CQ14: Is the use of postmortem imaging during external postmortem examinations useful?

Recommendation Grade: C1

The use of postmortem imaging during external postmortem examinations can be useful, as it may detect abnormalities that are not identifiable through external inspection alone, and in some cases, reveal findings directly related to the cause of death. However, interpretation of postmortem images requires caution. Certain causes of death may be overlooked or undetectable by imaging alone. Additionally, distinguishing between internal and external causes can be difficult, and postmortem changes may be mistaken for pathological findings. Therefore, it is recommended that postmortem imaging be interpreted by physicians with expertise in forensic medicine and experience in postmortem imaging.

Explanation

● Background

Postmortem external examination ("ken-an" in Japanese) refers to the procedure in which a physician performs a medical inspection of a body's exterior to determine the cause and manner of death, as well as to estimate the postmortem interval.

In Japan, the autopsy rate for unnatural deaths gradually increased from 11.4% in 2013 to 12.8% in 2016, but subsequently declined to 9.8% by 2022[1]. This rate remains significantly lower than that of Western countries[2 3]. Furthermore, when a death is judged to be due to natural causes during the police investigation or medical postmortem examination and no foul play is suspected, autopsy is rarely performed[2]. In such cases, conclusions about the cause and manner of death are often made solely based on scene findings and external examination, which may lead to missed diagnoses of internal pathology or trauma. There have already been cases reported in which postmortem imaging was useful in detecting such findings[2]. Postmortem imaging has also been studied as a tool for estimating the postmortem interval[4 5].

● Estimation of Natural Causes of Death Using Postmortem Imaging

According to studies comparing postmortem imaging findings with autopsy results, approximately 30–80% of natural deaths can be diagnosed using postmortem imaging[3 6–8]. Therefore, postmortem CT may also serve as a useful screening tool when autopsy cannot be performed[7]. In natural deaths, postmortem imaging is particularly effective in identifying hemorrhagic conditions—such as cerebral hemorrhage, subarachnoid hemorrhage, aortic dissection, and ruptured aortic aneurysm[3]—as well as respiratory failure as the direct cause of death, including acute respiratory distress syndrome (ARDS), diffuse alveolar damage (DAD), pneumonia, and airway obstruction[7 8]. On the other hand, a study examining differences in causes of death between individuals with and without epilepsy reported that

the diagnostic utility of postmortem CT was somewhat limited[9]. Several reports suggest that the diagnostic accuracy improves when clinical information is added[10 11]. The use of contrast-enhanced CT or MRI may also increase diagnostic yield (see CQ10).

Although the reported diagnostic rates for natural deaths vary, it is believed that some natural causes of death identifiable on postmortem CT may not be detected through external examination or case circumstances, including medical history. In a multicenter study of ruptured abdominal aortic aneurysms, only 1 out of 15 cases was suspected prior to postmortem CT[12]. Since many cases deemed to lack criminal suspicion and therefore considered not to require autopsy are expected to be natural deaths, these findings support the utility of performing postmortem CT during external examinations.

● Preventing Oversight of External Causes of Death

In traumatic deaths, some reports state that the cause of death can be identified in over 80% of cases using postmortem imaging[3]. In a study that performed CT scans on 80 cases judged to be non-criminal at the time of police inspection, involvement of external causes was found in 10 cases[2]. Even in deaths due to external causes, injuries may not be apparent based on external examination or scene context. Therefore, the use of postmortem CT during external examination is considered helpful in preventing the oversight of externally caused deaths. In such cases, the necessity of autopsy should be reconsidered.

Postmortem CT is also useful in identifying the cause and manner of death in suspected suicide cases[13]. In drug overdose cases, even when no abnormal findings are visible on the body surface, postmortem CT is useful for screening and documenting gastric and duodenal contents[14–16]. In such cases, a high-density sediment layer (typically over 100 HU) may be visible in the stomach[14].

Postmortem CT can also detect foreign bodies in the pharynx and larynx that are not externally visible[17–19], as well as objects inserted into the body as part of postmortem handling[20 21].

● Combination with Other Examinations

Although the diagnostic rate for determining the cause of death using CT images alone is not particularly high[2], it is well established that combining postmortem imaging with contrast-enhanced CT or tissue sampling significantly improves both the accuracy and quality of diagnosis[22–24]. Furthermore, several studies have reported that the addition of clinical information further enhances diagnostic performance[10 11].

● Conditions Difficult to Detect or Diagnose by CT

There are several diseases and conditions that are difficult to diagnose with postmortem CT, including ischemic heart disease, various types of poisoning, metabolic disorders, and inflammatory diseases[2]. In addition, certain injuries and pathological conditions are prone to being overlooked, such as cervical spinal cord injury, cardiac rupture, hollow organ injuries, diaphragmatic injury, and mediastinal hematoma[2]. Examples of important findings that could not be identified on CT but were confirmed at autopsy include coronary artery stenosis, coronary artery thrombosis, pulmonary embolism,

bronchiectasis, emphysema, liver laceration, splenic laceration, aspiration, micronodular cirrhosis, skull base fractures, and gastrointestinal ulcers[25]. There are also cases where conditions such as cancer, leukemia, sarcoidosis, bronchopneumonia, and tuberculosis were discovered for the first time through histopathological examination after autopsy[25].

Even when hemorrhagic lesions are identified on postmortem CT, it may not be possible to determine whether they are of endogenous or exogenous origin[2]. Furthermore, postmortem changes may sometimes be misinterpreted as pathological abnormalities. For these reasons, image interpretation should be performed by physicians with expertise in forensic medicine and experience in postmortem imaging[2].

● Estimation of Postmortem Interval (PMI)

Some studies have investigated whether postmortem changes visible on imaging could be used to estimate the postmortem interval. It has been reported that as the postmortem interval increases, the aortic wall becomes thicker and its outer diameter narrows[4 26]. Additionally, the CT attenuation values of cerebrospinal fluid and vitreous humor have been shown to increase over time[5 27]. There are also reports on the application of machine learning using postmortem CT data to estimate the postmortem interval[28]. However, as of now, no postmortem CT-based methods have been demonstrated to be more useful than traditional approaches used during external postmortem examinations.

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

【PubMed】

#	Search formula	Number of articles
1	Search: ((postmortem CT) OR (post-mortem CT)) OR (post mortem CT)	13,016
2	Search: ((((postmortem CT) OR (post-mortem CT)) OR (post mortem CT))) AND (estimate cause of death)	58

【医中誌 Ichushi-Web (Japan Medical Abstracts Society Database)】

#	Search formula	Number of articles
1	((@X 線 CT/TH and @死亡時画像診断/TH) or 死後 CT/AL) and ((@MRI/TH and @死亡時画像診断/TH) or 死後 MRI/AL)	96
2	((((@X 線 CT/TH and @死亡時画像診断/TH) or 死後 CT/AL) and ((@MRI/TH and @死亡時画像診断/TH) or 死後 MRI/AL)) and (PT=原著論文,解説,総説,図説,Q＆A,講義,会議録除く)	71

●Additional Sources Not Captured by the Search Strategy

References［1］,［3］,［10］,［17］,［18］,［19］,［23］

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2） Iwase H et al：Evaluation of computed tomography as a screening test for death inquest. J Forensic Sci 2010；55：1509-1515（level 5）

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8） Sonnemans LJP et al：Can virtual autopsy with postmortem CT improve clinical diagnosis of cause of death? A retrospective observational cohort study in a Dutch tertiary referral centre. BMJ Open 2018；8：e018834（level 4b）

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10） Ishida M et al：Common postmortem computed tomography findings following atraumatic death：differentiation between normal postmortem changes and pathologic lesions. Korean J Radiol 2015；16：798-809（level 4b）

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28）Klontzas ME et al：Post-mortem CT radiomics for the prediction of time since death. Eur Radiol 2023；33：8387-8395（level 4b）

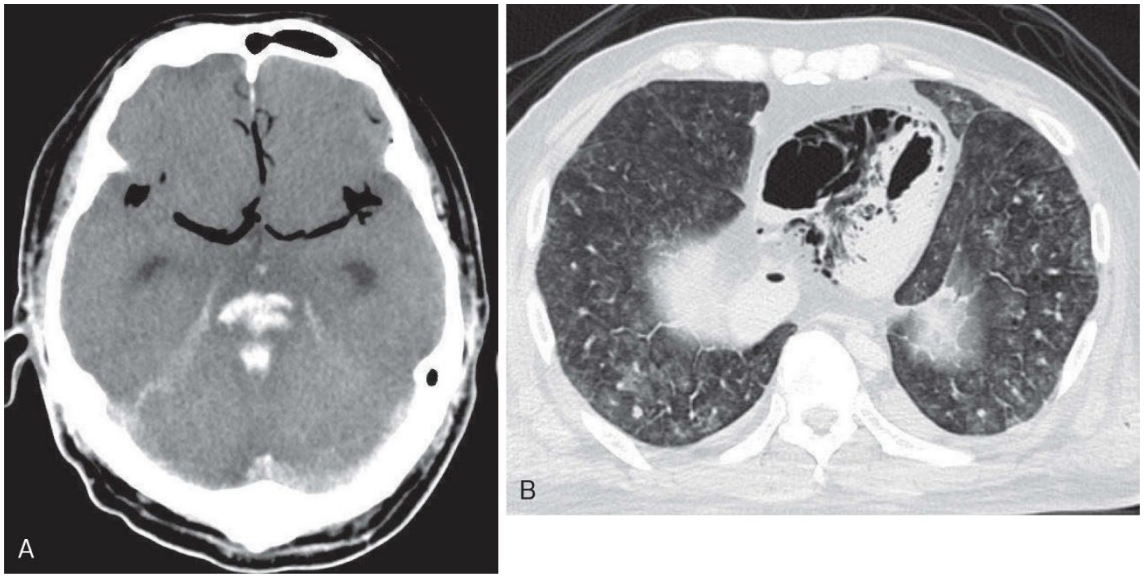

Figure 1. Brainstem Hemorrhage in a Man in His 50s

A: Head B: Chest

A high-density area is observed in the brainstem (A). Putrefactive gas is seen within the anterior and middle cerebral arteries. Gas is also noted within the cardiac chambers (B).

Even in cases with advanced decomposition, postmortem imaging may help identify the cause of death.

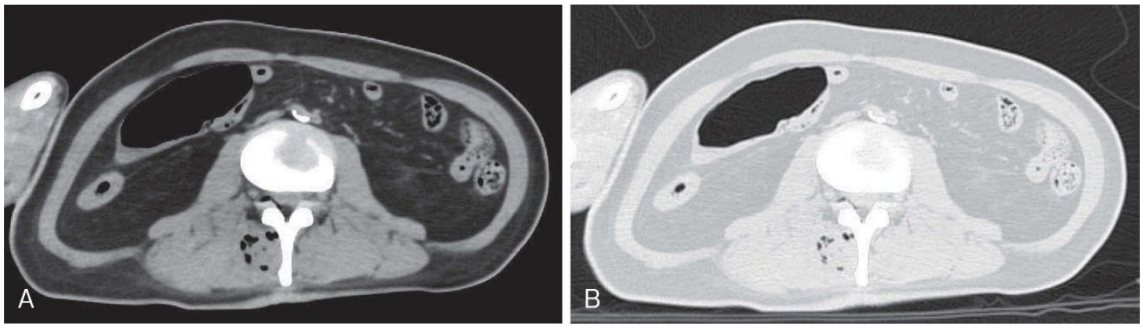

Figure 2. Lumbar Abscess in a Man in His 50s

A: Mediastinal Window Setting B: Lung Window Setting

Gas is observed within the paraspinal muscles and spinal canal in the lumbar region. Serological tests revealed a marked inflammatory response.

A whole-body postmortem CT scan was useful in identifying the condition.