CQ50. Is postmortem CT useful for diagnosing decompression illness?

Recommendation Grade

Assessment of condition: B

Determination of cause of death: C1

Postmortem CT is useful for evaluating the distribution of gas throughout the body, which is essential in the diagnosis of fatal decompression illness. However, interpretation requires caution. Gas may also be present due to causes other than decompression illness, such as postmortem off-gassing from intravascular dissolved gas following drowning or cardiac death in water, gas introduced by resuscitation procedures, or gas produced by decomposition. Since many of these types of gas increase with time after death, it is advisable to perform postmortem CT as early as possible—preferably within 48 hours, and ideally within 24 hours after death confirmation.

Explanation

● Background

Decompression illness refers to two distinct pathological conditions that arise when individuals who have been exposed to high-pressure environments, such as during diving operations, ascend rapidly. One is decompression sickness (DCS), in which nitrogen and other gases dissolved in the blood under high pressure form bubbles upon decompression, causing various disorders. The other is arterial gas embolism (AGE), which occurs when alveolar damage caused by decompression allows alveolar gas to enter the bloodstream, leading to embolism. These gas bubbles may obstruct capillaries, directly damage vascular structures, or provoke secondary inflammatory responses, resulting in a wide range of clinical symptoms. In severe cases, the central nervous system and cardiopulmonary systems may be affected, potentially leading to shock, cardiac arrest, and death[1–4]. Clinical reports have described a variety of imaging findings, ranging from mild cases that improve with hyperbaric oxygen therapy to fatal cases[5]. Traditionally, in autopsy cases of fatal decompression illness, findings such as pneumothorax, subcutaneous emphysema, and intravascular gas have been considered diagnostic hallmarks. Specialized techniques such as underwater autopsy have been attempted to demonstrate gas presence; however, accurately assessing the distribution of gas throughout the body has remained difficult[6].

In recent years, the use of imaging in postmortem investigations has increased, and postmortem CT (PMCT) has become recognized for its high sensitivity in detecting gas. As a result, PMCT is now regarded as an essential tool for ruling out fatal decompression illness[7–10]. When using PMCT to diagnose decompression-related fatalities, special caution is required. This is because gas can also be detected in cases unrelated to decompression illness, such as postmortem off-gassing (gas formation from intravascular dissolved gases following in-water deaths due to drowning or cardiac events), gas from resuscitation efforts, or gas produced during decomposition. Furthermore, many of these gases tend to increase proportionally with the postmortem interval[11]. Therefore, in suspected decompression illness cases, whole-body postmortem CT should be performed as early as possible after death—ideally within 24 hours and no later than 48 hours—to avoid confounding effects from decomposition gases. When appropriate, gas analysis may also contribute to more accurate evaluation of the condition.

● Characteristic Postmortem CT Findings in Fatal Decompression Illness

A case-control study involving 18 autopsy cases of individuals who died in diving accidents, all of whom underwent postmortem CT within 72 hours of death, reported the following findings:

(1) When the cervical major arteries were completely filled with gas and gas was also observed in the left ventricle, the negative predictive value for decompression illness was 100%, and the positive predictive value was 70%. This finding was identified as the most useful CT feature for diagnosing fatal decompression illness when postmortem CT was performed within 24 hours of death.

(2) The classical triad of decompression sickness—pneumothorax, subcutaneous emphysema, and intravascular gas—was found to be nonspecific for diagnosis[11].

In another report involving six cases of deaths that occurred during diving, measurement of intracardiac CO_2 concentrations was conducted in addition to postmortem CT. The cases suspected of death due to decompression illness showed slightly higher CO_2 concentrations compared to those suspected to have died from other causes such as drowning, suggesting the potential utility of CO_2 concentration in diagnosis[12]. Furthermore, in a case-control study involving 32 cases, including 10 deaths during scuba diving, most of the diver cases showed the presence of gas in the left ventricle and arteries. The average gas volume measured by semiquantitative analysis was higher than that in the control group. It was concluded that postmortem CT performed within 24 to 48 hours of death could be useful for diagnosing decompression illness when gas is absent in the portal vein and subcutaneous tissues, and when moderate or greater amounts of arterial gas are detected in semiquantitative analysis[13].

Other case reports have also contributed to the understanding of decompression illness. As early as 1983, gas was identified on head CT, plain chest X-rays showed gas in the right ventricle, and pulmonary angiography demonstrated gas in the pulmonary arteries, all of which were considered helpful in diagnosing decompression illness[14]. Subsequent studies have reported that postmortem CT and MRI provided superior evaluation of gas distribution in visceral organ vasculature compared to autopsy[15]; that postmortem CT was useful in assessing gas distribution and considering the cause of death in a case of sudden death during diving[16]; and that while postmortem CT is superior for macroscopic gas detection, histopathological evaluation at autopsy is useful for distinguishing whether the gas originated from decompression illness or from barotrauma-induced vascular injury in the pulmonary arteries after gas embolism. The combined use of both modalities has therefore been deemed meaningful[17].

◯ Literature Search Strategy and Selection (as of December 27, 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")) 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"))	31,033
2	((decompression) AND ((disease) OR (illness)OR(sickness))	23,649
3	#1 and #2	75
4	Scuba diving fatalities	150
5	#1 and #4	16

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

#	Search formula	Number of articles
1	((死亡時画像/AL) and ((FT=Y) and AB=Y)) or (((死後検査/TH or autopsy/AL) and imaging/AL) and ((FT=Y) and AB=Y) and (減圧症/AL)) or ((死後画像/AL) and ((FT=Y) and AB=Y))	294
2	(減圧症/AL)	1,787
3	#1 and #2	1

■References

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15) Plattner T et al：Virtopsy-postmortem multislice computed tomography （MSCT）and magnetic resonance imaging（ MRI） in a fatal scuba diving incident. J Forensic Sci 2003；48：1347-1355（level 5）
16) Dougherty S et al：Sudden death in a diver：a diagnostic conundrum. Wilderness Environ Med 2017；28：225-229（level 5）
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