Case #46

NAME Educational Activities Committee

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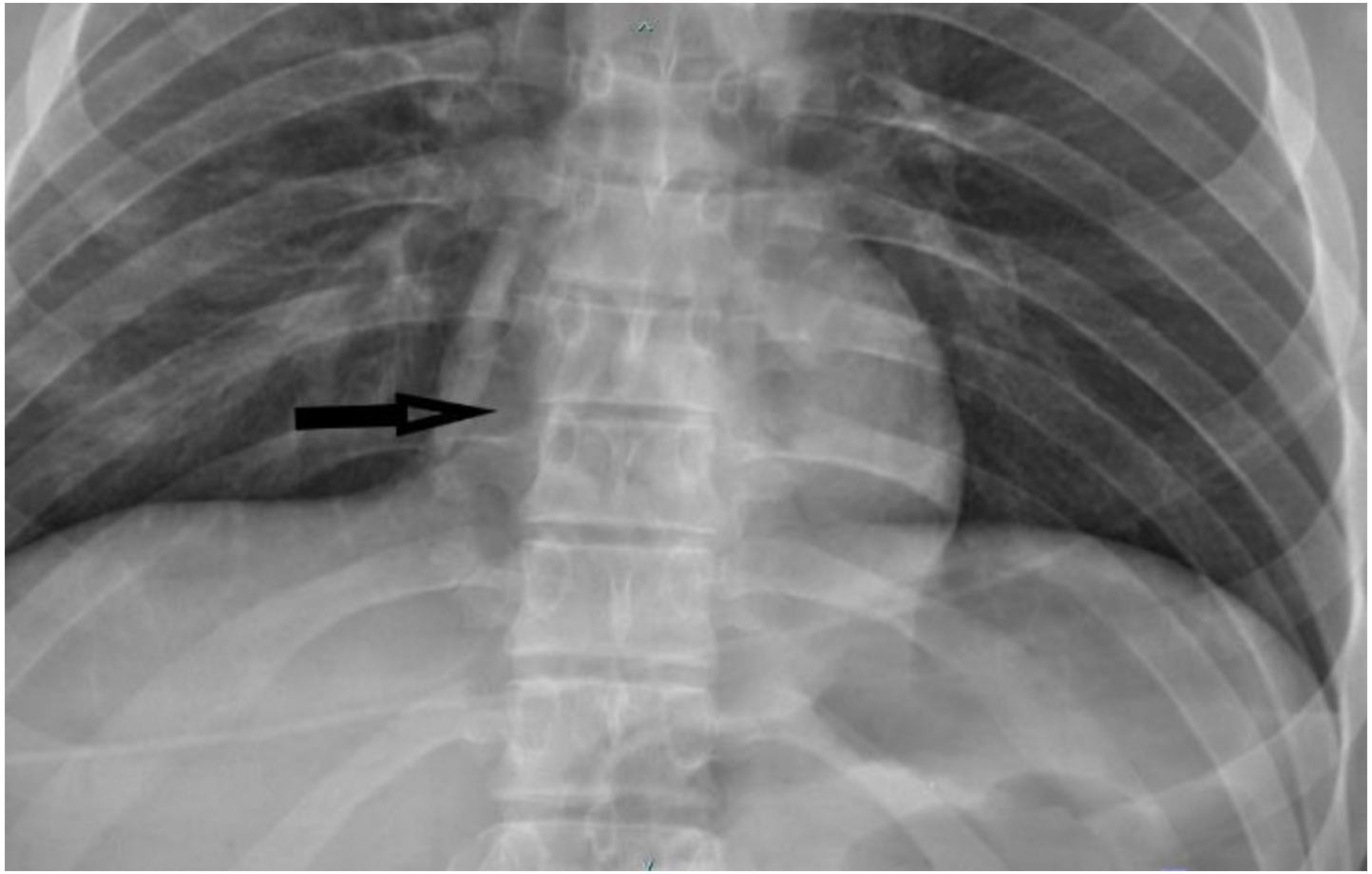
1. This image was taken before the autopsy of an adult male involved in a motor vehicle accident. Based on the radiographic findings, which of the following is most likely to be identified at autopsy?

- ◯ Aortic transection with hemopericardium
- ◯ Bilateral femur fractures
- ◯ Hemothorax
- ◯ Pulmonary hilar lacerations
- ◯ Extensive skull fractures

Answer...

E. Extensive skull fractures (CORRECT ANSWER, 28.39% % of responses)

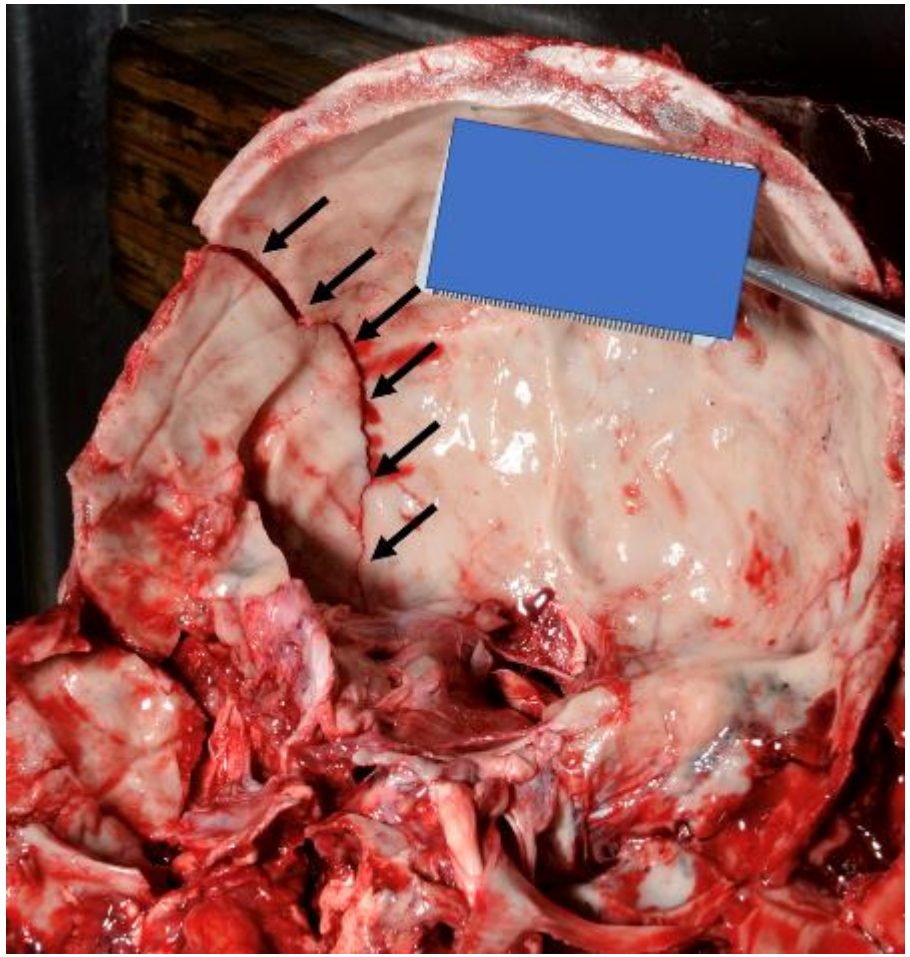
The X-ray shows evidence of air embolism within the right heart chambers, as depicted by the black arrow.



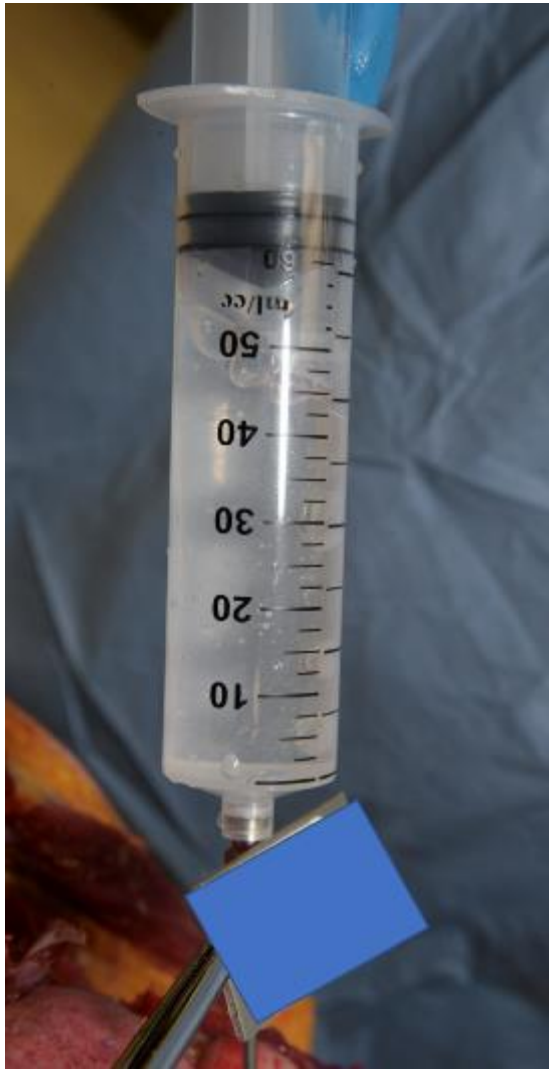
The radiograph showed an air embolism in the right heart chambers. This question was difficult because the mechanism was not a classic penetrating injury of the neck. Air embolism can occur as a result of sharp force injuries of the neck, blunt head or chest trauma, invasive medical procedures (e.g. thoracentesis, arterial catheterization, neurosurgery, cardiac surgery), or decompression syndrome. Large volumes of intracardiac air may cause hemodynamic instability and circulatory collapse due to interference with blood in the cardiac pump ("air lock").

In this case, the decedent sustained multiple blunt force injuries due to a motor vehicle accident (see neck image). Bilateral comminuted calvarial fractures and radiating basilar skull fractures were present. Air embolism to the heart has been described in cases of basilar skull fractures. The mechanism is still not entirely understood, but it is thought that air embolism may develop due to intracranial air passing through the arachnoid villi or via vein lacerations. Two conditions are needed to allow for the air to enter the venous system:

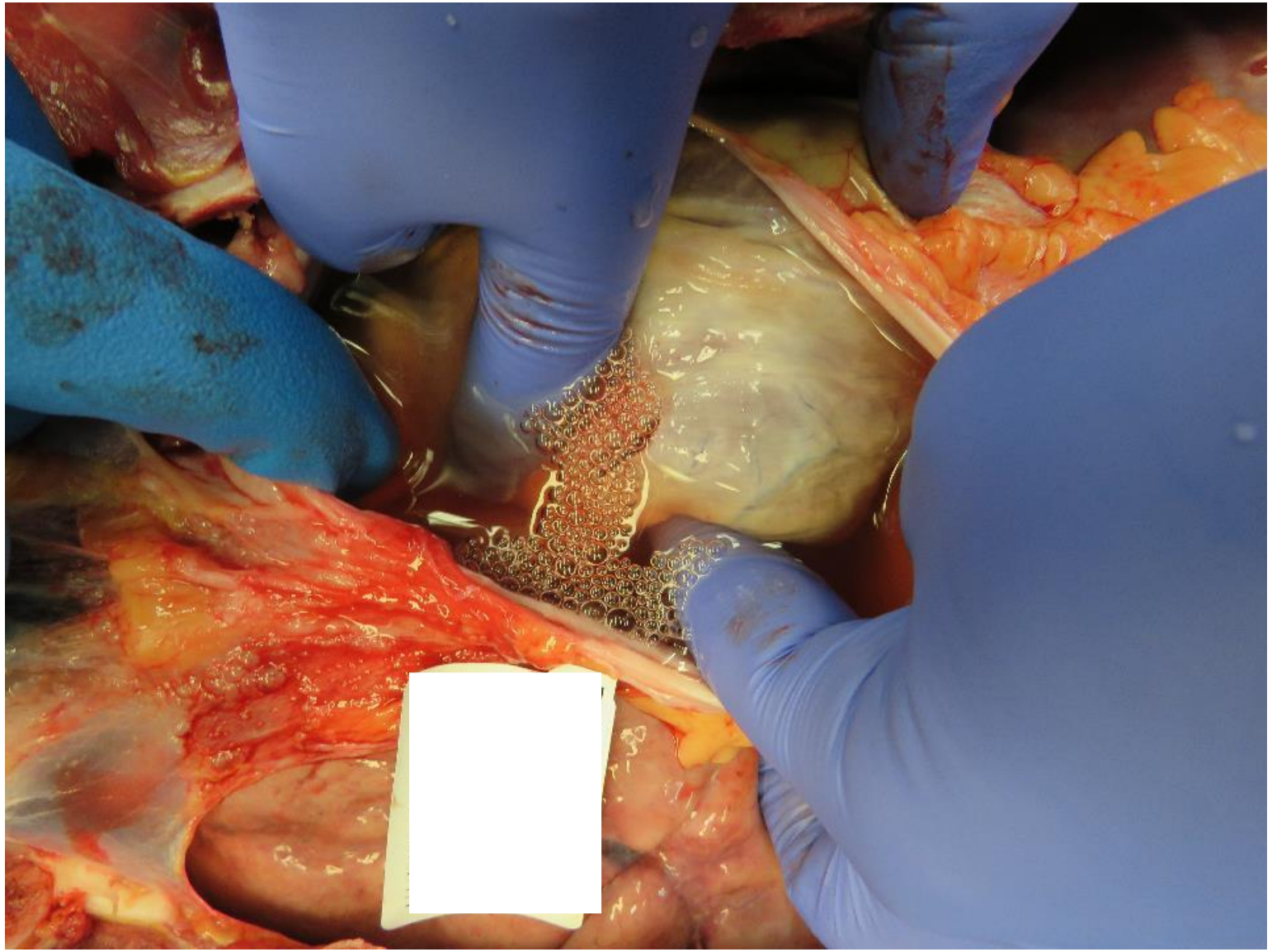
- There must be a communication between atmospheric air and a systemic vein (e.g., traumas or invasive procedures).
- A pressure gradient between the breached vein and the right side of the heart must be established to enable the air to enter the venous system. The negative pressure gradient between the cerebral veins and the right atrium allows air to siphon through the veins. Blood loss increases the risk of venous air embolism by decreasing central venous pressure.



When heart air embolism is suspected, a specific autopsy technique should be performed to confirm it. An easy and fast method is the following: exposing the pericardium without pulling on the surrounding tissues at the time of their removal. Open the pericardial sac anteriorly. Grab the heart by the apex without compressing it excessively. Puncture the right atrium using a syringe filled with water and gently draw back on the plunger. If air is present within the heart, bubbles will rise and be visible within the syringe.



Alternatively, the pericardial sac can be filled with water and then the right ventricle can be perforated with a scalpel below the water line. Bubbles should rise from the point of perforation.



A. Aortic transection with hemopericardium (39.02% of responses)

Aortic trauma is one of the most common findings in motor vehicle accidents (MVA). This is generally believed to be due to the heart being relatively mobile within the chest cavity, while the aortic arch remains largely fixed and tethered by the brachiocephalic vessels. Rapid deceleration will most commonly cause shearing forces leading to transections around the aortic isthmus or ligamentum arteriosum area.

With perforations within the pericardium, the blood accumulates within the pericardial cavity (hemopericardium), compressing the heart and leading to cardiac tamponade. Conventional chest X-rays generally show an enlarged cardiac silhouette (approximately 200 mL of blood is required to be visible). The heart appears surrounded by air (partially or entirely) with a sharply delineated pericardium outlined by lucency on either side. No air within the heart chambers is observed.

B. Bilateral femur fractures (3.78% of responses)

Femur fractures are common injuries seen in MVAs, especially head-on collisions. Orthopedic trauma to long bones, like the femur, can lead to fat embolism. When fat particles enter the circulation they can cause damage to capillary beds, especially in the pulmonary system, resulting in intense inflammatory response which results in a picture similar to acute respiratory distress syndrome (ARDS). These patients can quickly decompensate and develop respiratory failure. While fat emboli themselves are not visible by x-ray, occasionally the resulting diffuse interstitial infiltrates and pulmonary edema can be identified.

C. **Hemothorax** (14.69% of responses)

Hemothorax is the collection of blood into the pleural space (space between the visceral and parietal pleura). It usually results from blunt or penetrating chest trauma. The source of bleeding may be the chest wall, lung parenchyma, heart, or great vessels, and even diaphragmatic and abdominal injuries. Each pleural space can hold approximately 40% of the circulating blood volume. A large hemothorax can increase hydrostatic pressure causing impairment in preload and increasing pulmonary vascular resistance. These mechanisms result in tension hemothorax physiology and cause hemodynamic instability, cardiovascular collapse, and death.

Chest x-rays show cavity occupation by pleural fluid, meniscus of fluid blunting the costophrenic angle or diaphragmatic surface, and tracking up the pleural margins of the chest wall. Additional findings, such as rib fractures or pneumothorax, can be observed. However, no air within the heart chambers is observed.

D. **Pulmonary hilar lacerations** (14.13% of responses)

Pulmonary lacerations can be caused by penetrating or non-penetrating chest trauma. Pulmonary hilar lacerations should be suspected in the presence of massive hemothorax since they are often associated with large vessel injuries.

Pulmonary laceration cannot be identified on chest X-ray pictures at first because the elastic shrinkage of the normal lung parenchyma surrounds the laceration. Initial radiological signs appear after the first 48–72 hours. If hemothorax is present, pulmonary lacerations will not be visible on the chest x-ray due to the blood collection within the pleural space. No air within the heart is present.

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