CQ25 Is it possible to identify cerebral hemorrhages which are causes of death?

Grades of recommendations:
C1 for evaluating the condition
C2 for determining the cause of death

The usefulness of clinical CT in the diagnosis of cerebral hemorrhages has been established, and postmortem CT also show good ability to detect bleeding in the acute phase and is often in agreement with autopsies. Antemortem CT is a poor prognostic factor for cerebral hemorrhages, brain stem hemorrhages, high-volume hematomas, intraventricular hemorrhages, hydrocephalus/ventricular compression, midline-shift, heterogeneous hematomas, and edema around hematomas have been reported. These are the results of research on antemortem CT, and further investigation is needed to determine whether the findings of research on antemortem CT can be directly applied to postmortem CT.

Explanation----------
Usefulness of postmortem CT in interpretation of cerebral hemorrhages

The usefulness of clinical CT for interpretation of cerebral hemorrhages has been established. Hemorrhages in the acute phase are visualized as high attenuation areas compared to brain parenchyma, and the same holds true in postmortem CT [1]. Here, we will discuss intrinsic cerebral hemorrhages (intracerebral hemorrhages) including hypertensive cerebral hemorrhages.

Contrast/concordance rates between postmortem CT and autopsy findings of cerebral hemorrhages

In a study comparing postmortem CT and autopsies, multiple cases of cerebral hemorrhages on postmortem CT confirmed by autopsies have been reported [2-8].

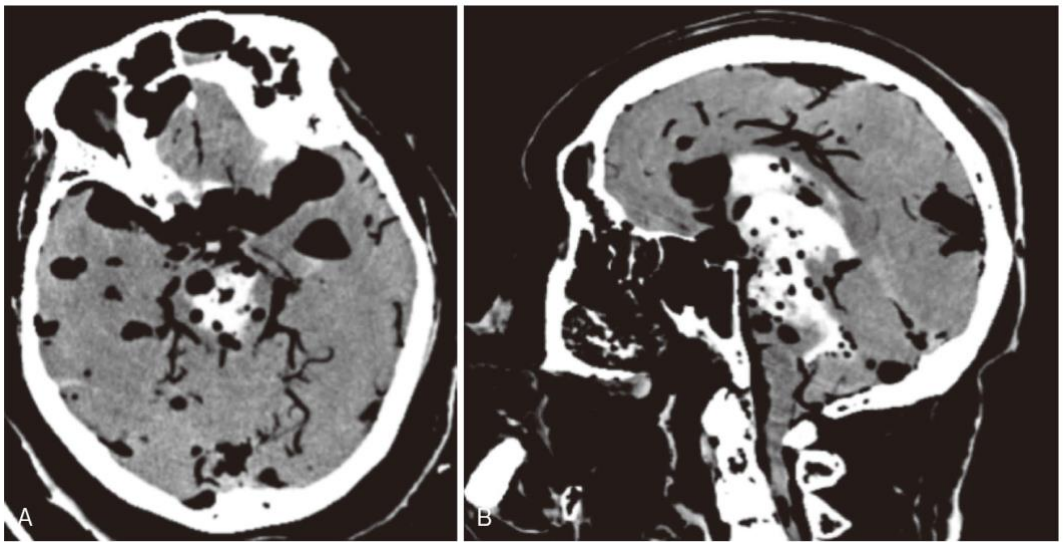
A study retrospectively examined whether postmortem CT could prove the cause of death in 339 cases where the cause was confirmed by autopsy. All 6 cases of fatal cerebral hemorrhages detected by postmortem CT were consistent with autopsy findings, and it was reported that the cause of death could be diagnosed [2]. In a study comparing autopsy findings of 13 patients and interpretations of postmortem CT by non-radiologists, interpretation of bleeding (2 out of 13 cases) on postmortem brain CT was also reported in the non-radiologist interpretations, which were in close agreement with autopsy findings [9].

There is a blinded study which compared autopsy findings and CT interpretations (by radiologists) in 203 patients with postmortem CT and autopsy findings of the head. The agreement rate between postmortem CT and autopsies was poorer for cerebral hemorrhages than with subarachnoid and

intraventricular hemorrhages. However, the subject of this study also included microscopic, non-lethal bleeding that could only be detected by an autopsy [10]. A study examining the diagnostic usefulness of postmortem CT/MRI and autopsies for multiple intracranial findings showed that postmortem CT/MRI had a sensitivity of 63% for intracranial bleeding, and postmortem CT for intraventricular hemorrhages had accuracies of 100% and postmortem MRI 80% [11].

There is also a report of highly decomposed cases where fatal cerebral hemorrhage was detected by postmortem CT. A few days after death, the hematoma attenuation increases due to aggregation. After that, due to factors such as dispersion of hematoma components, the attenuation of hematomas is said to decrease [12].

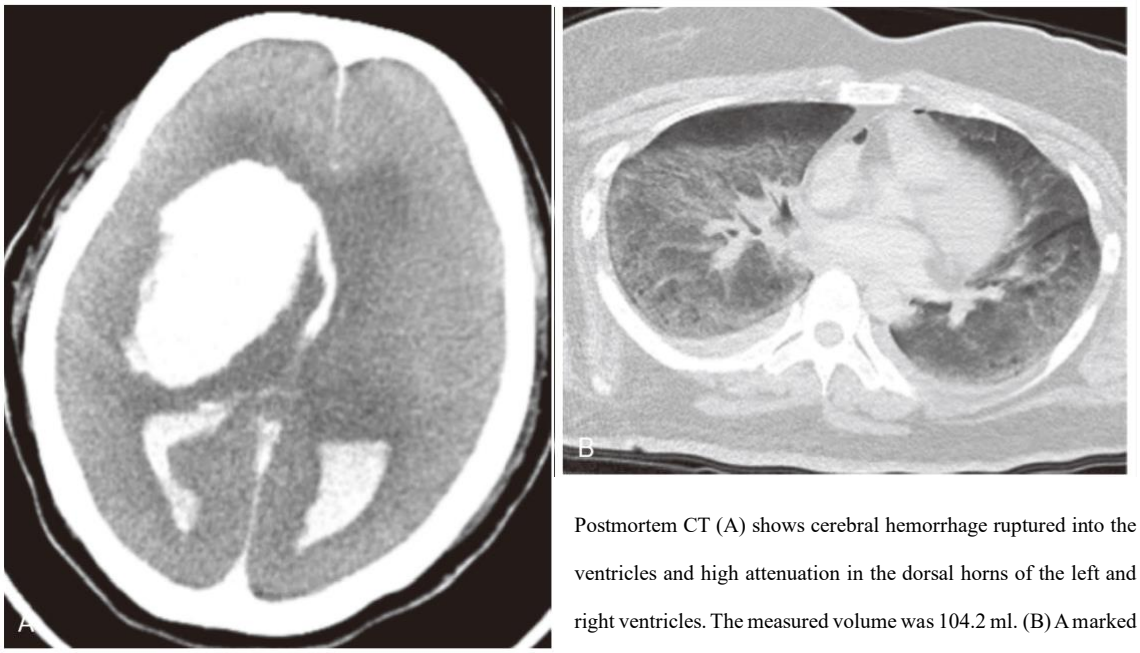
Figure 1 Brain stem bleeding (about 1 month after death)



A gas accumulation is centered inside the cerebral arteries and veins and confirmed by putrefaction.

Postmortem CT axial images (A) and sagittal images (B) show high attenuation from the brain stem pons to the midbrain and fornix.

Figure 2 Right brain thalamic hemorrhage



Postmortem CT (A) shows cerebral hemorrhage ruptured into the ventricles and high attenuation in the dorsal horns of the left and right ventricles. The measured volume was 104.2 ml. (B) A marked ground glass opacity was observed in both lungs, and pleural effusion was observed [(B)].

Findings that can be considered fatal with cerebral hemorrhages

There is a large number of studies on prognostic factors in cerebral hemorrhages in antemortem head CT. The following factors have been reported as prognostic factors on clinical CT associated with early death after the onset of cerebral hemorrhages; brain stem hemorrhages [13], high-volume hematomas [13-17], intraventricular hemorrhages [13, 14], hydrocephalus/ventricular compression [13], midline-shift [13, 17], heterogeneous hematomas [18-20], and edema around hematomas [21-23]. Edema around hematomas was not an independent factor for a poor prognosis in some studies [24]. There are also multiple reports that point to the relationship between the "ICH score (Glasgow coma scale, hematoma size, infratentorial origin of hemorrhage, intraventricular hemorrhage, and age of onset)", which is a score that combines CT findings and clinical findings [15, 25, 26]. Regarding the volume of hematomas, many studies suggest that bleeding of more than 30 cm^3 or (for cerebral lobe and subcortical hemorrhages) bleeding of more than 40 cm^3 has a poor rate of prognosis [17]. According to the ICH score, a hematoma of 30 cm^3 or more is considered as a factor in a poor prognosis [13, 17, 26].

However, regarding postmortem CT, there are no quantitative studies on what findings would have been fatal. Most of the research on antemortem CT has focused on findings at the onset of bleeding, and there is no definitive agreement on whether findings such as the characteristics of the hematoma or peri-hematoma edema, in particular, will be maintained on postmortem CT. Further study is needed on whether the research results from clinical CT can be applied to postmortem CT.

Column----------

In this CQ, we have used the following search formulas to search for articles and address the literature on intrinsic cerebral hemorrhages. However, caution is required when interpreting the postmortem CT to determine whether a hemorrhage is intrinsic or extrinsic. At the time of writing this guideline, there were no studies that indicated that postmortem head CT findings alone could be used to determine whether a cerebral hemorrhage was intrinsic or extrinsic. In determining whether a cerebral hemorrhage is trauma induced or not, the presence or absence of concomitant trauma findings, such as bone fracture or subdural/epidural hematomas, is important, and a comprehensive evaluation based on clinical information and the presence or absence of injury timing is necessary.

Literature search formula and literature selection (2019/5/12)

PubMed (2000-2019)

1) Diagnostic ability of fatal cerebral hemorrhage on postmortem CT

#	Search formula	Number of documents
1	(("postmortem" or "post-mortem" or "post mortem" or "forensic" or "pre-autopsy" or "autopsy")and("CT" or "computed tomography" or "MDCT" or "MSCT" or "neuroimaging"))or "minimally invasive autopsy" or "virtopsy" or "autopsy imaging"	6,875
2	“cerebral” or “intracranial” or “cranial” or “brain” or “head”	1,379,348
3	“hyperattenuation” or “high attenuation” or “hyperdense” or “high density”	62,956
4	“hematoma” or “bleeding” or “hemorrhage”	250,867
5	(#1 and #2 and #3)or(#1 and #2 and 4)	332

2) Factors of poor prognosis on head CT in cerebral hemorrhage

#	Search formula	Number of documents
1	“mortal” or “mortality” or “fatal” or “death” or “prediction” or “outcome”	2,573,382
2	“intracerebral hemorrhage” or “cerebral hemorrhage”	19,232
3	"computed tomography" or "CT"	419,480
4	#1 and #2 and #3	1,407

Ichushi（Medical Journal）

#	Search formula	Number of

		documents
1	(死後CT or 死亡時画像診断 orオートプシーイメージング)and(LA=日本語,英語 PT= 会議録除く)	516
2	(頭部 or 頭蓋内 or 脳)and(LA= 日本語, 英語 PT= 会議録除く)	439,002
3	(出血 or 血腫)and(LA= 日本語, 英語 PT= 会議録除く)	160,665
4	#1 and #2 and #3	59

From other than search formula

[5, 26]

References

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[2] Kasahara S et al: Diagnosable and non-diagnosable causes of death by postmortem computed tomography: a review of 339 forensic cases. Leg Med 2012; 14: 239-245 (Level 4b)

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