

CQ49: Are there any useful findings on postmortem CT for determining death due to heatstroke?

Recommendation Grade:

Condition Assessment: C2

Cause of Death Determination: D

At present, there are no findings reported to be specific to heatstroke. Therefore, caution is required when attempting to determine heatstroke using postmortem CT alone.

Explanation

• Background

Heatstroke is a form of hyperthermia caused by excessive heat exposure and dehydration, leading to dysfunction of the central nervous system and elevated core body temperature above the normal range of 36–37.5°C. As the condition worsens, symptoms such as headache, vomiting, impaired consciousness, organ failure, and coagulopathy may occur, potentially resulting in death.

• Postmortem CT Findings

Several studies have investigated postmortem CT findings potentially related to heatstroke:

Vessel Flattening Index (vFI):

A method has been proposed to calculate the vessel flattening index (vFI), defined as the ratio between the minor and major axes of the aorta or inferior vena cava, adjusted using the circumference-based circular area¹. A lower vFI indicates greater flattening. Although reduced vFI has been reported in cases of heatstroke (in the thoracic and abdominal aorta, and inferior vena cava), similar findings are also seen in deaths due to hemorrhage, asphyxia, and methamphetamine intoxication.

Estimated Lung Weight:

Using a method to estimate lung weight from CT data², heatstroke cases showed reduced estimated air volume. However, low values have also been reported in acute cardiac deaths, carbon monoxide poisoning, and drug intoxications.

Pulmonary Transparency:

A study investigating pulmonary transparency and cause of death³ found decreased lung transparency in heatstroke, but similar reductions were seen in deaths due to intoxication, congestive heart failure, and acute ischemic heart disease.

Estimated Heart Weight and Intracardiac Clot Evaluation:

In another method assessing cardiac enlargement and blood volume using postmortem CT⁴, lower heart volume and estimated intracardiac blood volume were observed in heatstroke cases. However, such findings also occur in fatal hemorrhage, cardiac tamponade, and acute cardiac death.

Volumetric Measurements of Heart and Both Lungs:

A method using postmortem CT to estimate the volumes of the heart and lungs⁵ did not identify any findings specific to heatstroke.

To date, no postmortem CT findings have been identified as specific to heatstroke. Furthermore, all studies cited above originate from a single institution and involve a limited number of heatstroke cases. Further accumulation of evidence is needed in future research.

Column: Clinical Research on Heatstroke

Since the publication of the 2020 edition of this guideline, no new reports have emerged concerning postmortem imaging findings specific to heatstroke, and thus no updated evidence is currently available. On the other hand, several reports exist regarding imaging in living patients (particularly MRI), including findings such as multifocal, bilateral symmetrical signal abnormalities in the brain parenchyma⁶, symmetrical signal abnormalities in the dentate nuclei and superior cerebellar peduncles⁷, and cases of persistent myocarditis occurring outside the brain⁸. Some studies have also discussed the possible involvement of mitochondrial dysfunction⁶. All of these reports involved imaging performed several days after onset, during the course of treatment. Therefore, it is presumed that a certain amount of time after symptom onset may be required before heatstroke-specific imaging findings can be detected. In the field of forensic medicine, where most heatstroke fatalities involve short agonal phases, it may be difficult to make definitive diagnoses using imaging studies alone.

○ Literature Search Strategy and Selection (as of February 21, 2024)

【PubMed】

#	Search formula	Number of articles
1	Search(postmortem)AND((computed tomography OR magnetic resonance))	14,238
2	Search((((postmortem)AND((computed tomography OR magnetic resonance))))AND heat stroke	6
3	Search((((((postmortem)AND((computed tomography OR magnetic resonance))))AND heat stroke))AND humans	5

●Additional Sources Not Captured by the Search Strategy

References [6] , [7] , [8]

■References

- 1) Sogawa N et al : Postmortem CT morphometry of great vessels with regard to the cause of death for investigating terminal circulatory status in forensic autopsy. *Int J Legal Med* 2015 ; 129 : 551-558 (level4b)
- 2) Sogawa N et al : 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. *Forensic Sci Int* 2014 ; 241 : 112-117 (level4b)
- 3) Michiue T et al : Quantitative analysis of pulmonary pathophysiology using postmortem computed tomography with regard to the cause of death. *Forensic Sci Int* 2012 ; 220 : 232-238 (level4b)
- 4) Michiue T et al : Cardiac dilatation index as an indicator of terminal central congestion evaluated using postmortem CT and forensic autopsy data. *Forensic Sci Int* 2016 ; 263 : 152-157 (level4b)
- 5) Sogawa N et al : Postmortem virtual volumetry of the heart and lung in situ using CT data for investigating terminal cardiopulmonary pathophysiology in forensic autopsy. *Leg Med* 2014 ; 16 : 187-192 (level4b)
- 6) Jones DG et al : Hyperthermic brain injury : characteristic magnetic resonance imaging findings and implications for pathophysiology. *Neurohospitalist* 2022 ; 12 : 575-576
- 7) Xu H et al : Diffusion tensor tractography of heatstroke. *Acta Neurol Belg* 2022 ; 122 : 211-212
- 8) Luo S et al : Multiparametric cardiac magnetic resonance reveals persistent myocardial inflammation in patients with exertional heat illness. *Eur Radiol* 2023 ; 33 : 8165-8176