Int J Legal Med (2007) 121:507–510
DOI 10.1007/s00414-007-0200-8

TECHNICAL NOTE

New identification possibilities with postmortem multislice computed tomography

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Received: 23 October 2006 / Accepted: 12 June 2007 / Published online: 28 September 2007

Abstract Historically, radiographical identification has been done by comparing conventional antemortem and postmortem X-ray images. The advent of new technologies such as multislice computed tomography (MSCT) is making traditional antemortem examination increasingly less frequent. The authors present the results of MSCT study of 35 corpses, which demonstrated features potentially useful for identification purposes in ten cases. These features, which relate to abnormalities of postcranial bone as well as of the internal organs, are presented. Attempts were made to find any antemortem X-rays or MSCTs on the cases described to compare the two antemortem and postmortem images. Although antemortem imaging was recovered for only two cases (one case with a skeletal abnormality and one case with a visceral abnormality), it permitted for both cases the comparison of antemortem and postmortem MSCTs.

Keywords Identification · Postmortem multislice computed tomography · Radiology · Thanatology

Presented at the XXth Congress of International Academy of Legal Medicine, Budapest, Hungary, August 2006.

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Introduction

When bodies must be identified, the forensic pathologist has to make use of all the evidence available, permanent and nonpermanent changes to the bodies but also personal possession, even if this might initially seem insignificant. Some international publications agreed upon standards concerning the identification of victims in mass fatality incidents [1, 2]. Even if radiological assistance is described as a secondary identification criterion for the identification of unidentified bodies, it may sometimes be the only way to perform a positive identification [1–10]. Historically, radiographical identification has been carried out by comparison of conventional antemortem and postmortem X-ray images, but the advent of new technologies such as multislice computed tomography (MSCT) and magnetic resonance imaging (MRI) is making traditional antemortem investigation increasingly less common [3]. Even if the forensic pathologist has no antemortem MSCT or MRI results available for comparison, postmortem scans can nevertheless supply valuable potential evidences for identification of an unknown body.

The authors present the results of 35 postmortem MSCTs, which demonstrated features potentially useful for identification in ten cases.

Materials and methods

This study was approved by the appropriate legal authorities.

Sample cases

A total of 35 corpses among those delivered to the forensic medicine department of our institution for external examination, with or without subsequent forensic autopsy, were studied. The study included 9 women and 26 men and mean age at death was 46 years. The sample comprised six cases of blunt trauma, seven gunshot wounds, one knife wound, four cases of drowning, seven of hanging, one death by choking, two deaths by intoxication, three deaths because of burns, three sudden cardiac deaths, and one exhumation.

Imaging

The anonymity of the decedents was preserved by wrapping the corpses in two artifact-free body bags. Axial MSCT was performed with 16×1.25-mm collimation on a Sensation 16 unit (Siemens, Erlangen, Germany). Two- (2D) and three-dimensional (3D) reconstructions were obtained on a Siemens Leonardo workstation; 2D reconstructions were obtained using multiplanar reconstruction mode, and 3D reconstructions were obtained using maximum intensity projection and the volume-rendering technique mode. The images were interpreted by board-certified radiologists. Dental analysis was excluded from the evaluation.

Autopsies

All three body cavities (cranium, thorax, and abdomen) were examined by board-certified forensic pathologists.

Fig. 1 Skeletal abnormalities revealed by post-mortem MSCTs. **a** 3D MSCT reconstruction of the right hip (VRT mode): consolidated impacted fracture (*arrow*). No infiltration of the soft tissues around the fracture was seen. Note the spinal scoliosis. **b** 3D MSCT reconstruction of the cervical spine (VRT mode), lateral view: nonconsolidated fractures of the left pedicle of the first cervical vertebra (*arrow*). Past history of cervical spine fracture. **c** 3D MSCT reconstruction (VRT mode) demonstrating a history of spinal surgery with the presence of Harrington instrumentation. Observe the multiple fractures of left ribs and hip (traumatic death). **d** 3D MSCT reconstruction of the hyoid bone (VRT mode): calcification of the left thyro-hyoid ligament (*arrow*). Note the fracture of the right upper horn of the thyroid cartilage (death by incomplete hanging; *arrowhead*)

Fig. 2 Abnormalities of the internal organs revealed by post-mortem MSCTs. **a** Frontal 2D CT reconstruction of the chest (MPR mode): past history of removal of the lower esophagus and stomach with a colon segment plasty. Presence of hyperdense surgical clips. **b** Axial MSCT image of the abdomen: numerous bilateral renal cysts (some hyperdense) of multicystic kidney disease in a young man. **c** Axial MSCT image of the abdomen: numerous metastatic tissue nodules involving both lungs. Note the left pneumothorax (*arrow*; homicidal death by gunshot)

Results

Of the 35 MSCT scans, ten revealed features of potential interest for identification.

Skeletal malformations and old fractures were observed, a consolidated fracture of the left hip (Fig. 1a), a nonconsolidated left pedicular cervical fracture of the first cervical vertebra (Fig. 1b), radio-opaque spinal surgical material with Harrington instrumentation (Fig. 1c), a calcified left thyro-hyoid ligament (Fig. 1d), bilateral isthmic spondylolisthesis of the fifth lumbar vertebra, and a thoracic vertebral angioma. Some skeletal abnormalities were confirmed by the police investigations: The deceased who had the Harrington instrumentation had a past history of spine fracture and surgery, and the deceased with a left pedicular cervical fracture had recent past history of cervical fracture. Except for the evidence of the Harrington instrumentation, none of these imaging findings were seen during autopsies.

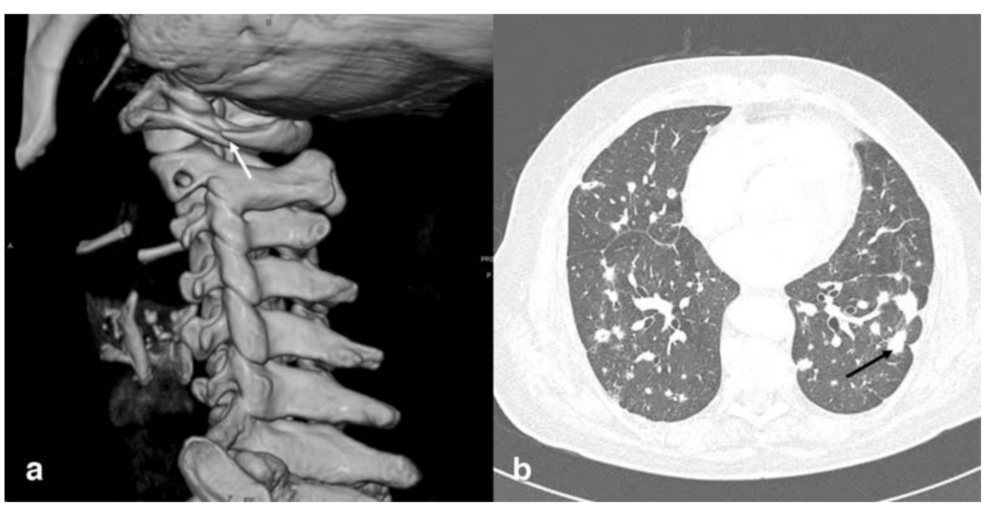
Abnormalities of the internal organs were also visualised: gastro-oesophageal removal with a colon segment plasty (Fig. 2a), pulmonary metastasis (Fig. 2b), multicystic kidney disease (Fig. 2c), and uterine excision. The medical past history of each cadaver revealed that all these abnormalities were known by the relatives and all these imaging findings were confirmed by the autopsy.

Attempts were made to seek locate antemortem X-rays or MSCTs on the cases described. Antemortem imaging was found for only two cases. The first case concerned the deceased with pulmonary metastasis secondary to breast carcinoma. The last antemortem MSCT performed 1 month before death showed tissular pulmonary nodules with a repartition similar to that seen on postmortem imaging (Fig. 3a). The second case concerned the victim who had a nonconsolidated left pedicular cervical fracture of the first cervical vertebra. The antemortem MCST performed 3 months before death showed a fracture similar to that diagnosed on postmortem images (Fig. 3b).

Discussion

Although the human skeleton has an abundance of potentially individualizing features sufficient to definitively establish or exclude an identity, the most common obstacle to achieving this objective is the absence of antemortem

Fig. 3 Ante-mortem MSCTs. **a** Axial MSCT image of the chest: numerous metastatic tissue nodules involving both lungs. Note the similar disposition of the nodules within the left lung (*arrows*) compared to Fig. 2c. **b** 3D MSCT reconstruction of the cervical spine (VRT mode), lateral view: fracture of the left pedicle of the first cervical vertebra (*arrow*)



documentation for adequate comparison [4]. Increasing use of computed tomography (CT) makes it more frequently available as an antemortem record [5]. The advantage of rapid examination time is relatively less in postmortem identification as the CT scan will certainly not be limited to the head [6, 7]. The thorax, abdomen, and limbs contain abundant information potentially relevant for identification, which is visible within seconds on the scout scan but is undetectable at external inspection, such as coronary stents and surgical implants. In particular, fragile teeth in burned corpses can be documented without manipulation or extraction, thus eliminating the risk of destroying the dentition [8, 9]. Identification by MSCT or sequential CT has already been described in several case reports [3, 4–6]. With this technology, the gantry angle and slice thickness were of special importance for the image geometry, at least in scans of the lumbar spine and skull [3, 4]. With multislice technology, the question of beam angulation and corpse positioning does not arise. Under certain conditions, elements of the past medical history of a deceased person can be diagnosed. Consolidated injuries of bone are visible, as well as modifications because of surgery. A major advantage of MSCT is the diagnosis of past history of internal surgical procedures. Numerous signs of medical diseases or surgical antecedents, which are visualised on nonenhanced MSCT, may be detected on postmortem examination.

In our study, ten skeletal and visceral abnormalities were seen out of the 35 postmortem MSCTs. These particular abnormalities were interpreted as potential elements of identification. Among these ten imaging findings, six were skeletal and four visceral. Autopsies were able to find all the visceral abnormalities but only one skeletal abnormality. The relatives of the victims were aware of all the visceral features (postdisease and postsurgery changes) but only of two out of the six skeletal abnormalities. The attempt to compare antemortem and postmortem MSCTs was successful for only two cases, which had pulmonary metastases and a cervical fracture, respectively. In our study, diagnosis of MSCT visceral abnormalities seems to be classified as interesting for further identification because all the relatives of the victims knew of the diseases. However, skeletal explorations, which found six features was deceptive because in most cases (four out of six), the family of the victims did not know of their existence. Concerning the traumatic bone injuries (three out of six), the relatives were aware of their existence because the deceased had been hospitalized and had undergone a surgery and/or medical surveillance. In fact, three out of all the skeletal abnormalities were thought to be occult (a calcified left thyro-hyoid ligament, a bilateral isthmic spondylolisthesis of the fifth lumbar vertebra, and a thoracic vertebral angioma) and consequently had no obvious interest for identification.

Another major advantage of MSCT is the possibility of performing an anthropological study of the cadaver. This avoids the necessity to prepare and deflesh bones, and the estimation of the ethnic origin, stature, age, and sex is possible [10–12]. In this domain, MSCT opens a new field of research that is called virtual anthropology.

In conclusion, the development of clinical MSCTs, allowing exploration of bone and of internal organs as well as comparisons of antemortem and postmortem scans, opens up new perspectives in the field of identification.

Acknowledgments The authors wish to thank the staff of the Radiology and Forensic Medicine departments of Rangueil Hospital, Toulouse. Sincere appreciation is also expressed to Nina Crowte for her assistance in the preparation of this manuscript.

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