

Imaging the Deceased: Post-mortem Radiology

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This article is part one of a two-part series about postmortem and forensic imaging.

A charred body arrives at the morgue. A victim of an auto accident, bloodied, with numerous crushed bones is dead at the scene. A religious person dies of unclear causes, and the family refuses an autopsy. In the United States, there's a good chance that a medical examiner will still cut into these corpses in search of clues about the cause of death. But technology advances mean that there are other options. Scanning the deceased with CT is commonly done in Europe, Australia, and Japan. It's slow to take hold in the United States, though a few chief medical examiner offices are leading the charge, incorporating imaging other than X-ray in their offices. And the implications are surprising.

The Office of the Armed Forces Medical Examiner at Dover Air Force Base in Delaware uses CT scanning on every body that comes in, says Angela Levy, MD, Professor of Radiology at Georgetown. Levy worked at the base 2004-2009, as part of a postmortem radiology research project, before retiring from the military.

"We found it helpful in almost all autopsies to screen the body prior to dissection, to look at areas that aren't routinely dissected, like the deep pelvis, lumbar spine region, and the sacrum. We found things that were unsuspected or things that weren't where the direct trauma or cause of death was," Levy said. For example, in one case, part of the bullet from a gunshot wound to the chest embolized in the pelvic vasculature.

While the autopsy process didn't change for them, CT imaging provided additional information, helping direct the autopsy or support the findings. It's useful to show evidence, particularly in complex trauma cases. "We found it was an important adjunct to autopsy but couldn't completely replace it," Levy said.

History of Forensic Imaging

X-ray has been used in forensic pathology for more than a hundred years, initially, a year after X-ray was discovered in 1895, to detect gunshot ballistics, said Barry Daly, MD, professor of diagnostic radiology and nuclear medicine at University of Maryland School of Medicine.

"When the multi-slice CT evolved around 2000, we began to do high resolution 3D multiplanar scans of the [deceased] body within a few years," Daly said. The technology was quickly adopted in Europe, as they realized the value of using it to replace or augment conventional autopsy.

For reasons discussed in the second article in this series, postmortem CT scanning has not been widely adopted in the U.S. "We've been trying to move and open the forensic market into using the technologies we've had forever. It's slow to mature here, it's not even close, due to funding and education," said Craig Hughes, a radiology technologist who now sells imaging equipment and turnkey solutions through Counterpoint Healthcare Consulting. He's been involved in postmortem radiology sales for almost four years.

Benefits of CT in Forensics

CT imaging in postmortem cases has numerous benefits. It's good for demonstrating major spinal injuries from severe trauma from a fatal car accident, for example.

"You'd spend hours doing an autopsy and at the end of the day, you still won't have a good image to show in a judicial proceeding, whether it's routine or allegations of wrongful death," Daly said. "You can't get a really good look

at those injuries in autopsy.”©Scott Richardson/Shutterstock.com

But by spending five minutes at a work station with whole body CT images, you can get a good look at the situation and get evidence a lay person can easily appreciate in court.

Another advantage is that CT images are more palatable to a lay viewer. “It’s somewhat sanitized, there isn’t blood dripping off everything,” Daly said. Ironically, in a murder case, sometimes judges won’t allow presentation of images because the injuries are too disturbing. “It seems contradictory. You beat someone to death and make it look really bad and the judge might throw the evidence out because it’s too gross to show to any lay person,” Daly said.



Imaging is advantageous because it’s noninvasive, which means it’s good for communities where autopsy isn’t widely accepted. For example, in Japan, the Buddhist culture is against autopsy, said Daly. Autopsy isn’t considered favorable by Muslim, Orthodox Jews, or Native Americans either, he said. “In Europe it’s unpopular where scandals have occurred, like where body parts of children in the UK were removed and not returned to the family,” Daly said.

If an autopsy still needs to be done, CT imaging can help narrow down the autopsy scope. A CT might show that a car accident victim who died from head trauma has a normal abdomen and pelvis. If an autopsy is still needed, it can be limited to the head.

MRI in Forensic Pathology

MRI is not used as frequently in forensics. The equipment is expensive and complicated, and it’s harder to generate protocols, just like in living patients. Plus, you can’t scan an entire adult body. “It’s not practical and would take far too long,” Daly said. As for advantages, MRI is good for looking at neurological injuries, the brain and spine. “We don’t see the spinal cord particularly well in CT,” he said. Even if fractures can be visualized well with CT, the cord itself isn’t visible on that technology, but with MRI, it’s better.

MRI is more actively used for looking at the cause of death of children and stillborn babies, since congenital issues and cardiac anomalies can be seen. “You could argue that the advantages of MR over CT are considerable and even more so in death than in life, because we can’t inject venous contrast for postmortem CT,” said Daly. “We rely on enhancement for showing organs. You can’t do that in a cadaver. In MR, you still can get good tissue differentiation, and the spinal cord nicely separates from cerebral spinal fluid.”

Over time, cadavers get decomposition changes and gas. “It’s much harder to do MR when this happens,” Daly said. MRI is not as valuable overall as CT, but there are settings in which it’s helpful, Daly said, like situations when you don’t want to do an autopsy under any circumstance. MRI is helpful as an adjunct to CT, like on the cervical spine to confirm brain stem compression seen on CT. A single body part can be imaged on MRI.

Pathology versus Radiology

A pathologist reading CT scans? They don’t teach that in residency, but the dividing line between what a pathologist reads postmortem versus a radiologist isn’t clear. Pathologists can learn how to read CT scans, said Daly, “They’re already good at anatomy.” At the Armed Forces Medical Examiner office, pathologists in training fellowships learn as they go, said Levy. While she was there, pathologists interpreted some of the scans, calling radiologists as needed for consultation.

As for running the scanners, the Chief Medical Examiner’s office in Maryland, which handles all the state’s cases, has a scanner and one part-time technologist who supervises the mortuary technician, said Daly. The mortuary

technician already does conventional X-ray, and has learned how to do the “basic cookie-cutter protocols, which are simple,” Daly said. “There aren’t a lot of complex protocols involved. So far it’s worked out fairly well, as long as there’s adequate supervision,” Daly said.

Training programs with continuous feedback from the experienced CT technologist is essential to make sure everything is done properly. The forensics office needs someone available to run the scanner around the clock when cases come in, often in the middle of the night. Autopsies are scheduled early in the morning, so the CT needs to be done first. “It would be quite expensive if you had a contract for CT techs to come in and do all the scans,” he said.

Hughes said an accredited program can be put together in the United States, but training is currently only done outside the country. “I’m an RT, so I believe anyone using radiation should be educated and have an understanding on how to use it.”

As for radiologists, reading postmortem scans aren’t the same as scans from live patients. There are differences between what you see in a live patient versus a corpse. “Are they postmortem artifacts or are you looking at something that’s a pathologic finding?” said Daly. One example is seeing fluid around the brain in a person discovered in a house fire. A radiologist might initially conclude that someone was killed by getting hit on the head, with a fire then set to hide the assault. “I would think that, until the forensic pathologist points out that they were burned, and [fluid inside the skull] is a normal effect of the fire,” said Daly. Radiologists have to be careful not to make errors about the true pathology findings, learning about normal postmortem changes that can simulate an injury.

The disease processes can be slightly different in corpses. “Often you see injuries or diseases you don’t see in a living individual,” Levy said. “Even from a radiologist’s perspective, there’s a learning curve for understanding the cause and mechanism of death, and the severity of injuries that kill people, that you don’t necessarily see in a hospital.”

For example, in a hospital it’s unusual to see traumatic injuries from motor vehicle accidents that instantly cause death. “People who die at the scene don’t come to the hospital,” she said. “That spectrum of injuries isn’t often seen by a practicing physician.”

Radiologists reading images from living patients may not recognize postmortem changes. They may need to adjust the way they interpret decomposition or lividity seen on CT, Levy said. And on the extreme side of forensic pathology, there may be evidence of insect or animal predation which happens to bodies left out or in the open, in the days or weeks after death. Those aren’t typically seen by a clinical radiologist. Radiologists would need to learn on the job from forensic pathologists or forensic anthropologists, who do the decomposition work.

Unfortunately, the U.S. lacks formal learning opportunities for postmortem radiology. While Daly took a course in Switzerland, “It’s certainly possible for a radiologist with an interest to pick it up, but you have to spend the time to learn it,” he said.