



## Forensic pathological evaluation of postmortem pulmonary CT high-density areas in serial autopsy cases of sudden cardiac death



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### ABSTRACT

Previous studies suggested substantial postmortem interference with pulmonary CT findings. The present study evaluated postmortem CT (PM-CT) morphology of the lung, compared with histology, in autopsy cases of sudden cardiac death without recovery from cardiac arrest (SCD,  $n = 22$ ) with regard to the posture at the time of death and postmortem interference from a forensic pathological viewpoint. In witnessed cases ( $n = 5$ ), a case of SCD in a prone position had anterior consolidation with weak hypostatic opacification in the posterior about 18 h later. Among unwitnessed deaths ( $n = 17$ ), 8 cases of death lying prone, sitting facedown and lying laterally had possible gravity-dependent opacity about 15–38 h postmortem. Hypostatic opacification with 'niveau' formation was not evident in more than half of the cases ( $n = 15$ ). Histological findings for ground glass opacification and consolidation on PM-CT varied by case, involving intraalveolar edema and hemorrhages, accompanied by marked congestion; however, possible postmortem hypostatic opacification mostly represented intraalveolar edema. CT morphology of acute pulmonary congestion in SCD may often remain without serious postmortem interference in cases without clinical intervention involving massive fluid infusion, suggesting plain PM-CT findings of the lung to be useful for investigating the death process when combined with histology; however, the possible influence of the hydration status of the lungs at the time of death should be assessed by evaluation of CT and autopsy findings.

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## 1. Introduction

Forensic radiology contributes to investigating not only skeletal structures and foreign bodies but also other pathologies including cardiopulmonary anatomy and pathophysiology [1,2]. In the last decade, diagnostic imaging procedures have been widely applied in postmortem investigation; postmortem CT (PM-CT) is especially popular worldwide, providing a spectrum of whole body morphology as a supplementary procedure before autopsy [1–9]. In particular, PM-CT morphology of the lungs presents evident variations, involving increased transparency or opacity due to congestion and edema in the death process and changes after death [1–4,10–19]. Previous studies were mostly intent on demonstrating or eliminating postmortem interference with pulmonary CT findings, stressing an evident increase of hypostatic high-density

areas [3,11]; however, pulmonary PM-CT morphology largely depends on the status of aeration and water content at the time of death, which are characteristic of the cause of death; pulmonary opacification is evident in cases with congestion and edema including sudden death due to a cardiac attack, possibly representing histology [13,14,19,20].

The present study evaluated PM-CT morphology of the lungs in sudden cardiac death without recovery from cardiac arrest with regard to the posture at the time of death and postmortem interference, on the basis of autopsy and histological findings, from a forensic pathological viewpoint.

## 2. Materials and methods

### 2.1. Materials

PM-CT data of serial autopsy cases of sudden cardiac death without recovery from cardiac arrest (SCD;  $n = 22$ , 0–91 years of age) without apparent putrefactive changes (within 2 days postmortem) were examined with regard to the pulmonary morphology, including hypostatic opacification. Causes of SCD were classified into acute/recurrent myocardial infarction ( $n = 8$ ), possible fatal arrhythmia without pathological evidence of myocardial infarction ( $n = 9$ ), comprising young subjects without significant coronary lesion ( $n = 6$ ; <50 years of age) and elderly subjects

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**Table 1**  
Case profiles.

Cause of death	Case no.	Age (year)/gender	Witness	CPR <sup>a</sup>	Survival time (h)	Elapsed time (h)		Posture on discovery	Livor mortis at autopsy	Lung weight (g) left/right	Effusion in the airway <sup>c</sup>	Complication
						Death–discovery/CT <sup>b</sup>	Discovery–CT					
Acute/reccurent myocardial infarction	1	64/M	+	+	<1	–/27	27	Sitting facedown	Back	790/820	–	–
	2	62/M	–	+	<0.5	<0.5/18	18	Supine	Back	590/740	+	–
	3	81/M	–	+	<0.5	<1/19	18	Supine	Back	510/640	–	–
	4	82/M	–	+	<0.5	<0.5/20	20	Supine	Back	665/705	–	–
	5	48/M	–	+	<0.5	<0.5/20	20	Sitting facedown	Back	1155/1350	++	COPD
	6	72/M	–	+	<0.5	<0.5/20	20	Sitting facedown	Back	365/500	–	–
	7	68/M	–	–	<0.5	<1/35	34	Prone	Back	535/600	–	–
	8	65/M	–	–	<0.5	5/15	10	Lateral (right)	Back	490/670	+	Metastatic colon cancer
Possible fatal arrhythmia	9	41/M	+	+	<0.5	–/18	18	Prone	Back	640/830	+	Focal pneumonia
	10	27/M	+	+	<0.5	–/8	8	Prone	Back	890/980	+	–
	11 <sup>d</sup>	16/M	+	+	<0.5	–/20	20	Prone	Back	905/860	++	–
	12	61/F	+	+	<0.5	–/32	32	Lateral	Back	560/760	++	–
	13	16/M	–	+	<0.5	<1/14	13	Supine	Back	505/805	++	–
	14	87/F	–	+	<0.5	<0.5/32	32	Prone	Back	275/400	+	–
	15	62/F	–	+	<0.5	<1/15	14	Prone	Back	220/315	–	–
	16	45/M	–	+	<0.5	<0.5/20	20	Sitting	Back	760/960	+	–
	17	43/M	–	+	1.5	<0.5/30	30	Sitting facedown	Back	410/530	–	–
CHF	18	1/F	–	+	6	<0.5/16	16	Lateral (left)	Back	86/154	+	–
CHF	19	91/F	–	–	1.5	12/38	26	Supine	Back	320/475	–	–
CHF	20	67/M	–	–	<0.5	16/38	22	Prone	Front + back	575/730	+	–
Myocarditis	21	67/M	–	+	84	<0.5/18	18	Prone	Back	590/955	+	–
CHD	22	0/F	–	+	<0.5	<0.5/28	28	Supine	Back	35/30	–	–

CHF, congestive heart failure; CHD, congenital heart disease; M, male; F, female; COPD, chronic obstructive pulmonary disease.

<sup>a</sup> Cardiopulmonary resuscitation without recovery (fluid infusion <500 ml).

<sup>b</sup> Estimated elapsed time for unwitnessed deaths; PM-CT was taken immediately before autopsy.

<sup>c</sup> Effusion in the trachea and bronchi at autopsy; –, insignificant; + a small to medium amount; ++, massive, filling the airway.

<sup>d</sup> DICOM (Digital Imaging and Communication in Medicine) CT data about 2 h after death were available.

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