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Evaluation of unenhanced post-mortem computed tomography to detect chest injuries in violent death

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Abstract
Purpose: The aim of this study was to assess the performances of unenhanced post-mortem computed tomography (CT) to detect thoracic injuries in violent death.
Materials and methods: Retrospectively, we conducted a review of unenhanced CT scans of 67 victims of violent deaths with thoracic injuries and compared CT findings with the results of clinical autopsy. Our gold standard was a comparison of CT scans with autopsy discussed in a monthly forensic radiology multidisciplinary team meeting (MDTM). The data were collected by organ system: heart, pericardium, aorta, lungs, pleura, bone, and diaphragm and performance indices (sensitivity, specificity, accuracy) were calculated.
Results: Pleural (59/67) and bone (55/67) injuries detected on CT were also found at autopsy and confirmed by the MDTM (sensitivity and specificity 100%). Seventeen out of 67 diaphragmatic lesions were visible on CT. Eighteen out of 67 were confirmed during MDTM after autopsy, yielding overall sensitivity of 94% and specificity of 98%. Forty out of 67 lung contusions were found on CT with two false positives and one false negative yielding 95% sensitivity for CT with a specificity of 96%, and accuracy of 95%. Fourteen out of 67 aortic injuries were found on CT compared to 19 confirmed during MDTM (sensitivity 74%, specificity 85%, accuracy 82%). In terms of pericardial lesions, 19/67 were found on CT and 20 on autopsy and confirmed during MDTM (sensitivity

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80%, specificity 94%, accuracy 85%). Ten out of 10/67 cardiac lesions were visible on CT imaging and 15 found on autopsy and confirmed during MDTM (sensitivity 57%, specificity 94%, accuracy 81%).
Conclusion: Unenhanced post-mortem CT performs well to detect pleural, pulmonary, bone and diaphragmatic injuries but less well to identify cardiac and aortic injuries, for which the use of indirect signs is essential.

Unenhanced post-mortem computed tomography (CT) is now a routine method, which is relatively straightforward to use in forensic medicine before autopsy for violent death [1]. It is performed at the request of a coroner before the autopsy and allows an initial assessment of the injuries and a cause of death to be proposed, it both guides and shortens the length of autopsy and is also extremely useful in the pediatric situation in which families often refuse conventional autopsy [2]. It can be difficult to interpret because of putrefaction effects [3] when large amounts of gas are present hindering the analysis, because of the redistribution of blood volumes but also because of the lack of contrast enhancement, which few groups currently use, as this greatly increases the complexity of the procedure. Despite these limitations, the investigation can perform well provided practitioners have a sound knowledge of normal and pathological post-mortem appearances.

The thorax is a complex anatomical region containing organs, which may be responsible for the cause of death when they are damaged, although its interpretation is complicated considerably by the lack of contrast enhancement, which is essential in living people (for the heart and aorta).

The aim of this study was to assess the performances of unenhanced post-mortem CT to detect thoracic injuries in violent death.

Materials and methods

Sample

One hundred and one cadavers underwent post-mortem CT following sudden violent death in our institution between January 2012 and March 2014. We excluded cadavers, which did not undergo autopsy following the CT ($n = 9$), cases of major putrefactions ($n = 5$), cases of charring ($n = 8$), asphyxia ($n = 3$) and drownings ($n = 9$). Sixty-seven cases were included in the study with 45 men and 22 women and a sex ratio of 2 to 1. The mean age was 47.2 years (SD, 18.6 years), and an interquartile range of 19 years. There were many different causes of death: 27/67 were road traffic accidents (40.3%), 13/67 were due to firearms, 19.4% including 8/13 suicides (61.5%) and 5/16 murders (38.5%). There were 6/67 suicides from jumps from heights (8.9%), 6/67 accidental falls (8.9%); 5/67 domestic accidents (7.5%); 3/67 accidents at work (4.5%); 3/67 deaths from knife injuries (4.5%) and 4/67 were of unknown cause (6%). The time between death and CT was under 12 hours (performed the same day in 28/67 cases), between 12 and 24 hours in 33/67 cases (when the CT was performed the next day) and between 24 and 48 hours in 6/67 cases (when the CT was performed two days after death). The longest time before the CT was performed was 48 hours after death, with an average of 19 hours and a shortest time of approximately 5 hours. CT and autopsy were always performed on the same day.

Protocol

CT

The cadaver arrived at the CT sealed in an airtight radiolucent body bag. The investigations were performed using the same 16 slice CT machine (Philips Brilliance, Eindhoven, Netherlands) without contrast enhancement using a standardized protocol (Table 1). The cranium was examined after postero-anterior and lateral views. This was followed by a second image acquisition from the vertex to as far as possible down the lower limbs (table movement limit) and a third additional image acquisition was carried out on the missing part of the lower limbs. Reconstructions were performed in the bone and lung windows routinely together with multiplanar (MPR) and volume rendering technique (VRT) reconstructions. Data were saved anonymously onto a PACS system (Synapse, FUJI, Tokyo, Japan).

CT images were read on a post-processing console following a systematic protocol by a radiologist and a forensic pathologist immediately after the investigation before the autopsy. The conditions under which the body had been found were known and were reported by the forensic pathologist.

Autopsy

A standardized autopsy technique was used for each case. The cadaver arrived in a mortuary body bag and the autopsy began with external examination of the body, including examination of the skin looking for wounds, firearm entry points and dermabrasions. The autopsy itself began with a scalp incision, followed by a chin to pubis incision. In the thorax, the procedure began with removal of the sterno-costal plate after lateral division of the ribs and the mediastinal pleura, allowing the mediastinum and lungs to