Post-mortem computed tomography in adults

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Introduction

There has been increasing interest in recent years in a new application of cross-sectional imaging, that of investigation of cause of death. A perceived public distaste for invasive autopsy, fuelled in part by the organ retention scandals of the late 1990s, coupled with disquiet about the fitness-for-practice of the coronial system, has led to a search for a less invasive alternative.

A post-mortem MRI service was introduced in Manchester in the 1990s in response to a demand from the Jewish community for an alternative to traditional coroner’s autopsy. Post-mortem CT and MR are now offered in an expanding number of locations, mostly funded by faith or community groups with religious and cultural objections to autopsy. However, the number of invasive autopsies being performed in England and Wales remains at a high level. Coroners requested autopsies in roughly 42% of the 46% of deaths referred to them in 2011, resulting in around 94,000 post-mortems. This compares with a post-mortem rate in Japan of approximately 2%.

Evidence for a variable standard of coronial autopsy came from the National Confidential Enquiry into Patient Outcome and Death in 2006, a review of autopsy reports produced for coroners which found that one in four reports was judged as poor or unacceptable and in nearly one in five cases, the cause of death as stated appeared questionable. Since 2006, a Department of Health sponsored study of adult deaths has investigated the use of post-mortem CT and MR, together with targeted angiography. The initial validation study reported in 2012. Briefly, post-mortem CT and MRI followed by full autopsy were performed in a series of 208 unselected adult deaths. The different modalities were reported independently and subsequently compared with the gold standard, full autopsy. CT was more accurate in identifying the cause of death when compared to MRI; there was a major discrepancy between autopsy and imaging diagnosis of 32% and 43% for CT and MRI respectively. In those cases of high diagnostic confidence by the radiologists, the findings correlated well, although not perfectly, with the subsequent autopsy diagnosis: the major discrepancy rate in this cohort was 16% for CT and 21% for MRI. Thus, radiologists were better able to correctly identify those cases in which imaging could provide an accurate cause of death using CT.

Important shortcomings of cross-sectional imaging were identified: the most common cause of natural death, ischaemic heart disease, was frequently missed, as were cases of pulmonary thromboembolism and various intra-abdominal lesions such as intestinal ischaemia and perforations. The imaging techniques were often unable to differentiate between pulmonary oedema and consolidation due to pneumonia. Unsurprisingly, both CT and MR were most accurate in the diagnosis of deaths resulting from malignancy and haemorrhage.

Both targeted and whole body post-mortem angiographic techniques have been developed in an attempt to improve the diagnosis of cardiovascular disease. Whole-body techniques provide excellent depiction of the circulatory system but are expensive and time-consuming to perform. A targeted method of post-mortem CT coronary angiography has recently been described that is simple, reliable, cheap, quick to perform and was sensitive in the identification of coronary heart disease in a pilot study of 10 patients. In a recent study of 120 sudden adult deaths referred for coroner’s autopsy, addition of this technique to a standard post-mortem CT has increased the proportion of cases in which a confident radiological cause of death can be given from around one third to just over two thirds (data published in abstract).

The combination of post-mortem CT with other minimally invasive techniques can be used to improve diagnostic accuracy. The number of invasive autopsies required for cases in which the history suggests drug abuse can be reduced by two thirds by employing CT together with aspiration of fluids for toxicology. This is of particular value in high risk autopsies, such as Hepatitis C virus-positive patients. The combination of post-mortem CT with ultrasound guided needle biopsy can be used to provide a precise histological diagnosis.

Logistics

It is clearly essential that post-mortem imaging does not interfere with scanning of the living. The simplest solution is to locate dedicated scanners in mortuaries and there are plans to install a CT scanner in the public mortuary in Bradford. If this solution is too expensive, and existing scanners in radiology departments are used, post-mortem imaging must be performed outside normal working hours. There is also a scarcity of radiologists with experience of post-mortem imaging diagnosis. The recent publication of a joint Royal College of Radiologists and Royal College of
Pathologists statement on standards for medico-legal post-mortem cross-sectional imaging in adults gives useful information for those wishing to become involved in this new service.11

In theory, images could be acquired in one centre and the images sent to a specialist centre for review. However the need for an instant decision as to whether coronary angiography is required, and the necessity for close co-operation between radiologist and pathologist make this option less practical. A Department of Health commissioned report entitled ‘Can cross-sectional imaging as an adjunct and/or alternative to the invasive autopsy be implemented within the NHS’ published in October 2012 recommends a national cross-sectional autopsy imaging service provided by 30 mortuary-based imaging centres in England.12

**Forensic autopsies**

Imaging has a long established role in forensic practice. Indeed, the first use of radiographs in a homicide investigation occurred in 1896. CT is highly sensitive in the detection of bony injuries and allows less gruesome depiction of these injuries to a jury. In this context, CT is used as a supplement, rather than an alternative, to invasive autopsy. Whether imaging could replace the autopsy in cases of suspicious or homicide death is yet to be tested in UK courts.

The opinion of the NHS Implementation Sub-group of the Department of Health Post Mortem, Forensic and Disaster Imaging Group is that the gold standard for such cases should be a combination of post-mortem CT and invasive autopsy.12 It is possible that using CT as an adjunct in this way would reduce the requirement for second autopsies.

**Future perspectives**

Public demand for non-invasive autopsy seems unlikely to wane. However, expansion of the use of imaging in death investigation will inevitably be more expensive than traditional coroners’ autopsies alone. Government funding for a national service incorporating imaging seems unlikely in the current financial climate. Funding is therefore likely to continue to come from families, or faith groups. It is essential that they are aware that, due to the limitations of post-mortem imaging, a significant percentage of cases will still require invasive autopsy. Research is continuing, particularly into the use of post-mortem angiographic techniques and MRI, with the hope that the accuracy of imaging diagnosis of cause of death will improve to the point that the need for additional invasive autopsy is negligible and the costs thereby reduced.

**References**

8. Roberts I S D, Traill Z C. Minimally invasive autopsy employing post-mortem CT and targeted coronary angiography; evaluation of its application to a routine Coronial service. Mod Pathol in press.

**Figure 1**

Axial post-mortem CT image showing pneumoperitoneum and extensive intra-vascular gas due to decomposition.

**Figure 2**

Axial post-mortem CT image with targeted coronary angiography showing decreased enhancement in the antero-lateral myocardium and haemopericardium due to a ruptured myocardial infarct.
Figure 3
Axial post-mortem CT image showing the calcified wall of a ruptured abdominal aortic aneurysm and blood in the retroperitoneum.