

Discrepancies between the measured distances of the anterior inner lung boundaries at autopsy and post-mortem CT

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Research Article

Keywords: Post-mortem computed tomography, cause of death, anterior inner lung boundaries, forensic, discrepancy

Posted Date: October 22nd, 2026

DOI: <https://doi.org/10.21203/rs.3.rs-11242023/v1>

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Additional Declarations: No competing interests reported.

Abstract

Background

In their forensic medical practice, the authors observed a recurring discrepancy between the distance between the anterior inner lung boundaries as determined by PMCT and as observed in situ during autopsy. The aim of this study was therefore to compare the distances between the anterior inner boundaries of the lungs as determined by PMCT and at autopsy in forensic cases, and to investigate the influence of various predictors on this difference.

Methods

In this retrospective study $n = 146$ deceased individuals (95 men and 51 women; median age 56.5 years) from forensic cases were investigated. The minimal distances between the anterior inner lung boundaries were measured in PMCT and during autopsy. Potential predictors (age, sex, BMI, post-mortem interval, cardiopulmonary resuscitation, lung weight, heart weight, cause of death, and thoracic pathologies) were analyzed.

Results

The distances measured between the anterior inner lung boundaries in-situ during the autopsy were, on average, 7.0 mm greater than the PMCT distances (paired t-test, $t = 4.22$, $p < 0.001$; Wilcoxon $p < 0.001$). Both the inter- and intra-rater ICCs were all above 0.99. Among the demographic parameters, pathologies, and causes of death examined, no clear or highly significant factor that influencing the measured difference between PMCT and autopsy could be identified.

Conclusion

Autopsy measurements of the anterior inner lung boundary distances were slightly larger on average than PMCT measurements. In most cases, these differences are unlikely to be forensically relevant. However, larger discrepancies may occur in individual cases and should be considered when comparing PMCT and autopsy findings.

Introduction

In forensic medicine, post-mortem computed tomography (PMCT) is a very useful additional examination to the forensic autopsy [1–5]. It is well established, that clinical radiology and forensic PMCT differ in some respects due to specific forensic circumstances and post-mortem changes [6]. Radiological PMCT image interpretation therefore requires specific training and experience in the post-

mortem forensic field. Discrepancies between the findings of the autopsy and those of the PMCT are of particular importance in this context [6–9].

Previous studies have shown that discrepancies between autopsy and PMCT can occur regularly, for example in the diagnosis of rib fractures, in determining the cause of death, in assessing tracheobronchial contents, or in assessing stomach contents in drowning cases [7–11]. It is therefore important for both forensic radiologists and forensic pathologists to be aware of such discrepancies and to classify them correctly for the respective forensic case. This can be of crucial importance in court proceedings, for example [7, 8].

In their forensic medical practice, the authors observed a frequently noticeable, recurring discrepancy between the distance between the anterior inner lung boundaries on PMCT and in situ during autopsy, with the distances on PMCT often appearing smaller than those observed during autopsy. Such a discrepancy had not yet been described in the scientific literature.

The distance between the anterior inner boundaries of the lungs in situ can be of forensic significance, as certain circumstances of death can have a relevant influence on this distance [12, 13]. For example, suffocation or drowning can cause the in situ distance between the inner lung boundaries to decrease or overlap due to acute hyperinflation of the lungs [12–22].

The aim of this study was therefore to compare the distances between the anterior inner lung boundaries as determined by PMCT and at autopsy in forensic cases, and to investigate the influence of various parameters -such as cause of death or thoracic pathologies- on this difference.

Methods and materials

Study design and study subjects

This is a retrospective study. The study subjects were n = 146 deceased individuals who were examined in 2020 and 2021 by the Institute of Forensic Medicine in Bern on behalf of the regional public prosecutor's office using PMCT and autopsy. Inclusion criteria were an age over 18 years and no relevant signs of decomposition. The autopsy took place immediately after the PMCT. Before the PMCT scans, the corpses were stored in cold chambers at 4°C.

Post-mortem imaging and lung measurements

The PMCT scans (Siemens Somatom® X.cite) were performed in the supine position in artifact-free body bags. The PMCT acquisition and reconstruction parameters were based on the currently valid and established protocol standards: tube voltage 140 kV, tube current 700 mAs, slice thickness 1 mm, increment 0.7 mm, Field of view was adapted to body part width, used filters: bone (Br 60), lung (B 60s),

and soft tissue (Br 40). The use of the PMCT imaging data was approved by the local ethics committee (Kantonale Ethikkommission Bern).

Measurements of the distance between the anterior inner boundaries of the lungs were conducted in a PACS (Sectra Workstation IDS7, Version 26.1.12.7792, ©2024, Sectra AB) in the B 60s reconstructed thorax data sets using the build-in measurement tool (Fig. 1). A multiplanar image reconstruction tool (MPR) was used to obtain optimal transverse views of the thorax and lungs by manually adjusting the image planes.

The minimum anterior distance between the lungs was measured in each case, as this appeared to be the most suitable reference for comparison between autopsy and PMCT. To do this, the lung was scrolled through completely in axial view and the smallest distance between the inner anterior lung boundaries was approximated. Several distance measurements were then taken in this region at intervals of a few millimeters, and the smallest measured distance was taken into account. In cases where there was an overlap of the anterior inner boundaries of the lungs, the maximum distance of the overlap was measured. Distances were recorded as positive values, whereas overlap of the anterior lung boundaries was recorded as a negative value. Contact without measurable overlap was recorded as 0 mm.

Measurements were performed by a resident physician (observer 1), who was blinded to the case circumstances and autopsy results and trained by a board-certified forensic pathologist (observer 2) with 15 years of experience in post-mortem imaging. The training was conducted over a period of 2 weeks using $n = 20$ randomly selected cases.

Forensic autopsy and lung measurements

Forensic autopsies were conducted by board-certified forensic pathologists in accordance with the Recommendation of the Committee of Ministers to Member States of Europe on the harmonization of medico-legal autopsy Rules [23]. All three body cavities were opened and all internal organs were removed and dissected [24–26]. To prepare the thorax, the skin was first opened with a longitudinal median incision and the underlying chest muscles were dissected. The anterior chest plate was then removed. This procedure was carried out by disarticulating both sternoclavicular joints and cutting through the anterior aspect of the ribs or costal cartilages with a rib shear. After careful removal of the chest plate, the lungs were first inspected in situ and the minimum distance between the anterior inner lung boundaries was measured using a ruler as a standard autopsy procedure by the physician. In cases where the inner lung boundaries overlapped, the maximum distance of the overlap was measured.

Statistics

Statistical analyses were performed in R 4.4.1. Continuous data are reported as mean and standard deviation when approximately normally distributed (assessed by Shapiro-Wilk), otherwise as median and

interquartile range. Categorical variables are given as counts and percentages.

Each measurement between the anterior inner lung boundaries consisted of a distance and an overlap value (mutually exclusive). The paired difference is autopsy minus PMCT distance and was tested with the paired t-test, with the central limit theorem justifying its use at $n = 146$ despite non-normal differences (Shapiro-Wilk $p < 0.001$). The Wilcoxon signed-rank test is reported alongside as a non-parametric check. Agreement between methods was assessed with Bland-Altman analysis. The parametric 95% limits of agreement with their 95% confidence intervals are reported following Bland and Altman (1999) [27]; the empirical 2.5th and 97.5th percentiles of the differences are given alongside. Proportional bias was tested by linear regression of the differences on their means (slope as effect estimate). Lin's concordance correlation coefficient (CCC) with z-transformed 95% confidence interval was used as a summary measure of agreement.

Potential predictors (age, sex, BMI, PMI, cardiopulmonary resuscitation (CPR), lung weight, heart weight, and thoracic pathologies) were screened in univariate analyses, using simple linear regression for continuous and binary variables and one-way ANOVA for cause of death. Resulting p-values were adjusted using the Benjamini-Hochberg (BH) procedure. We then fitted two multivariate linear regression models. Model A was pre-specified and contained BMI (used in place of weight and height to avoid collinearity), age, sex, PMI and CPR. Model B added the pathologies that were significant in the screening because their inclusion was data-driven, Model B was exploratory. Nested models were compared with an F-test.

Multicollinearity was assessed using the variance inflation factor and residual normality using the Shapiro-Wilk test. The significance level was $\alpha = 0.05$; all tests were two-sided.

For inter- and intra-rater reliability analysis, ten randomly selected cases were re-measured by a second observer, as well as by the first observer after a four-week interval. Reliability was quantified with intraclass correlation coefficients (ICC, two-way mixed effects, absolute agreement).

Results

The study cohort consisted of 95 men and 51 women; the median age was 56.5 years (IQR 39.2–68.8). Table 1 shows the demographic data, the distance measurements between the anterior inner lung boundaries as determined by autopsy and PMCT, and the number of pathologies observed in the study cohort. Table 2 shows the number of determined causes of death.

Table 1

Variable	Value	Range
Age (years)	56.5 [39.2–68.8]	18.0–94.0
Sex, male / female	95 (65.1%) / 51 (34.9%)	
Weight (kg)	76.0 [64.2–87.8]	41.0–150.0
Height (cm)	172.7 ($\pm$ 9.6)	137.0–197.0
BMI (kg/m ²)	25.4 [22.6–28.9]	15.8–42.9
Lung weight (g)	1329.6 ($\pm$ 446.4)	450.0–2950.0
Heart weight (g)	390.0 [320.0–475.0]	120.0–750.0
PMI (days)	2.0 [1.0–3.0]	1.0–4.0
CPR performed	50 (34.2%)	
PMCT distance (mm)	22.6 [2.6–53.7]	-13.0–113.9
Autopsy distance (mm)	34.0 [11.2–56.8]	-5.0–110.0
Difference (mm)	3.8 [-0.5–13.6]	-73.5–83.9
Pulmonary edema	107 (73.3%)	
Emphysema	40 (27.4%)	
Pneumothorax	24 (16.4%)	
Pulmonary fat embolism	34 (23.3%)	
Cardiomegaly	46 (31.5%)	
Pleural effusion	108 (73.9%)	
Rib fractures	59 (40.4%)	
Sternal fractures	38 (26.0%)	
Pleural adhesions	35 (24.0%)	
Demographic data, measurements of distance between the anterior inner lung boundaries, and the number of pathologies observed in the study cohort of n = 146 cases (PMI: post-mortem interval; CPR: cardiopulmonary resuscitation).		

Table 2

Cause of Death	n	%
Central Dysregulation	27	18.5%
Acute Cardiac Arrest	18	12.3%
Intoxication	16	11.0%
Strangulation	15	10.3%
Pulmonary Embolism	14	9.6%
Suffocation	14	9.6%
Drowning	12	8.2%
Fatal Hemorrhage	12	8.2%
Multi Organ Failure	12	8.2%
Unclear	6	4.1%
Determined causes of death in the study cohort (n = 146)		

The distances measured between the anterior inner lung boundaries in-situ during the autopsy were, on average, 7.0 mm greater than the PMCT distances (paired t-test, $t = 4.22$, $p < 0.001$; Wilcoxon $p < 0.001$). The corresponding effect size was small (Cohen's $d_z = 0.35$).

Inter- and intra-rater ICCs all exceeded 0.99. Given $n = 10$, confidence intervals were wide (Fig. 2).

Bland-Altman analysis (Fig. 3) showed a bias of 7.0 mm with wide individual scatter; the 95% limits of agreement ranged from -32.5 to 46.5 mm. Because the differences were not normally distributed, the empirical 2.5th and 97.5th percentiles are also reported and were slightly wider (-35.2 to 52.5 mm). No proportional bias was detected (slope = -0.062, $p = 0.31$). Lin's CCC was 0.736 (95% CI 0.655–0.801), corresponding to moderate agreement between methods. Full primary results are shown in Table 3.

Table 3

Statistic	Value
Mean difference (autopsy – PMCT)	7.0 mm
95% CI of mean difference	[3.7, 10.3] mm
Paired t-test	$t = 4.22, p < 0.001$
Wilcoxon signed-rank test	$V = 8032, p < 0.001$
Cohen's dz (paired)	0.349
Pearson r	0.759, $p < 0.001$
ICC(A,1) method comparison	0.738 [0.628, 0.814]
Bland–Altman mean difference	7.0 mm (95% CI: [3.7, 10.3])
Bland–Altman 95% LoA	[-32.5, 46.5] mm
95% CI of lower LoA	[-38.2, -26.7] mm
95% CI of upper LoA	[40.8, 52.2] mm
BA proportional bias	slope = -0.0623, $p = 0.313$
Results for the paired comparison of PMCT and autopsy distances of the anterior inner lung boundaries (n = 146).	

Nine cases (6.2%) showed an absolute difference exceeding 50 mm. Their exclusion reduced the mean difference to 5.5 mm and reduced the scatter accordingly: Cohen's dz rose modestly from 0.35 to 0.39, and Lin's CCC improved from 0.736 to 0.860 (95% CI 0.811–0.897). The bias remained statistically significant ($p < 0.001$). Excluding the four cases with zero distance and zero overlap in either modality (final n = 142) yielded a mean difference of 7.1 mm ($p < 0.001$).

In the univariate predictor model, two pathologies were associated with the paired difference after Benjamini-Hochberg (BH) correction (p (BH) = 0.03 each): pulmonary edema lowered the difference by 11.5 mm ($p = 0.003$), pneumothorax raised it by 13.2 mm ($p = 0.003$). Weight and height reached unadjusted significance ($p = 0.029$ and 0.026) but did not survive correction. No other predictor variable showed an association (Table 4).

Table 4

Variable	Estimate	95% CI	p	p (BH)
Age (years)	0.09	[-0.08, 0.27]	0.293	0.461
BMI (kg/m ²)	-0.42	[-1.03, 0.20]	0.184	0.438
Weight (kg)	-0.19	[-0.36, -0.02]	0.029	0.136
Height (cm)	-0.39	[-0.73, -0.05]	0.026	0.136
Lung weight (g)	-0.00	[-0.01, 0.00]	0.184	0.438
Heart weight (g)	-0.02	[-0.05, 0.01]	0.163	0.438
PMI (days)	0.37	[-1.35, 2.09]	0.671	0.850
Sex (male)	-0.02	[-6.96, 6.91]	0.995	0.995
CPR	1.23	[-5.77, 8.23]	0.729	0.865
Pulmonary edema	-11.48	[-18.92, -4.05]	0.003	0.029
Emphysema	0.96	[-6.59, 8.51]	0.801	0.896
Pneumothorax	13.21	[4.56, 21.87]	0.003	0.029
Pulmonary fat embolism	4.98	[-2.81, 12.76]	0.208	0.440
Cardiomegaly	2.02	[-5.09, 9.14]	0.574	0.780
Pleural effusion	-0.71	[-9.11, 7.70]	0.868	0.916
Rib fractures	-3.99	[-10.70, 2.71]	0.241	0.458
Sternal fractures	-3.93	[-11.44, 3.58]	0.303	0.461
Pleural adhesions	-6.14	[-13.82, 1.54]	0.116	0.438
Cause of death (F-test)	—	—	0.315	0.461
Univariate regression analysis of the paired PMCT and autopsy measurements of the anterior inner lung boundaries, taking various predictors into account. Bold: $p < 0.05$. p (BH) = Benjamini–Hochberg adjusted.				

Model A did not explain any variance beyond chance: R^2 was 0.03 with an adjusted R^2 of -0.008 ($p = 0.58$), and no covariate reached significance (Table 5). Adding pulmonary edema and pneumothorax (Model B, Table 6) raised R^2 to 0.13 (adj. $R^2 = 0.08$; nested-model F-test $p < 0.001$). Pneumothorax retained a coefficient close to its univariate value (12.3 mm, $p = 0.010$). Pulmonary edema attenuated to -7.7 mm ($p = 0.054$), suggesting confounding in the univariate estimate. Variance inflation factors were below 1.2 in both models, residuals mildly right-skewed. Coefficients are visualized in Fig. 4.

Table 5

Term	Estimate	95% CI	p
Intercept	11.70	[-8.22, 31.61]	0.247
BMI (kg/m ²)	-0.48	[-1.12, 0.15]	0.135
Age (years)	0.11	[-0.07, 0.29]	0.213
Sex (female vs. male)	-0.59	[-7.68, 6.51]	0.871
PMI (days)	0.60	[-1.17, 2.36]	0.506
CPR (yes vs. no)	1.39	[-5.80, 8.57]	0.703
R ² = 0.027, Adjusted R ² = -0.008, F(5, 146) = 0.76, p = 0.582			
Multivariate linear regression Model A, containing demographic data, post-mortem interval (PMI), and cardiopulmonary resuscitation (CPR).			

Table 6

Term	Estimate	95% CI	p
Intercept	15.98	[-4.31, 36.27]	0.122
BMI (kg/m ²)	-0.55	[-1.17, 0.06]	0.079
Age (years)	0.13	[-0.05, 0.31]	0.150
Sex (female vs. male)	-1.19	[-8.04, 5.65]	0.731
PMI (days)	0.77	[-0.95, 2.48]	0.379
CPR (yes vs. no)	1.53	[-5.47, 8.53]	0.666
Pulmonary edema	-7.71	[-15.56, 0.15]	0.054
Pneumothorax	12.32	[3.05, 21.59]	0.010
R ² = 0.127, Adjusted R ² = 0.082, F(7, 146) = 2.81, p = 0.0092			
Multivariate linear regression Model B (exploratory), containing demographic data, as well as pulmonary edema and pneumothorax as significant associated predictors. PMI: post-mortem interval, CPR: cardiopulmonary resuscitation.			

Across the different cause-of-death-groups, mean differences ranged from – 3.0 mm (acute cardiac arrest) to 17.4 mm (fatal hemorrhage), but the omnibus tests were not significant (one-way ANOVA $F(9, 136) = 1.18, p = 0.32$; Kruskal-Wallis $p = 0.53$), and with 6 to 27 cases per category the confidence intervals overlapped throughout (Table 7, Fig. 5).

Table 7

Cause of death	n	Mean (SD)	Median	95% CI
Fatal Hemorrhage	12	17.4 (19.7)	14.9	[4.8, 29.9]
Pulmonary Embolism	14	12.8 (27.6)	3.2	[-3.2, 28.7]
Multi Organ Failure	12	10.4 (20.6)	3.2	[-2.7, 23.4]
Strangulation	15	10.1 (15.8)	3.6	[1.3, 18.9]
Drowning	12	7.3 (12.2)	3.0	[-0.4, 15.1]
Central Dysregulation	27	6.2 (19.1)	6.8	[-1.4, 13.8]
Intoxication	16	6.1 (19.2)	2.0	[-4.2, 16.3]
Suffocation	14	4.7 (11.7)	7.6	[-2.0, 11.5]
Unclear	6	-0.3 (32.4)	9.3	[-34.3, 33.7]
Acute Cardiac Arrest	18	-3.0 (22.4)	1.1	[-14.1, 8.2]
Paired difference (autopsy – PMCT) by cause of death. One-way ANOVA $F(9, 136) = 1.18, p = 0.315$; Kruskal-Wallis chi-squared = 8.04, $p = 0.530$.				

Cause of death was therefore not entered into either multivariate model. Beyond the non-significant screening result, its ten categories would have required nine additional dummy variables: added to Model B this raised R^2 from 0.127 to 0.170 while *lowering* the adjusted R^2 from 0.082 to 0.064, the block itself contributed nothing ($F(9, 126) = 0.72, p = 0.69$), and the ratio of cases to estimated parameters fell from 17.9 to 8.4. This analysis is exploratory and the study was not powered to detect differences between individual causes of death.

Discussion

The results of this study show that the measured anterior inner lung boundaries differed significantly between PMCT and autopsy, with the distance determined at autopsy typically being greater. With a mean difference of 7 mm between PMCT and autopsy, the difference was not particularly large overall, but could amount to several centimeters in individual cases.

No clear or highly significant factor among the demographic parameters, pathologies, or causes of death examined could be identified as influencing the measured difference between PMCT and autopsy. In the exploratory multivariable analysis, pneumothorax was associated with a larger difference between PMCT and autopsy measurements. The reason for this association remains unclear.

From the authors' perspective, the invasive procedures performed during the autopsy of the thorax may be a major cause of the observed differences between the PMCT and the autopsy [24–26]. While the thorax was intact during the PMCT measurements, the soft tissue of the chest and the sternum had to be removed first in order to measure the inner lung boundaries during the autopsy. Removal of the sternum inevitably damages the anterior portion of the pleura and effectively opens the thoracic cavities, causing the anterior portions of the lungs to detach from the pleura [26]. This is likely to result in at least slight retraction of the anterior portions of the lungs and thus in an increase in the distance between their inner boundaries, which would partially explain the predominantly larger distances observed at autopsy. However, this mechanism cannot conclusively explain why the measured distances between PMCT and autopsy amounted to several centimeters in some cases or why distances were sometimes smaller at autopsy in others.

In forensic practice, the differences in measurements between PMCT and autopsy are likely to be so small in the majority of cases that they probably do not play a role in the assessment, especially since clear influencing factors could not be identified in most cases. In individual cases, however, differences of several centimeters may be observed, and forensic radiologists and forensic pathologists should be aware of the occurrence of such discrepancies and, under certain circumstances, be able to point them out.

Limitations: This study examined only fresh cadavers without significant signs of decomposition. Experience has shown that decomposed cadavers may exhibit significant changes in organs and tissues, as well as extensive gas accumulation [28]; therefore, the results of this study cannot be readily extrapolated to decomposed cadavers.

Overall, only a relatively small number of cases were examined, and the individual subgroups studied also had small sample sizes, a fact that must be taken into account when interpreting the results.

Observer reliability was assessed only for the PMCT measurements. A reproducibility test is lacking for the autopsy measurement due to the retrospective nature of the study.

Conclusion

Autopsy measurements of the anterior inner lung boundary distances were slightly larger on average than PMCT measurements. In most cases, these differences are unlikely to be forensically relevant. However, larger discrepancies may occur in individual cases and should be considered when comparing PMCT and autopsy findings.

Declarations

Acknowledgements

We would like to express our gratitude to our team of forensic pathologists and forensic technicians for their support with case handling.

Funding

none

Disclosure statement

Nothing to disclose

Compliance with Ethical Standards

Human Ethics and Consent to Participate declarations: not applicable

AI statement

No AI Tools were used in the creation of this manuscript

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References

1. Dirnhofer R, Jackowski C, Vock P, Potter K, Thali MJ (2006) Virtopsy: minimally invasive, imaging-guided virtual autopsy. *Radiographics* 26(5):1305–1333
2. Thali MJ, Yen K, Schweitzer W, Vock P, Boesch C, Ozdoba C, Schroth G, Ith M, Sonnenschein M, Doernhoefer T, Scheurer E, Plattner T, Dirnhofer R (2003) Virtopsy, a new imaging horizon in forensic pathology: virtual autopsy by postmortem multislice computed tomography (MSCT) and magnetic resonance imaging (MRI)—a feasibility study. *J Forensic Sci* 48(2):386–403
3. Norberti N, Tonelli P, Giaconi C, Nardi C, Focardi M, Nesi G, Miele V, Colagrande S (2019) State of the art in post-mortem computed tomography: a review of current literature. *Virchows Arch* 475(2):139–

4. Shiotani S, Kohno M, Ohashi N, Yamazaki K, Nakayama H, Watanabe K et al (2004) Non-traumatic postmortem computed tomographic (PMCT) findings of the lung. *Forensic Sci Int* 139:39–48
5. Dedouit F, Ducloyer M, Elifritz J, Adolphi NL, Yi-Li GW, Decker S, Ford J, Kolev Y, Thali M (2025) The current state of forensic imaging - post mortem imaging. *Int J Legal Med* 139(3):1141–1159. 10.1007/s00414-025-03461-xEpub 2025 Mar 24
6. Christe A, Flach P, Ross S, Spendlove D, Bolliger S, Vock P, Thali MJ (2010) Clinical radiology and postmortem imaging (Virtopsy) are not the same: specific and unspecific postmortem signs. *Leg Med (Tokyo)* 12(5):215–222
7. Gotsmy W, Lombardo P, Jackowski C, Brencicova E, Zech WD (2019) Layering of stomach contents in drowning cases in post-mortem computed tomography compared to forensic autopsy. *Int J Legal Med* 133(1):181–188. 10.1007/s00414-018-1850-4Epub 2018 Apr 24
8. Zech WD, Jackowski C, Schwendener N, Brencicova E, Schuster F, Lombardo P (2016) Postmortem CT versus forensic autopsy: frequent discrepancies of tracheobronchial content findings. *Int J Legal Med* 130(1):191–198. 10.1007/s00414-015-1264-5Epub 2015 Sep 23
9. Ampanozi G, Halbheer D, Ebert LC, Thali MJ, Held U (2020) Postmortem imaging findings and cause of death determination compared with autopsy: a systematic review of diagnostic test accuracy and meta-analysis. *Int J Legal Med* 134(1):321–337. 10.1007/s00414-019-02140-yEpub 2019 Aug 27
10. Lombardo P, Hartmann C, Fridle C, von Tengg-Koblighk H, Ruder TD, Zech WD (2026) Diagnostic accuracy of rib fracture detection in forensic post-mortem photon counting CT. *Int J Legal Med* 140(1):301–309
11. Schulze C, Hoppe H, Schweitzer W, Schwendener N, Grabherr S, Jackowski C (2013) Rib fractures at postmortem computed tomography (PMCT) validated against the autopsy. *Forensic Sci Int* 233(1–3):90–98
12. Madea B (2022) *Handbook of Forensic Medicine*, second edition, Hoboken, NJ: Wiley. ISBN: 978-1-119-64855-0
13. Saukko P, Knight B (2016) *Knight's Forensic Pathology*. 4th edition, CRC Press, Boca Raton. eBook ISBN9780429102356
14. Christe A, Aghayev E, Jackowski C, Thali MJ, Vock P (2008) Drowning post-mortem imaging findings by computed tomography. *Eur Radiol* 18:283–290
15. Ogawara T, Usui A, Homma N, Funayama M (2022) Diagnosing Drowning in Postmortem CT Images Using Artificial Intelligence. *Tohoku J Exp Med* 259(1):65–75. 10.1620/tjem.2022.J097Epub 2022 Nov 17
16. Usui A, Kawasumi Y, Funayama M, Saito H (2014) Postmortem Lung Features in Drowning Cases on Computed Tomography. *Jpn J Radiol* 32(7):414–420. 10.1007/s11604-014-0326-9
17. Van Hoyweghen A, Jacobs W, Op de Beeck B, Parizel P (2014) Can Post-Mortem CT Reliably Distinguish Between Drowning and Non-Drowning Asphyxiation? *Int J Legal Med* 129(1):159–164. 10.1007/s00414-014-1037-6

18. Vander Plaetsen S, De Letter E, Piette M, Van Parys G, Casselman J, Verstraete K (2015) Post-Mortem Evaluation of Drowning with Whole Body CT. *Forensic Sci Int* 249:35–41. 10.1016/j.forsciint.2015.01.008
19. Leth P, Madsen B (2017) Drowning Investigated by Post Mortem Computed Tomography and Autopsy. *J Forensic Radiol Imaging* 9:28–30. 10.1016/j.jofri.2017.02.002
20. Jakobsen SR, Schellerup L, Boel LWT, Hansen K (2025) Lung densitometry in postmortem computed tomography - comparison across different fatal asphyxia groups. *Forensic Sci Med Pathol* 21(2):548–554. 10.1007/s12024-024-00892-7Epub 2024 Sep 3
21. Schweitzer W, Thali M (2019) Fatal obstructive asphyxia: trans-pulmonary density gradient characteristic as relevant identifier in postmortem CT. *J Forensic Radiol Imaging* 19:100337
22. Sogawa N, Michiue T, Ishikawa T, Kawamoto O, Oritani S, Maeda H (2014) Postmortem volumetric CT data analysis of pulmonary air/gas content with regard to the cause of death for investigating terminal respiratory function in forensic autopsy. *mForensic Sci Int* 241:112–117
23. Recommendation (2000) no. R (99) 3 of the Committee of Ministers to member states on the harmonization of medico-legal autopsy rules. *Forensic Sci Int* 111(1–3):5–58
24. Rutty G (2005) *Essentials of autopsy practice, current methods and modern trends*, 3rd edn. Springer, London
25. Burton JL, Rutty G (2010) *The hospital autopsy, a manual of fundamental autopsy practice*, 3rd edn. Hodder Arnold, London
26. Walker JE, Rutty GN, Rodgers B, Woodford NW (2002) How should the chest wall be opened at necropsy? *J Clin Pathol* 55(1):72–75. 10.1136/jcp.55.1.72
27. Bland JM, Altman DG (1999) Measuring agreement in method comparison studies. *Stat Methods Med Res* 8(2):135–160. 10.1177/096228029900800204
28. Egger C, Vaucher P, Doenz F, Palmiere C, Mangin P, Grabherr S (2012) Development and validation of a postmortem radiological alteration index: the RA-Index. *Int J Legal Med* 126:559–566

Figures

Figure 1

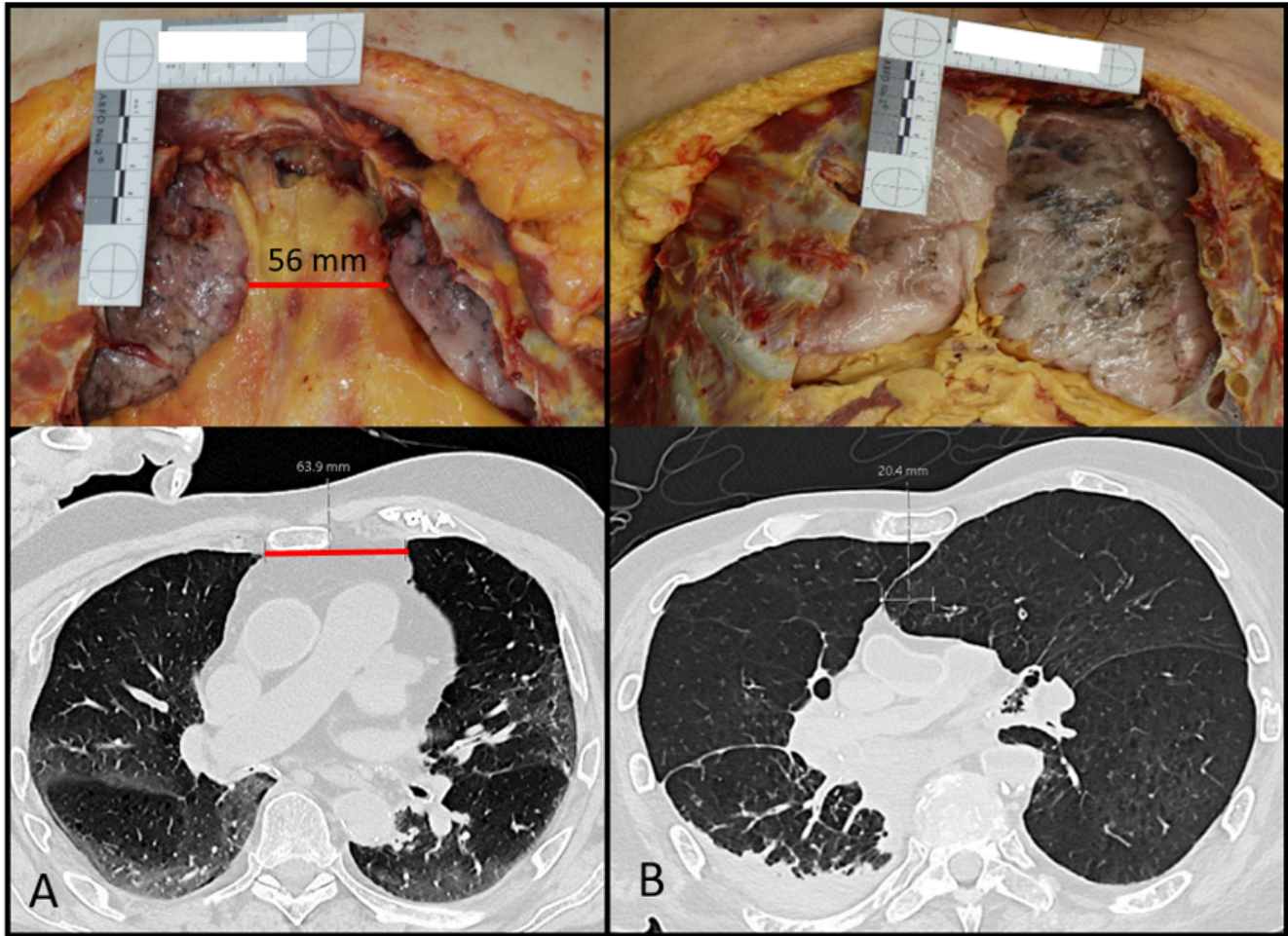


Figure 1

Examples of discrepancies between the minimum distance between the anterior inner lung boundaries measured during autopsy and determined by PMCT: A: autopsy distance approx. 56 mm, PMCT distance approx. 64 mm. B: autopsy lung boundaries merely touching, PMCT lung boundaries significantly overlapping.

Figure 4

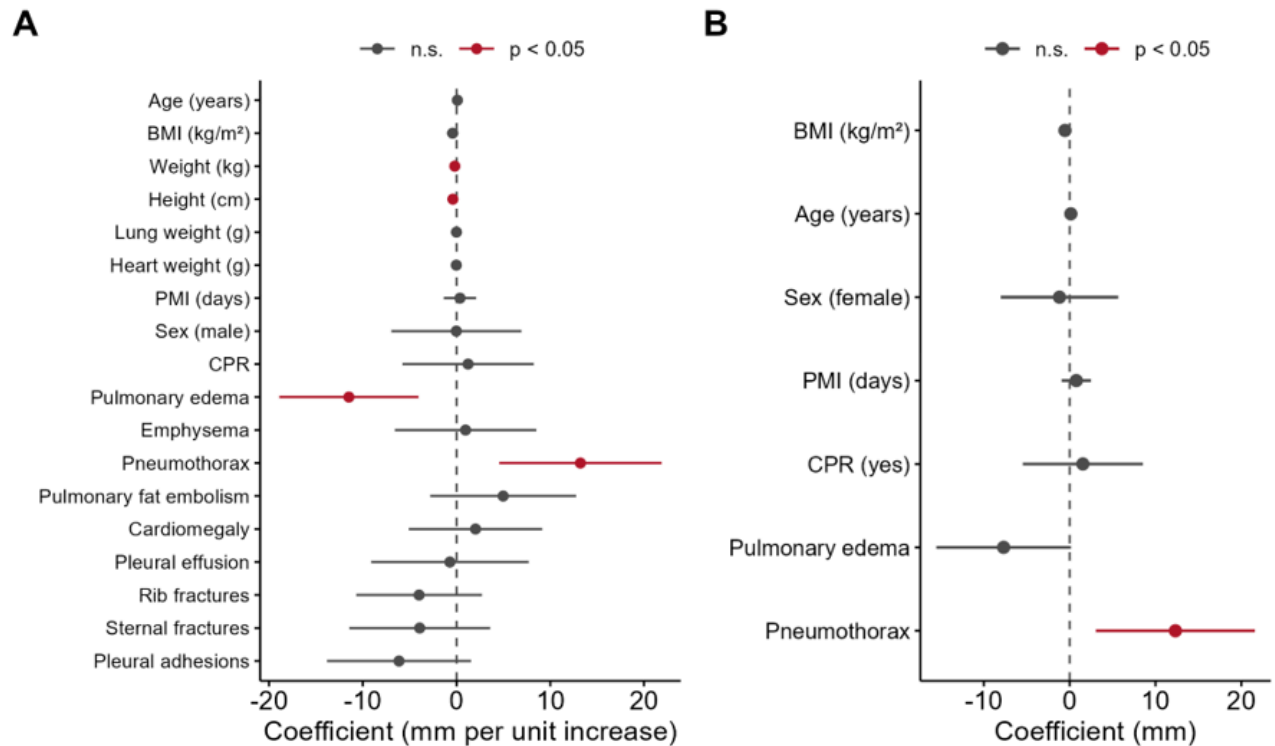


Figure 4

Significance of regression models for various predictors: **(A)** Univariate coefficients. **(B)** Model B (adjusted). Red: $p < 0.05$; n.s. = non-significant

Figure 5

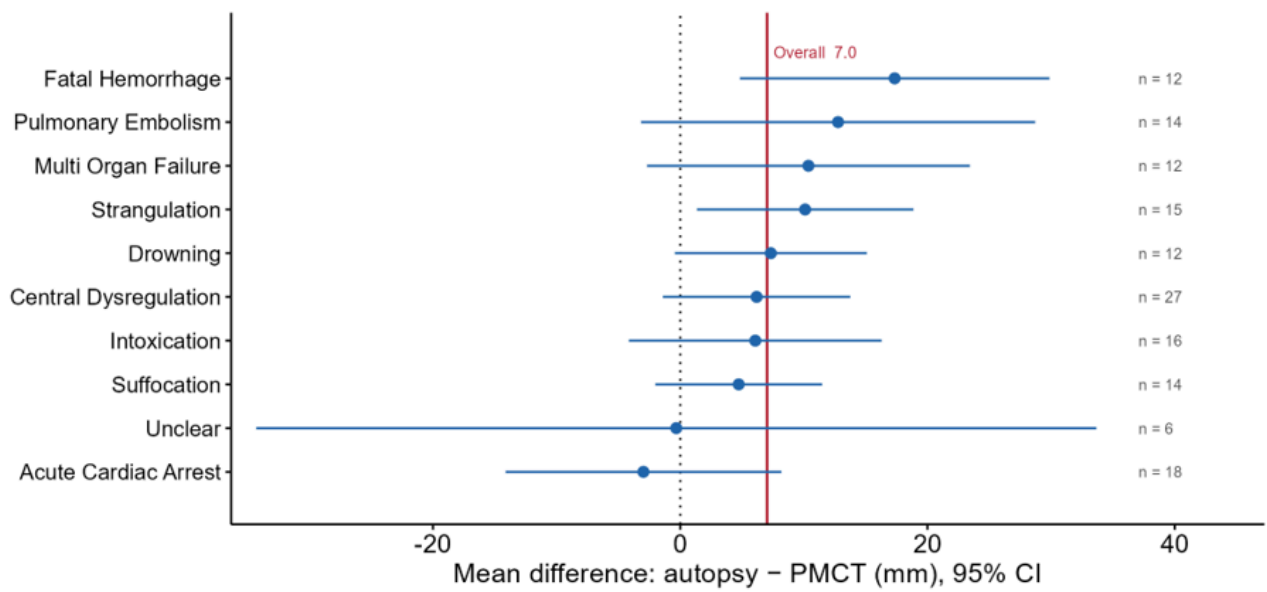


Figure 5

Mean paired difference (autopsy - PMCT) by cause of death, with 95% confidence intervals. Red line: overall mean difference. Dotted line: no difference.