Overview of physiological post-mortem alterations in total-body imaging of 100 in-hospital deceased patients

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Aims and objectives

The conventional autopsy serves many purposes in clinical medicine: it is an important quality control tool, it is used for education and research purposes and it gives accurate mortality statistics. (1) Despite the improvement of diagnostic tools available to clinicians, autopsies continue to show discrepancies between ante-mortem and post-mortem diagnosis. (2) However autopsy rates worldwide have gradually dropped over the last decades. (3,4)

A possible explanation for this could be the invasiveness of the conventional autopsy. As a response to the declining autopsy rate, post-mortem total-body imaging is steadily emerging as an alternative or adjunct to the invasive autopsy, not only in the forensic setting but also in clinical medicine. (5,6)

After death certain post-mortem processes affect the body that can change the imaging appearance of organs and surrounding soft-tissues. These processes can broadly be divided into livor mortis (hypostasis), rigor mortis (muscle stiffness), algor mortis (cooling of the body) and putrefaction (decomposition). Especially livor mortis and decomposition can have profound effects on both CT and MRI appearance. In contrast rigor mortis and algor mortis only have subtle effects on MRI and do not affect CT images. (7)

For accurate diagnostic interpretation of post-mortem imaging, it is important that the clinical radiologist becomes familiar with these alterations, in order to distinguish them from real pathology. This study gives an overview of the most common and less common non-pathological changes observed at cross-sectional total-body imaging.
Methods and materials

This study was undertaken as part of the Minimally Invasive Autopsy (MIA) study, in which 100 in-hospital deceased patients underwent a total-body CT and MRI of head and trunk. All scans were scored for post-mortem alterations that were previously reported in literature. A total of 69 features were scored per patient. We attributed a confidence score to each observed alteration that ranged from 1 (low confidence) to 5 (high confidence). E.g. score 1 was given to intravascular air that was clearly attributable to catheters or procedures, and score 5 when the observer interpreted the finding as a non-pathological post-mortem alteration.

We present the frequency of the most common alterations in our cohort per organ system and we correlate our observations with the post-mortem interval (PMI; time between death and imaging), post-resuscitation status (PRS) and intensive care unit (ICU) admittance.
Results

Common post-mortem alteration can be viewed in Figures 1-6.

Intravascular air (in any organ, both intra-arterial and intra-venous) was seen in 58% of cases, occurring more frequently in patients that had undergone resuscitation as compared to patients who had not (72% vs 47%, p=0.013). Air was most often seen in the heart (44%), liver (37%) and thoracic vasculature (31%). There was no correlation between PMI and presence of intravascular air.

Pleural effusion (p<0.001), periportal edema (p=0.001) and distended intestines (p=0.083) were also seen more often in patients that had undergone resuscitation, though distended intestines showed no statistically significant difference. Post-mortem clotting was seen more often in patients who had not undergone resuscitation (p=0.001). We believe this may be caused by anti-coagulation given during resuscitation attempts (Figure 7).

There was a trend of internal livores of the lungs being more pronounced at longer PMI (p=0.24), and the same applies to internal livores of the liver (p=0.076). PMI did not affect livores in spleen and kidneys.

Distended intestines showed a significant correlation with PMI (p=0.025). Similarly there was a significant correlation between PMI and loss of grey-white matter differentiation in the brain (p<0.001): loss differentiation was seen in 56% (14/25) of cases with PMI of less than 12 hours, in 92% (34/37) of cases with PMI between 12 and 24 hours and was present in all cases with PMI more than 24 hours (Figure 8).

Hyperdensity of cerebral arteries, intravenous clotting, subcutaneous edema, ascites and internal livores of the liver were seen more often in patients that had been admitted to the ICU prior to death, but only internal livores of the liver were statistically significant. Hyperintensity of T1 signal in the basal ganglia of the brain was seen less often in patients that had been admitted to the ICU (p=0.002) (Figure 9).
Fig. 1: The left two panels show CT images of the brain of a case with very short time between death and imaging (PMI) (5 hours), to the right are CT images of the brain of a case with longer PMI (63 hours). In the case with short PMI the distinction between grey and white brain matter can still be seen (arrows show areas where grey matter can be seen next to white matter), though less clearly than in living patients. With longer PMI this distinction becomes less clear.

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**Fig. 2:** Common post-mortem alterations that can occur in the brain.

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Fig. 3: Common post-mortem alterations that can occur in the blood vessels. Percentages indicate how often the alterations were seen in our cohort.

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Fig. 4: Common post-mortem alterations that can occur in the lungs. Percentages indicate how often the alterations were seen in our cohort.

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Fig. 5: Common post-mortem abdominal alterations. Percentages indicate how often the alterations were seen in our cohort.

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Fig. 6: Common post-mortem alterations that can occur in the heart. Percentages indicate how often the alterations were seen in our cohort.

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**Fig. 7:** Bar chart showing the relative percentages of PM-alterations in patients that had either received resuscitation prior to their death or not.

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Fig. 8: Bar chart showing percentage of cases with loss of grey-white matter differentiation with different PMI. It is clearly seen that loss of grey-white matter differentiation is seen more with a longer post-mortem interval (PMI); with PMI longer than 24 hours it was seen in 100% of cases.

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**Fig. 9:** Bar chart showing the relative percentages of PM-alterations in patients that had either been admitted to the intensive care unit prior to death or not.

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Conclusion

There is a wide variety of post-mortem alterations that can be observed in total-body imaging. These alterations differ among different patient groups and can mimic real pathology. Therefore clinical radiologists need to become familiar with these alterations for correct interpretation of post-mortem CT and MRI scans.
References


