CQ 1: What morphological, attenuation, or signal changes are observed as postmortem changes on CT or MRI?

Recommendation Grade: C2

In the brain, postmortem CT may show swelling and loss of the gray-white matter distinction. The heart tends to appear enlarged, with thickening and increased density of the ventricular walls. The aorta often shows narrowing of the vascular lumen and thickening of the vessel wall. Dilatation of the right atrium, right ventricle, and superior vena cava is also frequently observed. Additionally, the adrenal glands, kidneys, and spleen are reported to decrease in volume after death.

Explanation

● Postmortem Changes in the Brain

Regarding changes in attenuation values on postmortem CT of the brain, several studies have examined the loss of contrast between white and gray matter and blurred gray-white differentiation. One study comparing CT images taken before and immediately after death in the same patient reported that the attenuation of gray matter decreased after death.[1] This blurring of the gray-white boundary may occur due to cytotoxic edema, where increased water content lowers the attenuation of gray matter. Alternatively, ischemia-induced intracranial pressure elevation and venous congestion may lead to increased attenuation of white matter.

As for morphological changes in the brain observed on postmortem CT, the findings vary. In a study focused on sudden deaths, brain swelling was not clearly observed in CT scans taken immediately after death.[1] In contrast, a study on in-hospital deaths reported that brain swelling was relatively common in postmortem CT cases.[2] No clear correlation has been found between postmortem interval and brain swelling. Therefore, it is often difficult to determine whether the swelling occurred during the agonal phase or after death. Furthermore, brain swelling may have already been present before death, such as in cases of hypoxic-ischemic encephalopathy, making it challenging to pinpoint exactly when the swelling began.

● Postmortem Changes in the Heart

After death, the heart tends to appear enlarged on CT.[3] Particularly, dilatation of the right atrium and right ventricle is commonly observed.[4] At the same time, the myocardial walls become more contracted after death, leading to apparent thickening on postmortem CT[5] and a slight increase in attenuation values.[6] These changes are thought to result from rigor mortis. Compared with antemortem CT, the cardiothoracic ratio is reported to increase on postmortem CT.[3] This enlargement is influenced not only by postmortem cardiac changes but also by the fact that postmortem CT is typically performed in an expiration-like state.

● Postmortem Changes in the Aorta and Major Veins

On postmortem CT, the aortic wall often appears hyperdense.[7] Comparisons with antemortem CT in the same individuals have shown that the aortic wall tends to be thicker on postmortem CT.[8] In addition, the diameter of the aorta tends to decrease after death.[9] Distal to the abdominal aorta, collapse or flattening of the vessel may be seen—especially in elderly individuals. This flattening is thought to be due in part to reduced elastic fibers in the tunica media, which is more pronounced with aging.[9] Meanwhile, because intravascular pressure after death corresponds to the mean circulatory filling pressure, the superior vena cava, like the right atrium, tends to appear dilated.[4]

In contrast, postmortem changes in the inferior vena cava are usually less prominent.[10]

● Postmortem Changes in the Upper Abdominal Organs

There have been studies comparing postmortem CT and antemortem CT in the same individuals, focusing on organs such as the adrenal glands, kidneys, and spleen. The adrenal glands tend to show reduced volume on postmortem CT. This may reflect a decrease in intracellular fat, as suggested by pathological findings.[11] Both the kidneys and spleen have also been reported to decrease in volume after death.[12] [13] Particularly, in cases involving hemorrhage, the spleen showed a marked volume reduction.[12] Additionally, one study reported that the attenuation value of the spleen was higher on postmortem CT compared to antemortem CT.[13]

Column: Postmortem Brain Imaging Findings Are Influenced by Multiple Factors

Postmortem CT findings of the brain may show reduced parenchymal attenuation and narrowing of the cerebral sulci, similar to what is seen in hypoxic-ischemic brain injury. However, these findings are not always present. Many factors influence the appearance of the brain on postmortem CT, including the postmortem interval, underlying medical conditions, and circumstances at the time of death. Therefore, morphological and attenuation changes in the brain on postmortem CT can vary significantly between cases, and should be interpreted with caution.

As for postmortem MRI, similar structural changes as those seen on CT are thought to be visualized, but research in this area is still limited. Moreover, MRI signal intensity is believed to be more sensitive to environmental factors—such as the ambient temperature where the body is stored—leading to even greater visual variability than CT attenuation values.

○ Literature Search Strategy and Selection (as of November 9, 2023)

【PubMed】

#	Search formula	Number of articles
1	((((((((((postmortem) OR post-mortem) OR "post mortem")) AND imaging)) OR (((((postmortem) OR post-mortem) OR "post mortem"))	23,704

	AND CT)) OR (((((postmortem) OR post-mortem) OR "post mortem")) AND "computed tomography")) OR (((((postmortem) OR post-mortem)OR "post mortem")) AND MR)) OR (((((postmortem) OR post-mortem)OR "post mortem")) AND "magnetic resonance"))) OR (((((postmortem)OR post-mortem) OR "post mortem")) AND MDCT)) OR ((MSCT) AND(((postmortem) OR post-mortem) OR "post mortem")))	
2	(change) AND #1	5,901

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

#	Search formula	Number of articles
1	(死後 CT/AL or 死後 MRI/AL or (死亡時画像診断/TH or 死亡時画像診断/AL) or (死亡時画像診断/TH or オートプシーイメージング/AL)) and (LA=日本語, 英語 and PT= 会議録除く)	785
2	(変化) and #1	136

■References

1） Takahashi N et al：Quantitative analysis of brain edema and swelling on early postmortem computed tomography：comparison with antemortem computed tomography. Jpn J Radiol 2010；28：349-354（level4b）

2） Shirota G et al：Brain swelling and loss of gray and white matter differentiation in human postmortem cases by computed tomography. PLoS One 2015；10：e0143848（level4b）

3） Okuma H et al：Comparison of the cardiothoracic ratio between postmortem and antemortem computed tomography. Leg Med 2017；24：86-91（level4b）

4） Shiotani S et al：Dilatation of the heart on postmortem computed tomography （PMCT）：comparison with live CT. Radiat Med 2003；21：29-35（level5）

5） Okuma H et al：Heart wall is thicker on postmortem computed tomography than on antemortem ［corrected］ computed tomography：the first longitudinal study. PLoS One 2013；8：e76026（level4b）

6） Okuma H et al：Comparison of attenuation of striated muscle between postmortem and antemortem computed tomography：results of a longitudinal study. PLoS One 2014；9：e111457（level4b）

7） Shiotani S et al：Hyperattenuating aortic wall on postmortem computed tomography（PMCT）. Radiat Med 2002；20：201-206（level5）

8） Okuma H et al：Greater thickness of the aortic wall on postmortem computed tomography compared with antemortem computed tomography：the first longitudinal study. Int J Legal Med

2014；128：987-993（level4b）
9） Takahashi N et al：Changes in aortic shape and diameters after death：comparison of early postmortem computed tomography with antemortem computed tomography. Forensic Sci Int 2013；225：27-31（level4b）
10) Hyodoh H et al：Vascular measurement changes observed using postmortem computed tomography. Jpn J Radiol 2012；30：840-845（level4b）
11）Ishida M et al：Early postmortem volume reduction of adrenal gland：initial longitudinal computed tomographic study. Radiol Med 2015；120：662-669（level4b）
12）Takahashi N et al：Postmortem volume change of the spleen and kidney on early postmortem computed tomography：comparison with antemortem computed tomography. Jpn J Radiol 2019；37：534-542（level4b）
13）Okuma H et al：Comparison of volume and attenuation of the spleen between postmortem and antemortem computed tomography. Int J Legal Med 2016；130：1081-1087（level4b）