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Case report

Puzzling over intracranial gas: Disclosing a pitfall on postmortem computed tomography in a case of fatal blunt trauma

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ABSTRACT

We report a case of unusual intracranial gas distribution after fatal blunt force trauma to the chest. After a first cursory review of the post-mortem computed tomography (PMCT) images, the intracranial gas collection was misinterpreted as intraarterial air embolism. A second, more thorough review of the findings revealed an exclusive intra-thecal distribution of the gas, resulting in a pseudo-cisternography. This rare pattern was explained by the presence of a traumatic injury to the thoracic spine which had caused an open passage between the thoracic cavity and the spinal canal. Air had ascended to the non-injured, intact skull and filled the intra-thecal space. This case serves as a reminder that PMCT images should always be reviewed carefully and thoroughly. It is not sufficient to focus on major findings or skeletal injuries only. Subtle findings may often prove vital to establishing the cause of death.

1. Introduction

Post-mortem computed tomography (PMCT) is increasingly used worldwide, either as supplement to autopsy, as autopsy replacement or as triage modality [1–3]. There is general agreement that PMCT is superior to autopsy regarding the assessment of pathologic gas collections [3,4]. However, the interpretation of gas on post-mortem cross-sectional images can be challenging. A number of different factors contribute to the occurrence of post-mortem gas, including cardio-pulmonary resuscitation [5], penetrating trauma [6,7], barotrauma [8], septicemia, and post-mortem decomposition [9–11]. It can be very difficult to correctly identify the source of post-mortem gas collections and it is not unusual to find overlap between gas from decomposition and gas which is related to pathology. To make matters worse, most types of post-mortem gas collections are position dependent. This effect may obscure the source of a post-mortem gas collection.

In the skull, gas typically appears as a result of decomposition or in cases of penetrating trauma [12,13]. Traumatic intravascular, intracraninal gas collections may be the result of air embolism and it is therefore important to differentiate this traumatic finding from putrefaction.

Here we present a case where intracranial gas was noted in a non-decomposed case of acute penetrating thoracic trauma. Intracranial gas initially misinterpreted as intra-arterial gas, consistent with air embolism. However, a second review of the images revealed that gas was limited to the intra-thecal space, presenting as “pseudo-cisternography”. The exclusive presence of intra-thecal air is both rare and unusual with regard to the presence of a penetrating trauma. In order to avoid false conclusions regarding the cause or mechanism of death, gas collections should always be reviewed carefully. It is important to note that autopsy is unable to assess post-mortem gas collections. Therefore, gas collections must be assessed with the utmost care on post-mortem imaging. This case illustrates the challenges related to assessing post-mortem gas collections in the skull.

2. Case history

A 57 years old male construction worker (170 cm, 91 kg, body mass index 31.5 kg/m^2) was crushed to death by a building panel. The panel, which weighed several tons, had slipped from a truck

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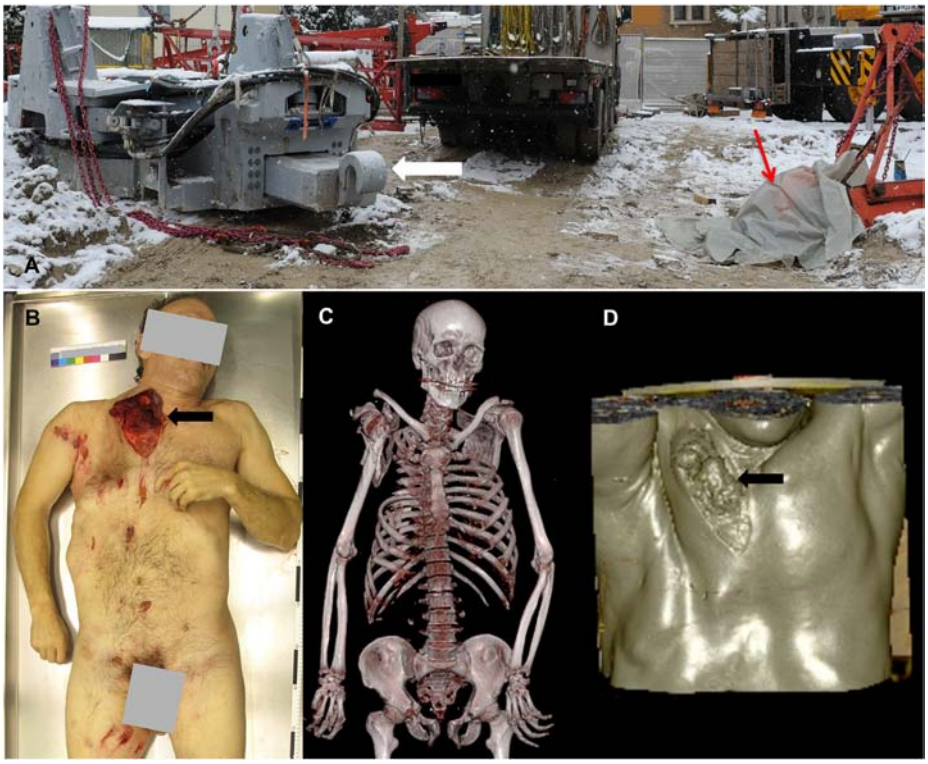

Fig. 1. A: A scene photograph of the building site where the builder was crushed from the back by a construction element weighting tons that slipped from an oversize truck (white bold arrow). The corpse (red arrow, covered by the white plane) was trapped with the torso between the massive construction element and a rigid metallic cage. B: Photograph of the body before autopsy. Note the penetrating wound to the right thorax (black bold arrow) and the flattening of the rib cage. External inspection also allows for the assumption of severe trauma to the right proximal upper extremity, the cervico-thoracic vertebral junction and the pelvis. C: 3-dimensional reconstruction of the torso and skull with anterior view. Note the trauma to the thorax with the major impact from the right and concomitant dislocation of the sternoclavicular joints, the right acromioclavicular joint and fractures of the sternum, comminuted fractures of the right scapula and the ipsilateral humerus and a pelvic open-book fracture due to anteroposterior compression. D: 3-dimensional reconstruction of the surface of the thorax with the externally visible open injury to the thoracic cavity (black bold arrow).

and hit the worker from behind. The worker was trapped between the building panel and a metallic cage. He died on site (Fig. 1).

3. External inspection

The external inspection of the decedent was performed on site by a forensic pathologist. Inspection revealed several traumatic findings, including a penetrating injury to the chest, flattening of the right hemithorax as well as instability of the rib cage, hypermobility of the right humerus, hypermobility of the neck, and instability of the pelvis. Minor findings included abrasions of the skin and subcutaneous emphysema at the level of the neck. The skull was intact.

4. Post-mortem imaging and autopsy

4.1. Methods

Imaging was performed on a dual-source CT scanner (SOMATOM Flash Definition, Siemens, Forchheim, Germany) with 2×128 slices. Automated dose modulation (CARE Dose4D™, Siemens, Forchheim, Germany) was used. Imaging included a true whole-body scan with extended field of view (slice thickness 2 mm), a separate head and neck scan (slice thickness 0.6 mm), a separate chest and abdomen scan with elevated arms (slice thickness 1 mm) with soft tissue and bone window/lung window with respectively a soft and hard kernel reconstruction. Multiplanar and 3-dimensional reconstructions were performed at a multi-modality workplace (LEONARDO, SynGo, Siemens Medical Solutions), and further read-out was performed on a PACS station (Picture and Archiving Communication System, Sectra, Linköping, Sweden).

Post-mortem interval between time of death and PMCT was 4 h. A board-certified radiologist (with 8 years of experience) and a radiology resident, both with training in post-mortem and forensic imaging, reviewed the images.

Autopsy was performed by a board-certified forensic pathologist with (16 years of experience) and a resident in forensic pathology. All imaging findings were reported to the autopsy team prior to the autopsy. Autopsy included opening of all the three body cavities (skull, thorax and abdomen) as well as dissection of all four extremities and the soft tissues of the torso. Autopsy was performed 18 h after death.

4.1.1. Results

Post-mortem imaging featured a number of traumatic findings of the chest, the abdomen, and the extremities. PMCT revealed no fractures of the skull or the facial bones. Nevertheless, there was a significant intracranial air collectio. In a cursory first review of the images, the intracranial gas was interpreted as air embolism (originating from the penetrating chest trauma). A second, more thorough review of the images revealed that the air was limited to the intra-thecal space. There was no intravascular gas and no sign of arterial air embolism. The intra-thecal air collections created an appearance of pseudo-cisternography at the level of the circle of Willis. (Figs. 2–4).

There was Chance fracture (flexion–distraction fracture) of the 1st and 2nd thoracic vertebra with transsection of the myelon and a significant collection of air in the spinal canal (Fig. 3). The 1st and