CQ 4: What imaging findings on postmortem CT or MRI suggest decomposition or autolysis?

Recommendation Grade:

Decomposition: C1

Autolysis: C2

Decomposition is typically associated with widespread gas formation throughout the organs, which can be clearly visualized on CT. However, gas can also be produced by other causes or during earlier postmortem stages, so differential diagnosis is necessary.

Gastrointestinal perforation caused by autolysis of the stomach may sometimes be distinguishable on imaging. On the other hand, autolysis in organs such as the pancreas and adrenal glands may result in minimal imaging changes, making diagnosis more challenging.

Explanation

● Decomposition and Autolysis

Decomposition, a late postmortem change, refers to the anaerobic breakdown of proteins and organic substances in the human body into simpler organic compounds, primarily due to the activity of microorganisms—particularly putrefactive bacteria of both endogenous (commensal) and exogenous origin. This process is initiated and sustained by various intestinal and environmental bacteria, which primarily proliferate within the blood vessels. The progression of decomposition is heavily influenced by temperature, humidity, and air circulation. Putrefactive gases, produced by anaerobic bacteria, first accumulate within the intestinal tract, and then progressively extend into the abdominal cavity, solid organs, and subcutaneous tissues.[1] In contrast, autolysis is a sterile, anaerobic process in which the body's own enzymes break down tissues after death, independent of bacterial activity. This section outlines the characteristic postmortem CT findings associated with decomposition and autolysis, organized by organ and tissue type.

● Systemic Changes

As the postmortem interval progresses, CT attenuation increases in dependent areas of fluid accumulation and soft tissues due to gravitational settling of blood, and also in dependent regions of blood vessels due to sedimentation of blood cells.[2] In the advanced stages of postmortem change (late postmortem phase), putrefactive gas becomes visible in vessels and organs throughout the body, and is readily detectable on postmortem CT. The production of gas is influenced by environmental factors such as temperature and humidity, but gas can continue to accumulate even when the body is stored in refrigerated conditions.[3] Gas related to decomposition typically shows a symmetrical distribution throughout the body.[4] In traumatic deaths, localized gas may be seen around open wounds, but extensive gas formation can also occur in non-traumatic deaths, which requires careful interpretation.[5]

When large amounts of gas are observed in the right heart, this suggests advanced systemic decomposition.[6] There are case reports of decomposed bodies of diabetic patients who died of sepsis, where gas-producing bacteria such as Escherichia coli, Klebsiella, and Clostridium species led to intravascular gas and gas within hepatic abscesses.[7]

● Central Nervous System

Autolysis of the brain parenchyma begins in the early postmortem period, leading to loss of contrast between gray and white matter and blurring of the cerebral sulci and ventricles.[2 8 9] These changes can become visible on CT within 6 hours after death.[2] As decomposition progresses, additional findings may include collapse of the brain parenchyma, gas accumulation within the cranial cavity and spinal canal, and eventually liquefaction of brain tissue.[8 10 11] Even in advanced decomposition, MRI may still allow partial assessment of the anatomical structure of the brain.[12] Furthermore, in cases where the patient experienced prolonged cerebral ischemia before death, autolytic changes may already be underway at the time of death, and brain softening may be seen very early postmortem. This should be taken into consideration during interpretation.

● Cardiovascular System

Gas accumulation is frequently observed in the right heart, particularly in the right atrium.[6 8 10] Cardiac chamber enlargement and gas within the myocardium may also be seen.[10] As decomposition progresses, intravascular gas tends to spread throughout the venous system, although there is usually little distinction between arteries and veins in terms of gas distribution.[6 8] Gas within the arterial system can result not only from decomposition, but also from mechanisms such as exsolution of dissolved gases in the blood or barotrauma.[13 14] Intravascular gas can also be observed in postmortem CT of children, similar to adults.[13] Gas caused by putrefaction typically shows widespread distribution, which differs from the more localized pattern seen with air embolism.[4 15] There are also reports of intravascular gas detected in the early postmortem period, suggesting that not all gas is due to decomposition—bacteremia before death may be a possible cause, and careful differentiation is needed.[16]

● Respiratory System

Even in the early postmortem period, prior to visible decomposition, fluid accumulation in the airways, pulmonary edema, and pleural effusion are frequently observed.[8 13 17]

Pulmonary congestion can sometimes be difficult to distinguish from antemortem conditions, such as pneumonia or interstitial lung disease.[18]

However, these findings do not necessarily indicate decomposition or autolysis.

● Gastrointestinal System

As decomposition progresses, gas appears within the intestinal walls and mesenteric veins, eventually leading to free intraperitoneal gas and bowel dilation.[2 8 13 19]

The stomach is particularly prone to autolysis. After death, the gastric mucosa is digested by pepsin

in the gastric juices, leading to thinning of the gastric wall and potentially resulting in perforation.[1] There are reports of free intraperitoneal gas on postmortem CT caused by gastric perforation due to autolysis.[20] In cases of postmortem gastrointestinal perforation due to autolysis, gas may be observed along the abdominal wall, or within the cardiac chambers or liver on CT.[20] When free intraperitoneal gas is detected on postmortem CT, one potential clue that suggests antemortem gastrointestinal perforation—rather than postmortem autolysis—is the absence of other typical decomposition-related gas findings, such as widespread putrefactive gas elsewhere in the body. This distinction is important for differentiating autolytic perforation from a true antemortem gastrointestinal perforation.[20]

● Body Cavities and Retroperitoneum

Pleural and peritoneal effusions can be observed early in the postmortem period.[10] As decomposition advances, extensive gas formation occurs within both the thoracic and abdominal cavities.[8 10 13] Putrefactive fluid may show a wide range of CT attenuation values, from approximately −130 to +80 HU, which can sometimes lead to misinterpretation as hemorrhage.[21]

● Solid Organs

Gravitational settling of blood may result in layered distribution of blood components within solid organs, but such changes are difficult to evaluate on postmortem imaging.[17 18] In the liver, gas in the portal vein may be observed, often extending into the liver parenchyma.[2 22–25] The amount of gas tends to increase over time after death,[23 26] and although putrefaction is suspected as the cause, this has not been definitively proven. One study on the temporal changes in intrahepatic gas on postmortem CT reported that gas gradually became prominent in the left lobe, but did not increase in the posterior segment of the right lobe.[22] Another report noted that intrahepatic gas was first seen in the portal vein, and if portal venous gas was absent, gas was not observed in other hepatic veins.[23] On postmortem CT, gas is commonly seen not only in the liver, but also in multiple organs.[5 16 19] Although longer postmortem intervals tend to be associated with gas in multiple organs, the correlation is not definitive.[16] Intrahepatic gas has also been reported on postmortem MRI.[27]

The hepatobiliary system is considered a common initial site of decomposition.[4] The pancreas and adrenal glands undergo early autolysis, but often show minimal changes on postmortem imaging.[1 2 4 28]

● Bones and Soft Tissues

Emphysematous changes in the subcutaneous soft tissues tend to spread with the progression of decomposition, and are particularly prominent in the skeletal muscles and periscrotal region.[8 10]

◯ Literature Search Strategy and Selection (February 12, 2024)

【PubMed】

#	Search formula	Number of articles

1	((((((((((postmortem)OR post-mortem)OR "post mortem"))AND imaging))OR(((((postmortem)OR post-mortem)OR "post mortem"))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"))	31,184
2	putrefaction OR autolysis OR decomposition	82,931
3	#1 and #2	264

【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)	5,100
2	(死亡時/AL) and ((FT=Y) and PT=原著論文,会議録除く and CK=ヒト)	990
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)	369,108
4	((X 線 CT/TH or X 線 CT/AL)) and ((FT=Y) and PT=会議録除く and CK=ヒト)	146,742
5	((MRI/TH or MRI/AL)) and ((FT=Y) and PT=原著論文,会議録除く and CK=ヒト)	116,691
6	(#1 or #2) and (#3 or #4 or #5)	1,493
7	(腐敗/AL or 自己融解/AL or 自家融解/AL) and (X 線 CT/TH or CT/AL)	3,652
8	#6 and #7	14

●Additional Sources Not Captured by the Search Strategy

References［16］, ［25］, ［26］

■References

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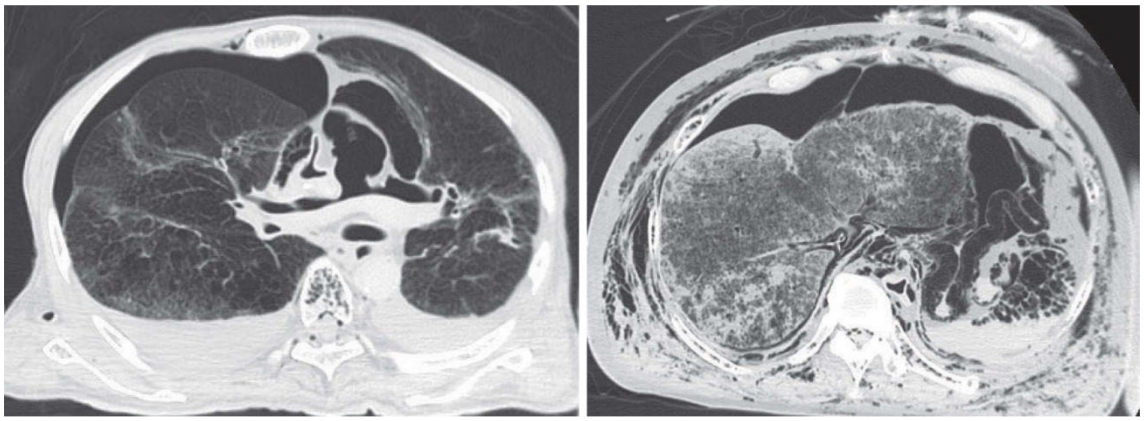

Figure. Left: Male in his 60s　Right: Male in his 60s (Different Case)

With decomposition, putrefactive gas spreads beyond the cardiovascular system, extending into the pleural cavity, peritoneal cavity, and subcutaneous connective tissues.

As decomposition progresses, gas also becomes evident within solid organs, causing the liver and spleen to appear spongiform due to gas accumulation—commonly referred to as "foamy liver/spleen".