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Preliminary communication

Computed tomography as routine in connection with medico-legal autopsies

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Abstract

CT-scanning as routine examination before medico-legal autopsy was introduced at the Institute of Forensic Medicine in Copenhagen, Denmark, in December 2002. The present series comprises of 525 medico-legal examinations performed in the year 2003. The purpose is to determine the value of CT-scanning prior to the post-mortem examination. All findings, CT- as well as patho-anatomic findings – more than 4000 – were registered in a database. To increase the clearness, the findings are divided in accordance to regions such as head, thorax, abdomen, pelvis, extremities and vessels and the CT-findings are compared to the patho-anatomic findings, with the purpose to estimate the advantages and disadvantages with the two types of examination. The preliminary results show, that the CT-scanner is superior when it comes to detection of extremity fractures. The scanner has ability in detecting hemorrhages and hematomas, especially, intracranial.

Keywords: Forensic science; Forensic radiology; Post-mortem; Computed tomography; Spiral computed tomography; Helical computed tomography; Medico-legal autopsies; Virtual autopsy; Virtopsy

1. Introduction

In 1895, Wilhelm Conrad Roentgen (1845–1923) presented the first human X-ray image. He demonstrated the skeleton of his wife's hand [1]. In the very same year, an X-ray examination was introduced as evidence in Court, demonstrating a bullet in a leg, at a person who was shot, but the surgeon had not been able to find the projectile. The bullet was localized in the lower leg between the tibia and fibula. The image was presented in Court, and the perpetrator was sentenced to 14 years in prison [1]. Three years later the technique was used in examination of a dead body [2]. For many years X-ray examination, in connection with forensic autopsies, has been limited to certain cases such as bullet wounds, battered child syndrome and drowning, as well as for identification purposes, etc. [3–6]. From the early 1970s computed tomography has been developed, which makes it possible to create radiological cross-sections of the entire body. The X-ray tube rotates around the object in question. Opposite the tube a detector that catches the X-ray beams is placed, and the result is managed in a computer. In that way cross-sections of the object are performed, and since the tube rotates, shadows from bones or other X-ray resistant objects are avoided. In 1998, a new generation of CT scanners was introduced which made it possible to produce numerous cross-sections of a complete body in less than 1 min. This technique, together with multi slice computed tomography (MSCT), has been applied in a few selected cases and in a few smaller series with great success during the last few years [3,7,8]. The Institute of Forensic Medicine in Copenhagen obtained in April 2002 a Spiral CT scanner, and from December 2002 it has been a routine procedure in the Department of Forensic Pathology to make a full body scan of all corpses prior to the post-mortem examination.

2. Materials and methods

Our goal was to evaluate, if spiral (helical) computed tomography (SCT) was able to add substantially to the quality and thoroughness of medico-legal autopsies, when the X-ray examinations were performed routinely prior to the post-mortem in all medico-legal cases done at the Copenhagen institute; the SCT-examination has been done by a single forensic pathologist who had no specific training in radiology. Since only one forensic pathologist performed all the X-ray

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Table 1
Sex and age in CT-scanned material

Age	Male	Female	Total
<10	12	7	19
10–19	4	6	10
20–29	45	12	57
30–39	59	17	76
40–49	87	27	114
50–59	72	49	121
60–69	38	30	68
70–79	22	16	38
>79	9	13	22
Total	348	177	525

examinations in the first period of time, we were able only to collect 525 cases – 348 males and 177 females – out of a total of 824 post-mortems, which accounts to 64% of the total load. The reason why so many cases were excluded is due to the fact, that some cases could not pass the opening in the scanner due to heavy overweight or inconvenient position of the extremities as a result of rigor—the opening having a diameter on 70 cm, but the main reason being the absence of the operator (vacations, meetings, seminars, etc.). Of the 824 autopsies 540 were males and 282 females while 2 were undetermined (human remains). This shows that the present material is representative for the total load (Table 1) Plate 1.

Fig. 1. 3D-reconstruction of skull with multiple fractures.

In all cases the scanning procedure is identical. After scanning of the head a full body scanning is performed from the neck to below the pelvis. If a fracture is observed, a magnitude of thin slices is developed for possible 3D reconstructions (Fig. 1). All noticeable findings are written down, and all relevant images are developed, discussed with and handed over to the pathologist, who will perform the post-mortem. After the autopsy the forensic pathologist will compare the X-ray findings with the autopsy findings, and write down the results, so the scan operator can see, if there are any differences between the two examinations. In the present material the scan operator did not have access to the anamnestic information. This has been changed from 2004. All images are stored on CDROM, and the developed images are also stored. A CT-image consists of a number of pixels, whereby each pixel may

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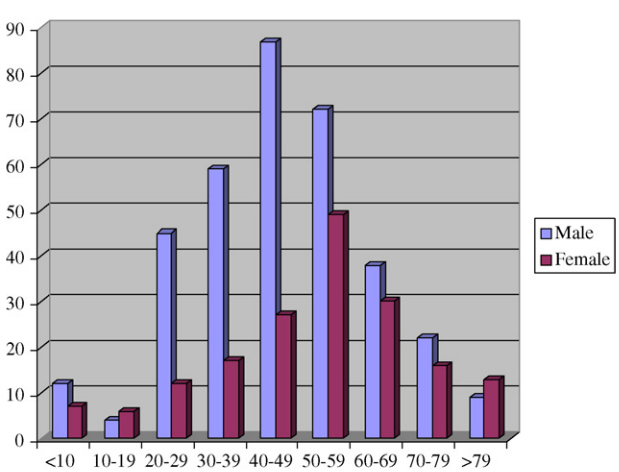

Plate 1. Sex and age in CT-scanned material.

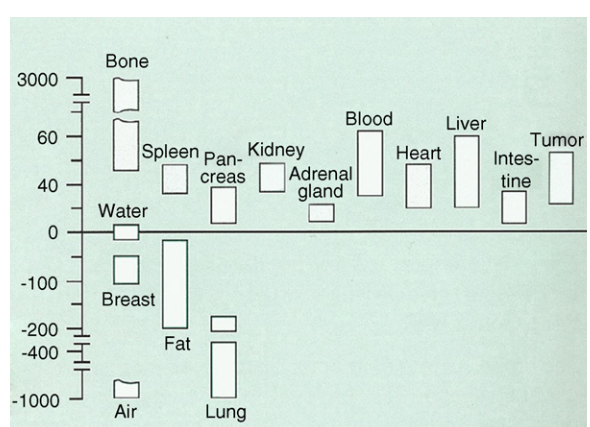

Fig. 2. Hounsfield units (HU) for different kinds of tissues, water, and air [9].