CQ27: Should all high-density areas observed in the cranium on postmortem head CT be interpreted as intracranial hemorrhage?

Recommendation Grade: C2

On postmortem head CT, high-density areas may appear due to postmortem changes or non-hemorrhagic conditions and may mimic true bleeding. For example, postmortem hypostasis can cause high attenuation in dependent dural venous sinuses. In cases of diffuse cerebral swelling or cerebral edema, high-density areas may appear in the cerebral sulci or basal cisterns—resembling subarachnoid hemorrhage (pseudo-subarachnoid hemorrhage; pseudo-SAH). There have also been reports of foreign materials presenting with attenuation values similar to hemorrhage. Careful interpretation is required to distinguish these findings from true intracranial hemorrhage.

Explanation

● Background

The utility of head CT in detecting intracranial hemorrhage is well established in clinical practice. While acute to subacute hemorrhages appear as high-density areas on CT, postmortem CT may also show high-density regions due to normal postmortem changes or other non-hemorrhagic conditions. Therefore, it is essential to differentiate these from true intracranial hemorrhage.

● Intracranial High-Density Areas as Postmortem Changes

In postmortem CT, blood settling due to gravity (postmortem hypostasis) commonly results in high attenuation within dependent blood vessels. Within the cranium, this manifests as increased density in venous sinuses, especially the dorsal portion of the superior sagittal sinus[1–5] (see also CQ2). According to a study on normal postmortem changes observed with whole-body CT and MRI in in-hospital deaths, high attenuation in the superior sagittal sinus due to hypostasis was present in 96% of cases[6]. A comparative study of 50 cases with both antemortem and postmortem head CT showed a significant increase in CT values in the dorsal part of the superior sagittal sinus after death compared to antemortem scans. The same study noted that this increase was particularly marked in cases with prominent postmortem hypostasis of the heart and great vessels[4]. In a pediatric case where postmortem CT showed high attenuation in the cerebellar tentorium, autopsy revealed no subdural or subarachnoid hemorrhage; rather, the hyperdensity corresponded to congestion in the cerebellar tentorium[7].

● Pseudo-Subarachnoid Hemorrhage (Pseudo-SAH) Due to Cerebral Edema

In conditions involving cerebral edema and swelling—such as hypoxic-ischemic encephalopathy and acute cerebral infarction—high-density areas may appear in the cerebral sulci and basal cisterns. This phenomenon is known as pseudo-subarachnoid hemorrhage (pseudo-SAH)[8–12]. A quantitative study of 168 in-hospital autopsy cases found that the diagnostic performance of postmortem CT for

subarachnoid hemorrhage (SAH) showed a sensitivity of 95.2% and specificity of 94.6%. Among 28 cases in which SAH was suspected on postmortem CT, 8 were determined to be pseudo-SAH[11]. According to the same study, helpful indicators for distinguishing true SAH from pseudo-SAH on postmortem CT include: asymmetrical distribution of SAH findings, coexisting fresh hemorrhage in the ventricles or brain parenchyma, and the presence of thick, high-density regions—all of which suggest true SAH.

● Artifacts on Head CT

As with conventional antemortem CT, CT-specific artifacts on postmortem imaging may resemble hemorrhage. A study investigating the diagnostic performance of postmortem CT for extra-parenchymal intracranial hemorrhage reported false-positive findings of epidural, subdural, and subarachnoid hemorrhages due to edge gradient effects caused by pneumocephalus, dental metal artifacts, and beam hardening artifacts[13].

● Epidural Blood Accumulation in Burned Bodies (see CQ47)

In burned bodies, elevated intracranial temperature may cause contraction of the dura mater and rupture of the venous sinuses, leading to epidural blood accumulation—commonly referred to as "thermal hematoma"—which must be differentiated from trauma-induced epidural hemorrhage[14].

● Other High-Density Structures

As with antemortem CT, intracranial calcified lesions (e.g., tumors, ectopic calcification) may mimic hemorrhage. In one traffic accident fatality, a calcified meningioma was initially misinterpreted as a hemorrhage[15]. A unique postmortem CT finding involved high-density polymer material used during postmortem body care to prevent cranial fluid leakage, which had entered the ventricles and appeared hyperdense on imaging[16]. Another reported case involved numerous hyperdense foci in the subarachnoid space on postmortem head CT of a traffic accident fatality, which were identified—via autopsy and X-ray fluorescence analysis—as residual oil-based contrast material used in myelography[17]. Although oil-based myelography has not been performed since the early 1980s, caution is warranted in individuals who may have undergone such procedures in the past.

○ Literature Search Strategy and Selection (as of July 30, 2023)

【PubMed】

#	Search formula	Number of articles
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" Filters: from 2000-2023	11,544

2	"cerebral" or "intracranial" or "cranial" or "brain" or "head"	1,953,433
3	"hyperattenuation" or "high attenuation" or "hyperdense" or "high density"	88,306
4	"hematoma" or "bleeding" or "hemorrhage"	350,585
5	(#1 and #2 and #3) or (#1 and #2 and 4)	531

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

#	Search formula	Number of articles
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)	767
2	(頭部 or 頭蓋内 or 脳)and(LA=日本語,英語 PT=会議録除く)	494,280
3	(出血 or 血腫)and(LA=日本語,英語 PT=会議録除く)	190,127
4	#1 and #2 and #3	75

●Additional Sources Not Captured by the Search Strategy

References［3］, ［12］, ［13］, ［14］

■References

1) Smith AB et al：Common and expected postmortem CT observations involving the brain：mimics of antemortem pathology. AJNR 2012；33：1387-1391（level 5）
2) Yen K et al：Post-mortem forensic neuroimaging：correlation of MSCT and MRI findings with autopsy results. Forensic Sci Int 2007；173：21-35（level 4b）
3) Levy AD et al：Postmortem imaging：MDCT features of postmortem change and decomposition. Am J Forensic Med Pathol 2010；31：12-17（level 5）
4) Takahashi N et al：Quantitative analysis of intracranial hypostasis：comparison of early postmortem and antemortem CT findings. AJR Am J Roentgenol 2010；195：W388-393（level 4b）
5) Christe A et al：Clinical radiology and postmortem imaging（ virtopsy）are not the same：specific and unspecific postmortem signs. Leg Med 2010；12：215-222（level 5）
6) Wagensveld IM et al：Total-body CT and MR features of postmortem change in in-hospital deaths. PLoS One 2017；12：e0185115（level 4b）
7) Kibayashi K et al：Dural hemorrhage of the tentorium on postmortem cranial computed tomographic scans in children. Forensic Sci Int 2005；154：206-209（level 5）
8) Chute DJ et al：Pseudo-subarachnoid hemorrhage of the head diagnosed by computerized axial tomography：a postmortem study of ten medical examiner cases. J Forensic Sci 2002；47：360-365（level 5）

9) Given CA 2nd et al：Pseudo-subarachnoid hemorrhage：a potential imaging pitfall associated with diffuse cerebral edema. AJNR Am J Neuroradiol 2003；24：254-256（level 5）
10) Misra V et al：Pseudo-subarachnoid hemorrhage in a patient with acute cerebellar infarction. Neurol Res 2008；30：813-815（level 5）
11) Shirota G et al：The pseudo-SAH sign：an imaging pitfall in postmortem computed tomography. Int J Leg Med 2017；131：1647-1653（level 4b）
12) Yuzawa H et al：Pseudo-subarachnoid hemorrhage found in patients with postresuscitation encephalopathy：characteristics of CT findings and clinical importance. AJNR Am J Neuroradiol 2008；29：1544-1549（level 4b）
13) Añon J et al：Traumatic extra-axial hemorrhage：correlation of postmortem MSCT, MRI, and forensic-pathological findings. J Magn Reson Imaging 2008；28：823-836（level 4b）
14) Coty JB et al：Burned bodies：post-mortem computed tomography, an essential tool for modern forensic medicine. Insights Imaging 2018；9：731-743（level 5）
15) Qian H et al：Subtentorial meningioma misdiagnosed as cerebral hemorrhage in postmortem computed tomography imaging：a case report. Am J Forensic Med Pathol 2017；38：103-106（level 5）
16) Kanazawa A et al：New pitfalls of high-density postmortem computed tomography. Leg Med 2014；16：297-299（level 5）
17) 田中直子ほか：油性造影剤遺残の 1 例．法医病理 2017；23：29-32（level 5）