## CQ 12: Is Postmortem CT Angiography (PMCTA) Useful for Estimating the Cause of Death?

**Recommendation Grade: B**

Postmortem CT angiography (PMCTA)—a technique that uses contrast agents—has demonstrated high utility in evaluating vascular pathologies such as infarction and hemorrhage, as well as vascular injuries due to trauma. It can reveal abnormalities that may be difficult to detect during autopsy, thereby serving as a complementary tool to traditional dissection. Most of the published reports on PMCTA originate from outside Japan, and the method is not yet widely adopted in Japan. However, in the field of forensic medicine in Japan, selective coronary angiography using CT at the time of autopsy is being performed in some cases.

### Explanation

**● Background**

In standard postmortem CT, it is often difficult to precisely identify sites of hemorrhage due to organ or vascular injury. As a solution, the use of contrast-enhanced postmortem CT angiography (PMCTA) has been reported. Since blood circulation ceases after death, contrast administration methods must differ from those used in clinical (antemortem) settings. For whole-body angiography, techniques commonly reported from outside Japan include the insertion of catheters into the femoral or axillary arteries and veins, combined with the use of extracorporeal perfusion devices[1–3], or specialized systems that monitor injection pressure[4–7]. Some protocols involve multi-phase imaging, including: Arterial phase (injection via arterial catheter), Venous phase (via venous catheter), Dynamic phase (continuous infusion during scanning). This allows for differentiation between arterial and venous injuries.[4] In Japan, a method for PMCTA in emergency settings has been reported, which involves contrast injection through peripheral veins combined with chest compressions, simulating cardiopulmonary resuscitation.[8 9] In stillborns and neonates, contrast agents have been injected via the umbilical cord or bone marrow.[10]

Several localized angiography techniques have also been reported, including:

- Selective coronary angiography via catheter insertion into the ascending aorta[11]
- Targeted vessel imaging through catheters placed in situ[12–15]
- Organ-specific perfusion, such as injecting contrast into dissected vessels of extracted brain or heart specimens[16 17]

Various types of contrast agents have been used:

- Water-soluble agents[1–3]
- Oil-based agents[4 18]
- **Negative contrast (gases)**[19]

- Gelatin-barium mixtures[20 21]
- Resin-based agents

Each has its advantages and limitations, depending on the imaging goal and context.[22]

● Usefulness of PMCTA (See also CQ32)

Postmortem CT angiography (PMCTA) using contrast agents has been reported to be highly effective in a wide range of conditions, including:

- Vascular injuries due to trauma or medical procedures[23–29]
- Vessel rupture secondary to dissection[30]
- Cardiac rupture from myocardial infarction[26]
- Thrombosis of coronary or mesenteric arteries[25 26 31–35]
- Pulmonary thromboembolism[26 36]
- Vascular malformations, including in newborns[37–39]
- Identification of the responsible vessel in cerebral hemorrhage and subarachnoid hemorrhage[16 26 40]

PMCTA is particularly valuable in postoperative cases, where anatomical distortion makes evaluation by autopsy difficult.[41] Beyond vascular evaluation, PMCTA can also demonstrate contrast enhancement in infarcted myocardium caused by myocardial infarction.[17 31 33] However, some reports note that in completely occluded coronary arteries, enhancement of the myocardium may not be visible.[32] There are also cases where hepatic tumors, which were unclear on non-contrast postmortem CT, became clearly delineated on PMCTA after contrast injection via the inferior vena cava.[42] According to a systematic review, the diagnostic sensitivity for identifying the accurate cause of death was:

- PMCTA: 0.79 (95% CI: 0.52–0.93)
- Postmortem CT (non-contrast) and postmortem MRI: lower values

PMCTA showed the highest sensitivity.[43]

PMCTA is also considered useful in unexpected in-hospital deaths, particularly for evaluating implanted medical devices and post-interventional states. It serves as a practical tool to maintain the quality of autopsy when it is subsequently performed.[25 44]

In addition, PMCTA is helpful for measuring vascular diameter and cardiac chamber size, and has been reported to allow easier measurement than standard postmortem CT in certain contexts.[45 46]

**● PMCTA and Autopsy**

Studies comparing PMCTA and autopsy have shown that PMCTA provides comparable or even superior diagnostic capability to autopsy for identifying: Sites of vascular injury and vascular occlusions[4 11 47–50] Therefore, in cases where the cause of death involves morphological abnormalities in the vasculature, PMCTA is considered effective in detecting these abnormalities.

However, for conditions without clear structural changes, such as myocardial cell lysis or myocardial

necrosis, PMCTA has been reported to have lower sensitivity compared to conventional autopsy.[17 26 33 51–53]

PMCTA and autopsy are thus considered complementary diagnostic tools. The usefulness of each method depends on the clinical question and characteristics of the case. For accurate determination of the cause of death, a combined approach using both PMCTA and autopsy is recommended.[11 49 54] On the other hand, some studies suggest that performing PMCTA may allow for a reduction in the number of cases requiring autopsy.[55] It should be noted, however, that in Japan, performing PMCTA on a body prior to formal authorization for autopsy could potentially be considered a violation of Article 190 (crime of damaging a corpse) of the Penal Code. Thus, legal caution is required.[56]

**● Correlation with Other Examinations and Artifacts**

In postmortem investigations such as external examinations and autopsies, histopathological and toxicological testing are often performed concurrently. These analyses require the collection of various biological samples (e.g., blood, urine, cerebrospinal fluid) from the body.

In such cases, it is important to consider the influence of contrast agents administered during PMCTA. Some studies have reported that oil-based contrast agents may reach peripheral vessels and be difficult to distinguish from fat emboli.[22] On the other hand, there are also reports suggesting that biochemical analyses of the vitreous humor[56] and pericardial effusion[23] are not affected by contrast agents. If sample collection can be performed prior to contrast administration, it may increase the feasibility and diagnostic value of PMCTA.

PMCTA is also associated with certain artifacts, pitfalls, and complications, including:

- Inadequate opacification of vessels
- Inhomogeneous contrast enhancement
- Leakage of contrast agent into the gastrointestinal tract
- Catheter misplacement
- Vascular injury during catheter insertion or contrast infusion[30 57–59]

Among these, inhomogeneous enhancement can often be mitigated by performing multi-phase contrast imaging or by changing the position of the body during scanning.[60]

○ Literature Search Strategy and Selection (January 11, 2024)

【PubMed】

| # | Search formula | Number of articles |
|---|---|---|
| 1 | Search (((((("postmortem CT" OR "postmortem imaging") OR "postmortem CT") OR "post-mortem imaging"))) AND angiography) Filters：published in the last 10 years | 81 |
| 2 | Search ((((("postmortem CT" OR "postmortem imaging") OR "post- | 6 |

| | | |
|---|---|---|
| | mortem CT") OR "post-mortem imaging"))) AND "contrast enhancement") Filters： published in the last 10 years | |
| 3 | Search (((((((("postmortem CT" OR "postmortem imaging") OR "postmortem CT") OR "post-mortem imaging"))) AND angiography)) AND "last 10 years"[PDat])) OR (((((((("postmortem CT" OR "postmortem imaging") OR "post-mortem CT") OR "post-mortem imaging"))) AND "contrast enhancement")) AND "last 10 years"[PDat]) Filters：published in the last 10 years | 78 |

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

| # | Search formula | Number of articles |
|---|---|---|
| 1 | (死後/AL) and ((FT=Y) and PT= 原著論文, 会議録除く and CK=ヒト) | 5,094 |
| 2 | (死亡時/AL) and ((FT=Y) and PT= 原著論文, 会議録除く and CK=ヒト) | 979 |
| 3 | ((画像診断/TH or 画像診断/AL)) and ((FT=Y) and PT= 会議録除く and CK=ヒト) | 367,754 |
| 4 | ((X 線 CT/TH or X 線 CT/AL)) and ((FT=Y) and PT= 会議録除く and CK=ヒト) | 146,191 |
| 5 | #1 or #2 | 5,773 |
| 6 | #3 or #4 | 367,964 |
| 7 | #5 and #6 | 1,421 |
| 8 | ((造影/TH or 造影/AL)) and ((FT=Y) and PT= 原著論文, 会議録除く and CK=ヒト) | 88,134 |
| 9 | #7 and #8 | 163 |
| 10 | (#9) and (DT=2014:2024) | 51 |

●Additional Sources Not Captured by the Search Strategy

References［1］,［3］,［8］,［9］, ［15］,［22］, ［44］,［49］,［52］,［59］

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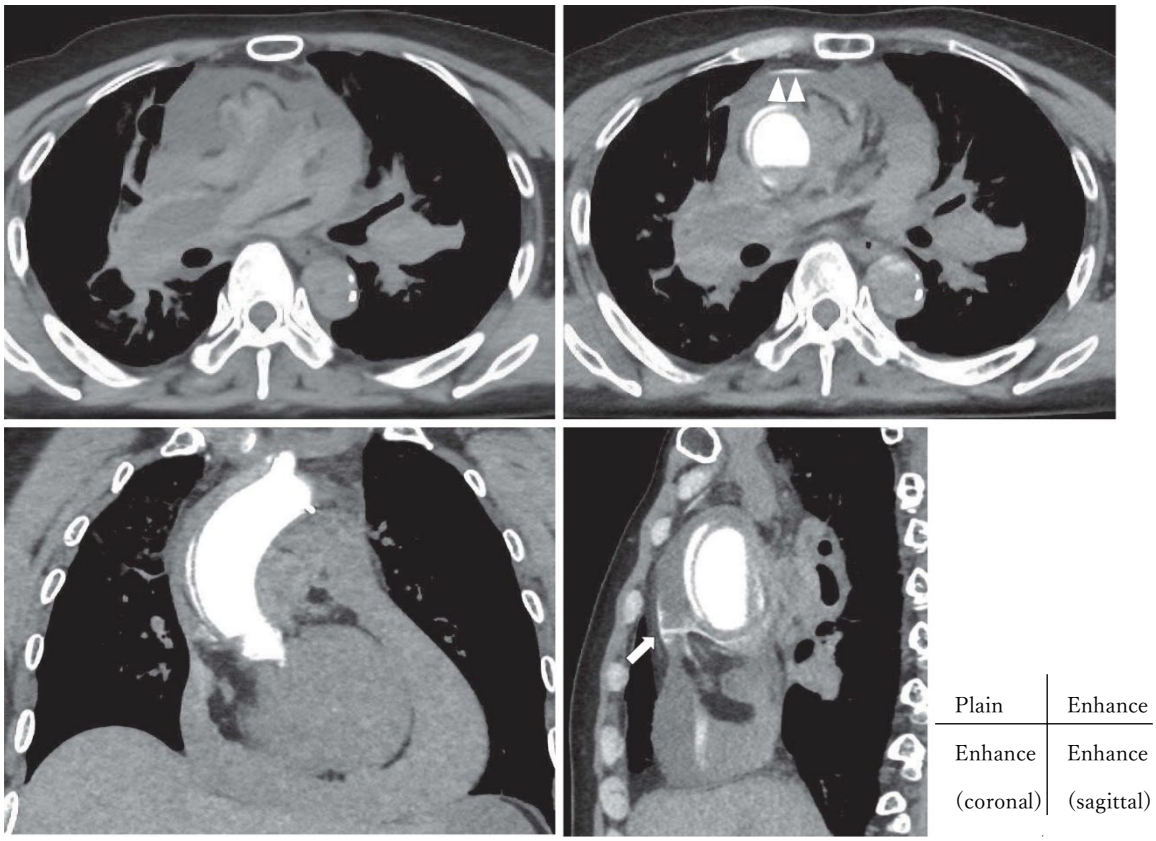


**Figure: Female in her 60s – Aortic Dissection**

Non-contrast postmortem CT shows a high-attenuation area surrounding the heart and pulmonary artery, indicating hemorrhagic cardiac tamponade. Following contrast administration, contrast leakage into the pericardial cavity is observed (△). On sagittal multiplanar reconstruction (MPR) images, the site where contrast leaks from the true lumen into the pericardial space can be identified (⇨).