CQ31 What are useful findings in postmortem images to determine pneumonia?

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

In the case of pneumonia, it is reported that postmortem CT showed segmental or multiple patchy consolidations. However, similar findings may occur due to postmortem changes (postmortem hypostasis), pulmonary congestion, pulmonary edema, and others. At present, there is an insufficient number of studies on postmortem images of pneumonia and no evidence is available to determine pneumonia from images.

Ventilated postmortem CT have been reported as a method to reduce the opacity caused by postmortem changes. However, no optimal methodology for ventilation has been established, and complications such as air leakage into the pleural cavity and dilation of the gastrointestinal tract have been reported.

Explanation----------

Postmortem changes in the lungs

For postmortem changes in the lungs on postmortem CT, it is known that a gravitationally dominant consolidation or ground-glass opacity (dependent density) appears, reflecting the gravitational movement of blood within the pulmonary vessels and the movement of water within the vessels into the interstitium and alveoli (CQ2). This is characterized by the formation of a horizontal level distinguishing two normal areas, and has been reported to correspond mainly to intralobular edema by histopathology [1-4]. Other postmortem changes in the lungs have not been adequately studied. When the body is placed in a horizontal supine position, the horizontal plane is at the same height (flat throughout). However, a predominantly gravitational opacity may be difficult to distinguish from aspiration pneumonia, pathological pulmonary edema, and others. The phenomenon of postmortem hypostasis may not be noticeable immediately after death or in the early postmortem period, but it expands with time after death. It has been reported that multiple CT scans over time show an increase in the area of elevated absorption due to intrapulmonary hypostasis [1, 5].

Diagnostic potential of pneumonia by postmortem CT

There is one descriptive study [6] that segmental or multiple patchy consolidation areas were identified on postmortem CT in pneumonia cases, but this study is not a comparative study of postmortem CT findings and pathological diagnosis. In addition, due to the following issues, careful consideration is required when diagnosing pneumonia by postmortem CT:

① Exclusion of cases of severe damage, chest injury, hemothorax/pneumothorax, massive pleural effusion, and putrefaction gas.

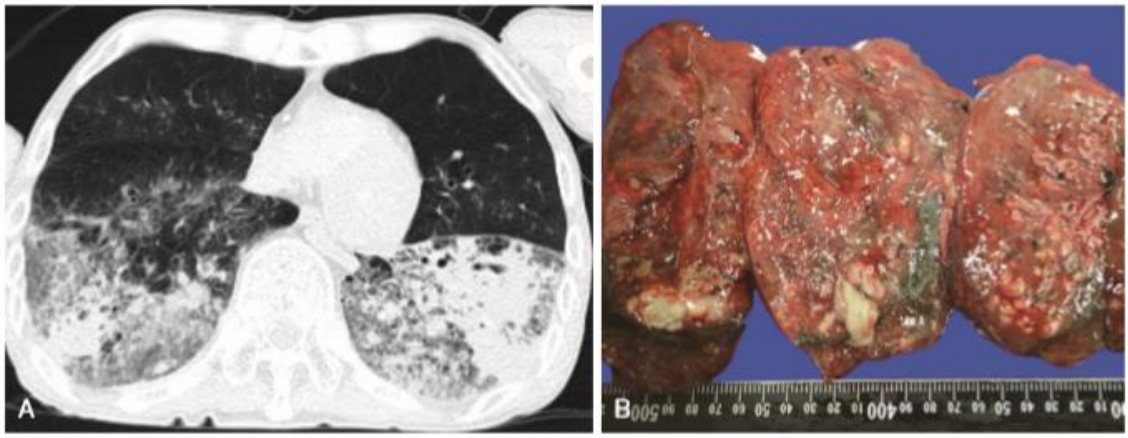
② No description of cases where there is laterality in the findings of the lungs,

③ The interval between the estimated time of death until the postmortem CT scanning is not detailed (the influence of postmortem changes due to hypostasis [1] is not taken into consideration).

According to a report that diagnosed the cause of death in adult death cases from postmortem images [7], when interpreted by a radiologist with no experience in postmortem CT, 32% of cases resulted in large discrepancies from the autopsy findings, and the same applied to bronchopneumonia.

In a study of non-traumatic death, cases where the cause of death is suspected as pneumonia showed more consolidation than other cases and less of dependent densities were observed. However, the findings of the lung were examined only for three matters: dependent density, ground glass opacity attenuation, and consolidation, and autopsy confirmation in this study was limited to 16 out of 150 cases [8].

Figure 1, Male in the 70s, pneumonia, found in his car

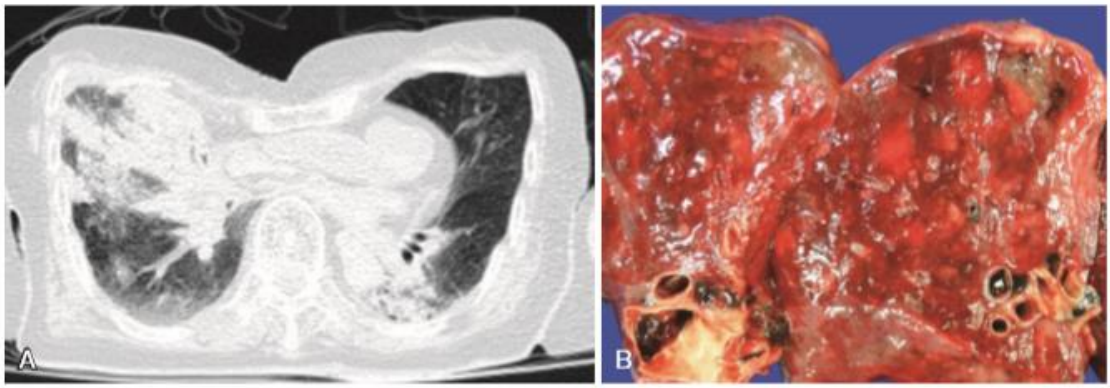


A CT: Consolidation is observed within the hypostasis of the lung field.

B Macroscopic findings: Right lower lobe. There is yellowish brown pus.

On the postmortem CT, the lungs change significantly with time, usually resulting in hypostasis (postmortem changes). Therefore, normally, the liquid accumulates on the gravity side of the position assumed after death, and the air content is reduced on the gravity side of the lung field. Postmortem CT will interpret the presence of pneumonia based on the site and a lung field concentration that differs from that of the hypostasis. Lung findings are affected by resuscitation (infusion and others), and the determination has to pay attention to observations (information) such as whether resuscitation has been attempted.

Figure 2, Female in the 80s, pneumonia, found in her room (resuscitation attempted)



A CT: The thoracic cavity is recessed and deformed. Consolidation different from hypostasis is observed in the upper right lobe. A ground glass opacity, considered to be a result of hypostasis, is observed on both dorsal sides.

B Macroscopic findings: Right upper lobe. There is spotted yellowish brown pus.

The position in which deceased was discovered (supine/prone) and whether there are conflicting findings in the distribution of pulmonary hypostasis in postmortem CT are matters to be confirmed by the image findings. If there is left-right difference in lung hypostasis, it is necessary to consider the mechanism of its occurrence. As in this example, in the case of a deceased without lung hypostasis on the left ventral side and hypostasis on both dorsal sides, there is no mechanism that can explain the consolidation of the right ventral lung as a normal postmortem change. Therefore, the organic pathology must be taken into consideration, and pneumonia and tumors can be differentiated. In this example, pneumonia was confirmed by the autopsy.

There is a study of 104 non-trauma in-hospital death cases (208 lungs) for which both postmortem CT and autopsies were obtained. Here, it was reported that the pneumonia group had a significantly higher frequency of opacities without a distinguishing plane formation, segmental consolidation/ground glass opacities, centrilobular nodules compared to the non-pneumonia group [9]. In a study comparing whole-body postmortem CT and autopsy results of children, there were multiple cases of pulmonary inflammation where the postmortem CT diagnosis and autopsy were not consistent [10].

A study comparing postmortem CT and autopsy findings of the lungs of infants, postmortem CT often show widespread increased attenuation due to atelectasis regardless of the cause of death, making it difficult to diagnose pneumonia here [11].

At present, it is difficult to estimate the cause of death because postmortem CT lung findings are often nonspecific.

Ventilated postmortem CT trials

Recently, studies with ventilated postmortem CT have been reported [12-14]. Ventilated postmortem CT observations are based on a method of mimicking breath-hold inspiratory scans in the living by using a ventilator through an endotracheal intubation tube, oral/nasal airway, and cricothyrotomy. It

has been reported that the use of ventilated postmortem CT reduces the opacities associated with horizontal plane formation, which is considered to be a postmortem change, and makes it easier to evaluate the presence or absence of pathological changes including pneumonia [13]. However, the optimal method for ventilated postmortem CT has not been established, and air leakage into the thoracic cavity and expansion of the gastrointestinal tract have been reported [12].

Column----------

There have been efforts to unify and standardize the expressions used in lung findings of chest CT. Here, we describe the definitions of postmortem changes of postmortem CT and the terms necessary for the interpretation of pneumonia. “Ground-glass opacity” refers to a generally uniform spread of a pale opacity where the internal pulmonary blood vessels can be recognized. “Consolidation” refers to the spread of a uniform and dense opacity in which the internal pulmonary blood vessels cannot be recognized. Air bronchogram is often seen inside, but this will be the result of the examination of antemortem CT, and is not always present in postmortem CT. The origin of the term consolidation comes from a description in autopsy specimens of pulmonary lesions with inflammatory cell infiltration due to pneumonia that are stiffer than in the normal aerated lung. It should be noted that consolidation in autopsy findings does not always match “consolidation” in postmortem pulmonary CT. Dependent opacity/density refers to the subpleural opacity on the gravity side caused by gravity dependent atelectasis. (Reference: Japan Society of Medical and Radiology, Chest Radiology Research Group: Imaging Guidelines for Diffuse Lung Disease 1998)

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

PubMed(2000-2019)

#	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 "minimally invasive autopsy" or "virtopsy" or "autopsy imaging"	5,564
2	“pneumonia” or “pneumonitis” or “lung" of "pulmonary"	165,615
3	#1 and #2	443

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	(肺 or 肺炎 or 胸部)and(LA=日本語,英語 PT=会議録除く)	345,984
3	#1 and #2	181

From other than search formula
[3, 9, 13, 14]

References

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[14] Rutty GN et al: Ventilated post-mortem computed tomography through the use of a definitive airway. Int J Legal Med 2015; 129: 325-334 (Level 4b)