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Interobserver agreement of the injury diagnoses obtained by postmortem computed tomography of traffic fatality victims and a comparison with autopsy results☆

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ABSTRACT

The present study investigated the interobserver variation between a radiologist and a forensic pathologist in 994 injury diagnoses obtained by postmortem computed tomography (CT) of 67 traffic fatality victims, and the results were compared with diagnoses obtained by autopsy. The injuries were coded according to the abbreviated injury scale (AIS). We found a low interobserver variability for postmortem CT injury diagnoses, and the variability was the lowest for injuries with a high AIS severity score. The radiologist diagnosed more injuries than the pathologist, especially in the skeletal system, but the pathologist diagnosed more organ injuries. We recommend the use of a radiologist as a consultant for the evaluation of postmortem CT images. Training in radiology should be included in forensic medicine postgraduate training. CT was superior to autopsy in detecting abnormal air accumulations, but autopsy was superior to CT in the detection of organ injuries and aortic ruptures. We recommend a combination of CT and autopsy for the postmortem investigation of traffic fatality victims.

1. Introduction

Computed tomography (CT) has been introduced as a tool for postmortem investigations at forensic institutes around the globe [1–4]. In 2006, we introduced CT as a routine procedure for all of the autopsies performed at the Institute of Forensic Medicine, University of Southern Denmark [5,6].

The present study is the first investigation of interobserver variation in the interpretation of postmortem CT images between a forensic pathologist and a radiologist. The present study also contains a comparison of the CT results with the diagnoses obtained by autopsy.

The purpose of the present study is to estimate the validity of postmortem CT injury diagnoses by studying the differences in the diagnostic pattern between two observers with different educational backgrounds. In addition, we wanted to compare the validated CT diagnoses with autopsy diagnoses to contribute to the ongoing discussion about the usefulness of CT in postmortem investigations.

2. Materials and methods

A series of traffic fatality victims underwent a CT scan and an autopsy at the Institute of Forensic Medicine, University of Southern Denmark between 2006 and 2009. A fatal road traffic injury is defined as a fatal injury incurred as the result of a collision on a public road involving at least one moving vehicle (WHO). The CT scanner was a Siemens Somatom Spirit dual slice CT scanner, and contrast was not used. The head, neck, thorax, abdomen and extremities were scanned separately. The scan protocols are shown in Table 1. The CT images were viewed at a Siemens Syngo MultiModality workstation (software syngoMMWP version VE31A).

The autopsies were performed according to the Danish government's official guidelines and were supervised by a board certified specialist in forensic medicine. The pleural cavities were opened under water to investigate if a pneumothorax was present. The institute is accredited according to DS/EN ISO/IEC 17020.

The data collection sequence is shown in Fig. 1. The imaging was performed immediately before the autopsy, and both the CT scan and the autopsy were performed on the day or the day after the medicolegal examination. The CT scan and the autopsy diagnoses were obtained and registered independent of each other by two different pathologists before the CT results were disclosed to the pathologist who performed the autopsy. Later (for the purpose of this study), a board certified radiologist re-evaluated the CT images without prior knowledge of the primary CT or autopsy diagnoses. The radiologist was trained in clinical CT but had no previous experience with postmortem CT scans. The pathologist had five years of experience in postmortem CT but was not a board certified specialist in radiology. Both axial cross sections, multiplanar reconstructions and volume-rendered images were used.

All of the injuries were coded according to the abbreviated injury scale (AIS), which is a coding system that is widely used by trauma centres [7]. Coding with the AIS enabled a standardised registration that was suitable for comparisons. The data were entered in a computer database (SPSS version 18.0) with the diagnosis code as the unit of analysis. The κ measure for agreement was calculated with a golden standard, which was obtained by combining the autopsy and CT findings. The

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Table 1
Scan protocols used for post mortem CT at the Institute of Forensic Medicine, University of Southern Denmark, 2006–2007.

	Head	Neck	Thorax	Abdomen
mAs	110	110	60	80
kV	130	130	130	130
Slice	1 mm	3 mm	5 mm	5 mm
Pitch	0.95	0.95	1.8	1.8
Rotation time	1.5 s	1.5 s	1.0 s	1.0 s
FoV	200 mm	200 mm	300 mm	300 mm
Kernel	B31 (medium smooth) and H60 (sharp)	B50 (medium sharp)	B31 (medium smooth) and B70 (high res)	B31 (medium smooth)
Recon increment	0.5 mm	1.5	2.5	2.5

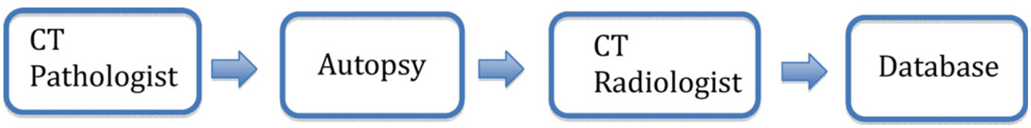

Fig. 1. Data collection. The pathologist evaluated the CT-images shortly before the autopsy. The autopsy diagnoses were registered before the result of the CT scanning was revealed. The radiologist evaluated the CT images retrospectively at a later time without knowledge of the previous CT or autopsy diagnoses. The diagnoses were then registered in a computer database.

autopsy was used as the gold standard for the lesions that were visualised by autopsy (inner organs, ribcage, cranial base and cranial vault), and the CT scan results that were evaluated by the radiologist were used as the gold standard for all of the other lesions.

The analysis strategy is shown in Fig. 2. The philosophy was to evaluate the validity of the CT diagnoses first, assuming that a high interobserver difference indicated a low validity. Then, a comparison was made between the validated primary CT diagnosis and the autopsy diagnosis.

3. Results

The present investigation consisted of a consecutive series of 67 traffic fatality victims. No cases were excluded from the study. Nine hundred ninety-four AIS injury diagnoses were registered. Tables 2 and 3 contain background information about the accident types. Fig. 3 and Tables 4–6 show how the CT diagnoses were distributed between the two observers. Tables 4–6 show the distribution of the injuries on the type of tissue that was injured (skeletal/organ/blood or air accumulation), on the AIS region and on the AIS severity score, respectively.

A comparison of the injury diagnoses obtained from the primary CT investigation and from the autopsy are shown in Tables 7 and 8. In Table 7, the 916 injury diagnoses that were obtained from primary CT and/or autopsy were divided based on the diagnosis method (CT or autopsy), the type of tissue injured and the AIS severity score. In Table 8, the injury diagnoses were recoded and combined, and some of the clinically most important categories (47% of all injuries) were selected for further study. There was a 59% overlap between the primary CT diagnoses and the autopsy diagnoses. Interestingly, 21% and 20% of the injury diagnoses were obtained by CT alone and autopsy alone, respectively. Table 7 shows that the overlap between autopsy and CT was greatest when the AIS severity score was high. In addition, the overlap was high for lesions in the skeletal system and instances of haematomas. Table 8 contains information about some clinically important injuries. Remarkably, almost half of all of the cases of pneumothorax were detected by CT rather than

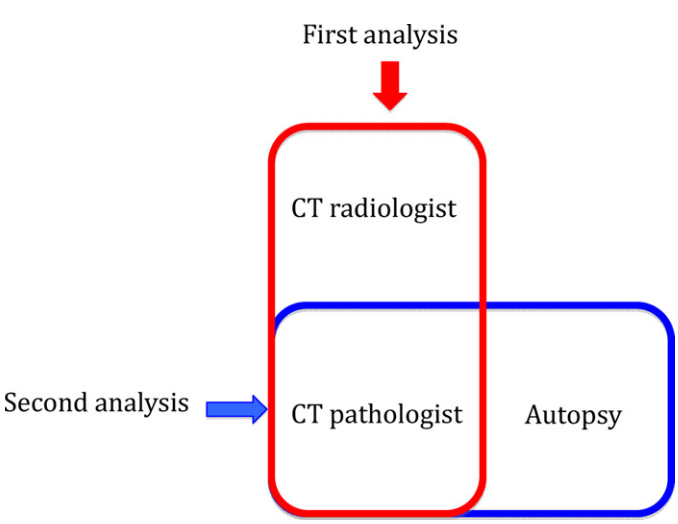

Fig. 2. Analysis strategy. First an inter observer variation between the radiologist and the pathologist was performed in order to evaluate the validity of the CT diagnoses, assuming that a high inter observer difference would indicate a low validity. Then a comparison was made between the validated primary CT-diagnoses and the autopsy diagnoses.

Table 2
Count of traffic fatalities in Southern Denmark 2006–2009 distributed on activity at the time of accident.

Activity	Count (%)
Car driver	18 (27)
MC or moped driver	14 (21)
Cyclist	9 (13)
Car passenger	8 (12)
MC passenger	1 (1)
Pedestrian	17 (25)
Total	67 (99)

Percentages do not total 100 due to rounding.

Table 3
Count of traffic fatalities in Southern Denmark 2006–2009 distributed on vehicles involved.

Vehicles	Count (%)
Solo accident car/truck/MC	14 (21)
Car–pedestrian	12 (18)
Car/truck–bike	9 (13)
Car–MC/moped	9 (13)
Car–Truck/bus	6 (9)
Car–car	6 (9)
Truck–MC/moped	3 (4)
Truck–pedestrian	3 (4)
Truck–truck	2 (3)
Train–pedestrian	2 (3)
MC–MC	1 (1)
Total	67 (98)

Percentages do not total 100 due to rounding.