 2022 Jun 3]. Available from: https://www.news18.com/news/buzz/aiims-becomes-first-in-south-se-asia-to-start-virtual-autopsy-with-no-cuts-what-is-it-3558146.html