

Virtopsy: New Advancements in

Forensic Science and Autopsy

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I verify that I have adhered to all rules and regulations set forth by the Oklahoma Society of Radiologic Technologists while writing this paper. I have received and read the rules and regulations.

Abstract

Radiologic imaging has, in the past, contributed some to forensic science and autopsy; but, newer modalities are changing the way forensic pathologists view what radiology has to offer them. Multislice computed tomography (MSCT), Magnetic resonance imaging (MRI), and photogrammetry and three dimensional (3D) surface scanning are non-invasive techniques that are increasingly being used for post-mortem examinations. These imaging tools have not yet been widely implemented in autopsy, but they are proving to be an invaluable autopsy tool. As interest and need for these modalities develop in forensic science and autopsy, there will be more need for Radiologic Technologists (RT) in this field.

Introduction

For many years, the use of imaging methods as a non-invasive tool for documenting important forensic findings has consistently been far behind the technical development of these methods themselves.¹⁻³ “The gold standard of examining a deceased person is still the opening of the corpse with an exact oral description and a written documentation.”¹ Ordinary two-dimensional photography is used to document the important external and internal findings.¹ One major problem with the conventional autopsy is that once the forensic pathologist has completed the autopsy and the body has been cremated, there is no

way to go back and repeat the exam.¹⁻³ This problem could potentially result in the loss of findings that were missed or not documented.¹

MSCT and MRI, along with photogrammetry and 3D surface scanning, can help prevent the loss of vital information. Some forensic labs have begun to implement these modalities and they are continually proving themselves to be a great resource for autopsies.¹⁻³ MSCT and MRI can assist the conventional autopsy in many ways; in some cases, they can even replace the need for a conventional autopsy. Photogrammetry and 3D surface scanning has been accepted in the court systems because of the important information it can provide to a forensic case.¹⁻³ Although these imaging methods are not yet widely used in autopsies, great potential for growth does exist once the forensic world realizes how much these modalities have to offer.¹⁻⁴

Discussion

The purpose of an autopsy is not just to determine the cause of death; it is also to find out the circumstances surrounding the death for all interested parties of the investigation. The suspected cause of death can also be changed by information that is gleaned by the police during their investigation. The forensic pathologist must find and consolidate the data and then interpret the information using the previously gathered information about the cause of death.¹⁻² A report is then compiled that satisfies the needs of multiple parties.² With all of these steps and processes comes a great potential for loss or misrepresentation of data.

Radiologic imaging has contributed somewhat to the pathologic investigation by providing some record of the anatomy and pathology of the corpse prior to autopsy. Pathologists have used radiographic films taken before the autopsy and fluoroscopy during the autopsy to document small fractures and to locate foreign objects.² These modalities are helpful, but they are far behind the technology that radiology can provide a pathologist today.¹⁻⁵ “Diagnostic imaging is still underused in forensics, mainly due to unawareness of its potential and the lack of teaching and experience.”³

There is a new form of autopsy that is being used in some forensic laboratories, called virtopsy, which encompasses the use of newer radiologic imaging modalities. The name ‘virtopsy’ is a combination of the words ‘virtual’ and ‘autopsy’.¹⁻³ Virtopsy consists of body volume analysis and documentation using MSCT, and MRI; and 3D body surface analysis and documentation using photogrammetry and 3D surface scanning.³

The focus of virtopsy right now is to teach pathologists and radiologists about what MSCT, MRI, and photogrammetry and 3D surface scanning can offer to forensic science and autopsy.¹⁻³ Radiologic technologists (RT) with CT and/or MRI certifications are not yet being heavily employed to work in virtopsy since it is currently not a widespread field. As more pathologists and radiologists decide to learn how to use these new tools, virtopsy will continue to grow and become more prevalent.¹⁻³

MSCT is the tool used most frequently in virtopsy.¹ A whole body MSCT scan is run on the deceased person before the autopsy is performed. This scan provides a permanent record of the anatomy and pathology of a corpse before the pathologist begins his conventional autopsy.¹⁻³ “The main advantage of a pre-autopsy MSCT scan is that it provides additional information to the traditional autopsy.”¹ It also permits the pathologist to plan part the procedure ahead of time by locating foreign bodies and potential hazards; sometimes, it can even foreshadow the need to speak with the coroner and next of kin about specific tissue and organs before the autopsy.²

MSCT can also provide some information that conventional autopsy cannot. Finding a pneumothorax or air embolism is fairly difficult in traditional autopsy.¹ Once the pathologist opens up the body, the gas is able to escape. A post-mortem MSCT scan can detect the gas because it does not absorb X-rays so a pneumothorax is localized easily.¹ Moreover, MSCT is a good tool for detecting mid-ear trauma; specifically lesions of the ossicular chain, which cannot be seen with a conventional autopsy.⁴ The acquisition time for doing the MSCT on a corpse is only about 10 minutes.^{1,3} This is a relatively short period of time when considering how much information a pre-autopsy MSCT scan can offer a forensic pathologist.

Figure 1 is an abdominal CT scan of a pedestrian who was rolled over by a car. It demonstrates massive soft tissue emphysema which is a vital sign of

trauma in this type of accident.³ Air collections between the muscle and the skin

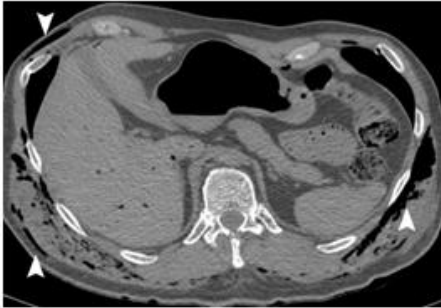


Figure 1. Abdominal CT scan³

indicate that the pedestrian was still breathing for some time after the accident.³ Some of this information would have been lost during the conventional autopsy because the air pockets would have escaped when the pathologist opened up the body.¹⁻³

MRI is another excellent tool that is aiding the conventional autopsy. “For the pre-autopsy, the MRI scans the head, thorax and abdomen, and, depending on the case, other additional regions (e.g. extremities when injured).”¹ This tool is being used to detect pathological findings in soft tissue areas, like subcutaneous fat and inner organs.¹⁻² MRI in combination with MSCT is being used in cases involving fatal hemorrhage or hypothermia.¹⁻³ Another special indication for MRI is strangulation,¹ and since MRI is non-invasive and requires no radiation

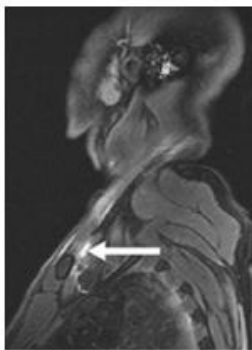


Figure 2a. MRI scan³

exposure, it is also being used as a tool to aid the external examination of victims who have survived strangulation.¹⁻³

Figures 2a and 2b are both of a person who died from strangulation.³ Figure 2a is a sagittal MRI of the corpse after the fatal strangulation. The arrow is pointing to an area of hyper intensity where the sternocleidomastoid muscle inserts into the

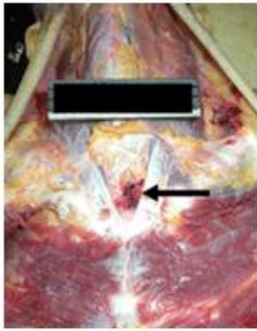


Figure 2b. Autopsy

sternoclavicular region. This is a finding that indicates circulation continued after the strangulation had begun. Figure 2b is the corresponding autopsy photo taken during the autopsy. Note that the MRI taken before the autopsy gave the pathologist exact information regarding what to look for.³

Photograph³

MRI is also a useful tool when cardiac findings are expected.^{1-3, 5} Figures 3a and 3b are both MR images of a heart following natural cardiac death.³ Figure 3a is a short-axis MRI showing a hypo-intense area in the left lateral wall of the heart. In the area surrounding the myocardial tissue, areas

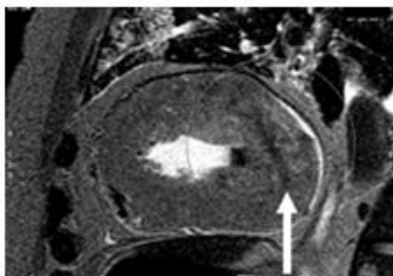


Figure 3a. MRI scan³

of hyper-intensity are also shown.³ Figure 3b is the corresponding autopsy photograph taken after the heart was removed from the body. Again, note that the MRI of the heart taken before the autopsy gave the pathologist exact information regarding what to look for.³



Figure 3b. Autopsy photograph³

MRI does have some shortcomings that could keep it from being implemented into a forensic pathology setting, though.

MRI is much more costly than MSCT.² Also, the acquisition time for MRI is 1.5 to 3.5 hours.¹⁻³ This is a considerable length

of time when a pathologist is ready to do an autopsy on a corpse. For this reason, MRI has rarely been used as a whole-body screening tool.² The pathologist and the staff would need to plan ahead for time to do the MRI. Despite its drawbacks, MRI is a better tool than MSCT for defining visceral structures and for delineating pathology.²

Aside from using radiological imaging techniques to document internal findings, virtopsy also uses digital photogrammetry and 3D surface scanning to document external findings.¹ The GOM TRITOP/ATOS III is a reliable system that reproduces the geometry of an object with high resolution in 3D.^{1,3} This system can scan a body, a weapon, or a car from an accident and display a model of the object in real color.^{1,3} The finished scan also displays the tiniest defects or injuries of the models.¹⁻³ These models, along with the radiological data, are being used to reconstruct accidents and homicides for law enforcement purposes.¹⁻⁵

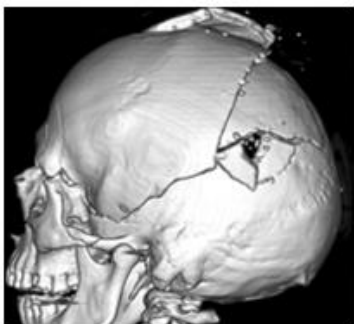


Figure 4a. 3D reconstruction³ compared to the model of the actual injury to prove whether or not the gun fired the object that caused the injury.^{1,3} Figures 4a

Photogrammetry and 3D surface scanning has already been accepted by the court system.¹

3D reconstruction can be used to compare a gunshot injury to a suspected weapon.¹ The model of the presumed weapon can be



Figure 4b. Autopsy Photograph³

and 4b are of a gunshot wound to the head.³ Figure 4a is an anteroposterior 3D CT image showing the gunshot wound entrance with sharp external margins. The path of the bullet can also be seen by mapping the pattern of damage inflicted to the skull.³ Figure 4b is the corresponding autopsy photograph of the gun shot wound.³



Figure 5a. 3D CT image³



Figure 5b. 3D CT image of accident³

In order to reconstruct a traffic accident, photogrammetry and 3D surface scanning is done on the vehicles involved, and on the bodies of the persons affected by the accident.^{1,3} The scans are then compared to find out how the accident occurred.^{1,3} Figures 5a and 5b are real data-base reconstructions of a pedestrian who was hit by a car.³ Figure 5a is a 3D CT that is demonstrating how collected information about joints is used to build movable extremity models.³ First the skeleton is built; then the surface details are added.^{1,3} Figure 5b is demonstrating how the 3D surface image of the car, including the damage, can be correlated with the injuries of the victim. The end result is a forensic reconstruction of how the accident occurred.^{1,3}

Conclusion

In the past, radiologic imaging has had minimal influence in forensic science and autopsy, but recent developments in newer imaging modalities have begun to broaden the scope of what radiology can be used for. Virtopsy is a new form of autopsy that is employing the use of MSCT, MRI, and photogrammetry and 3D surface scanning. MSCT and MRI can give a forensic pathologist valuable information about a corpse before the autopsy; sometimes these modalities can even provide information that a conventional autopsy cannot. Photogrammetry and 3D surface scanning has already found its way into the courtroom because of its ability to reconstruct accidents and homicides in 3D images.

Virtopsy is not widely used now because of lack of knowledge and teaching about its potential uses. Pathologists and radiologists will need additional training in order to implement these modalities into a forensic pathology setting. As more forensic pathologists and radiologists decide to learn about how to use these new modalities to aid in autopsies, virtopsy will become more widespread. This is good news for the RT with CT and/or MRI certifications. As the use of virtopsy becomes more prevalent, there will be an increased need for these specially certified radiologic technologists in the field of forensic science and autopsy.

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