Legal Medicine 19 (2016) 96–100

Contents lists available at ScienceDirect

Legal Medicine

journal homepage: www.elsevier.com/locate/legalmed

Postmortem computed tomography findings in the thorax – Experimental evaluation

Hideki Hyodoh *, Jyunya Shimizu, Masumi Rokukawa, Shunichiro Okazaki, Keisuke Mizuo, Satoshi Watanabe

Department of Legal Medicine, Sapporo Medical University, S1 W17 Chuo-ku, Sapporo 060-8556, Japan

ARTICLE INFO

Article history:
Received 10 July 2015
Received in revised form 30 July 2015
Accepted 30 July 2015
Available online 31 July 2015

Keywords:
Postmortem CT
Hypostasis
Pleural effusion
Postmortem change
Forensic radiology

ABSTRACT

Objective: Experimental fatal models were prepared to investigate the time-related course of lung changes using postmortem CT (PMCT). This study was approved by our institutional animal ethics committee.
Materials and methods: Twenty-four NZW rabbits (female 24, 2.30–4.30 (mean 3.10) kg) were divided into 4 fatal groups; drowning, hypothermia, bag suffocation, and Potassium Chloride intravenous (control) group. All individuals were examined by CT (Aquilion CX, Toshiba, Japan) on postmortem time course until detection of putrefaction air. The percent of aerated lung volume (%ALV = 100 * (ALV/total lung volume)) was measured and the pleural space fluid was investigated by axial imaging. A paired *t*-test and Bonferroni/Dunn study were employed for statistical evaluation.
Results: In intra-group analysis, the %ALV showed statistically different periods compared with each pre-image: 4–48 h in control, 1–24 h in drowning, 5–6 h in hypothermia, and 1–4 h in bag suffocation. In inter-group comparison (compared with control group), the %ALV increased in suffocation and decreased in drowning within 12 h. The %ALV remained significantly high in hypothermia until 24 h. The earliest detection times of pleural space fluid collection were different in each group: control (20 h), drowning (18 h), suffocation (36 h), and hypothermia (95 h).
Conclusion: The lung hypostasis and the appearance of pleural space fluid collection presented differently in individual causes of death and depending on the postmortem time.
© 2015 Elsevier Ireland Ltd. All rights reserved.

1. Introduction

A recent topic of interest in forensic radiology is post-mortem imaging using computed tomography (CT) [1–5]. The postmortem CT (PMCT) was capable of identifying injuries [6], intracranial hemorrhage [7], aortic dissection [8], and hemopericardium [5,8], and using PMCT is useful to evaluate the causes of death prior to the autopsy investigation.

There were some reports about the pattern of lung appearance on PMCT, and relationships were suggested to the cause of terminal respiratory function and/or the severity and duration of heart failure in the agony period [9,10]. However, lung aeration changes according to the postmortem term, so that if the CT examination is in the late postmortem period, the postmortem changes may cause an overlap with the state relating to some causes of death [11], making it difficult to evaluate delayed PMCT for pulmonary pathology.

Previously, we reported the lung aeration and pleural space fluid collection using repeated PMCT in the same cadaver [11]. And we found that lung aeration decreased according to the postmortem time, and pleural space fluid appeared at 30 h after death [11]. But we had no information about the earlier postmortem period change of pulmonary aeration and pleural space fluid collection (from time of death to 18 h), and in addition, there have been no report to evaluate the early time-related course of PMCT according to the causes of death. Therefore, we performed an experimental evaluation to investigate the early postmortem change in terms of the pulmonary aeration and pleural space fluid to determine a time-related course and cause-related changes.

2. Materials and methods

This study was approved by our institutional animal ethic committee (2013/10/11, 13-074). From November 2013 to March 2015,

* Corresponding author.
E-mail address: hyodoh@sapmed.ac.jp (H. Hyodoh).

http://dx.doi.org/10.1016/j.legalmed.2015.07.015
1344-6223/© 2015 Elsevier Ireland Ltd. All rights reserved.

adolescent female New Zealand White rabbits ($n = 24$, weighting 2.3–4.3 (average 3.1) kg) were enrolled in this study. According to the causes of death procedure, all the bodies were divided into four groups ($n = 6$ each); Potassium Chloride intravenous (KCl i.v.) (estimated as control), drowning, hypothermia, and bag suffocation. After deep sedation procedure (Xylazine i.m. 4 mg/kg, Ketamine i.m. 50 mg/kg), all bodies were examined by computed tomography (CT) as pre-procedural image.

For the KCl i.v. group, KCl (2 mol/kg (149 mg/kg)) was injected via the auricular vein. For the drowning group, the rabbit's head was submerged in a water bath and kept in position for 10 min. For the hypothermia group, the total body was placed in an environment under zero degrees Celsius after shaving the hair. For the bag suffocation group, the rabbit's head was put in a sealed bag and kept there for 10 min. At the confirmation of termination of heartbeat and respiratory function, the time of death was estimated for all bodies.

2.1. CT examination

After the pre-procedural image, all bodies were sacrificed. Then, the bodies were placed into a sealed body bag and placed in the CT room (20 ° C) though the whole observation period. According to the time schedule (postmortem time: 1, 2, 3, 4, 5, 6, 12, 24, 36, 48, 60, and 72 h), the whole bodies were examined by CT with minimum body re-positioning. After 72 h, CT examination was repeated every 12 h until the body contained massive gas due to putrefaction.

A 64-slice multi-detector CT scanner (Aquilion CX, Toshiba, Tochigi, Japan) was used, employing the following protocol: 120 kV, 200 mA, 0.5 s/rotation, pitch factor 0.641, configuration 0.5×32, reconstruction 0.5 mm.

All of the datasets were stored in the DICOM format. The DICOM data were transferred to a workstation (SYNAPSE VINCENT V4.1, FUJIFILM, Tokyo, Japan). Using manual adjustments, total lung volume and aerated lung volume (ALV) (−700 and −1000 HU) were measured semi-automatically and the results were confirmed by a board-certified radiologist. In addition, the appearance time of pleural space fluid on PMCT was documented.

2.2. Imaging analysis

2.2.1. Pulmonary aeration

Using the following formula, the percentage of aerated lung volume (%ALV) was calculated:

$$\%\text{ALV} = (\text{ALV}/\text{total lung volume}) * 100$$

2.2.2. Pleural space fluid appearance

Using axial source image, the appearance time of pleural space fluid collection was documented and compared with the control group.

2.3. Statistical analysis

To evaluate the statistical difference, the %ALV was compared according to the time difference in each group (intra-group comparison), and compared with the control group (inter-group comparison). The appearance time of pleural space fluid collection was compared with the control group. The JMP (SAS Institute Inc., North California, USA, version 11.0.0) software was used with a paired t-test and Bonferroni/Dunn study. Differences with $p < 0.05$ were considered statistically significant.

3. Results

Twenty-four rabbits were sacrificed in deep state of sedation. In the hypothermic group, it needed 4–6 (average 4.6) h to confirm heart-beat/respiration cessation, so that 1–2 (1.8) additional Ketamine injections were required.

At the pre-procedural images, the aerated lung volume (−1000 and −700 HU) were 4.1–13.1 (8.8 ± 1.3) ml in the KCl i.v. (as control) group, 4.7–17.5 (11.8 ± 3.5) ml in the drowning group, 2.6–20.3 (8.5 ± 3.5) ml in the hypothermic group, and 2.0–6.2 (4.5 ± 0.6) ml in the bag suffocation group. According to the course of postmortem time, the aerated lung volumes were changed (Table 1).

3.1. %ALV intra-group comparison (compared with pre image) (Fig. 1)

In the control group, %ALV showed no significant difference within the first 3 h of the postmortem period. After 4 and 48 h into the postmortem period, %ALV showed significant decrease. After 72 h, %ALV was increasing and showed no significant difference statistically.

In the drowning group, %ALV had decreased significantly within 24 h of the postmortem period. After 36 h, %ALV increased and there was no significant difference statistically.

In the hypothermic group, %ALV showed no significant difference within the first 4 h of the postmortem period. After 5 and 6 h into the postmortem period, %ALV had increased significantly. After 6 h, %ALV showed no statistically significant difference.

In the bag suffocation group, %ALV showed a significant increase within 4 h of the postmortem period. After 5 h, %ALV decreased and there was no statistically significant difference.

3.2. %ALV inter-group comparison (compared with control group) (Fig. 1)

In the drowning group, the %ALV decreased statistically from 1 to 3 h into the postmortem period, but showed no difference after 4 h. From 12 to 24 h, the %ALV presented the same as in the control group, but the %ALV increased earlier than the control group from 36 to 48 h.

In the hypothermic group, the %ALV measured the same as the control group within 2 h of the postmortem period, but it remained statistically higher from 4 to 24 h. After 48 h, the %ALV decreased transiently and increased again after 60 h.

In the bag suffocation group, the %ALV was significantly higher from 3 to 5 h into the postmortem period. After 6 to 24 h, the %ALV decreased and there were no significant difference compared with the control group.

3.3. Pleural space fluid appearance (Fig. 2)

The appearance times of pleural space fluid collection were 20.7 (5–33) h in the control group, 18.1 (5–36) h in the drowning group, 104.5 (29–144) h in the hypothermic group, and 33.7 (5–77) h in the bag suffocation group. All groups presented pleural space fluid collection before the re-increase in %ALV. The hypothermic group only showed a statistical difference in appearance time delay compared with the other 3 groups.

4. Discussion

4.1. Early postmortem period (within 24 h)

There have been some reports about the postmortem time course of lung hypostasis, and it is thought to be the same as livor

Download English Version:

https://daneshyari.com/en/article/103454

Download Persian Version:

https://daneshyari.com/article/103454

Daneshyari.com