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Bone Marrow Emboli Versus Fat Emboli as the Cause of Unexpected Death

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ABSTRACT: Thromboemboli were found diffusely throughout the pulmonary vasculature system of a 76-year-old white female who died unexpectedly 3 days following injury and repair of a left hip intracapsular fracture. A diffuse chronic nonspecific myocarditis with marked fat atrophy, an acute myocardial infarct of the posterior left ventricular papillary muscle, and an acute right lower lobe bronchopneumonia are believed to be the cause of death.

KEYWORDS: pathology and biology, death, emboli

Over the years it has been stated that the immediate cause of the majority of unexpected deaths following bone trauma or surgery is either bone marrow emboli or fat emboli to the pulmonary vasculature system [1]. The purpose of this article, for medicolegal reasons, is to associate the time interval necessary between trauma and death on the basis of histologic changes in the emboli to determine if the emboli are the cause of death. The case below illustrates just such an example.

Case Report

The deceased was a 76-year-old white female who while walking her dog on 13 Feb. 1984 sustained a left intracapsular hip fracture when she was knocked over by a dog which in turn landed on her left hip. She was transported to the hospital emergency room, where a physical examination revealed flexion of the left leg at 45°, and marked tenderness to motion on both internal and external rotation. A chest X-ray was clear and a radiograph of the left hip revealed a subcapital hip fracture.

Past medical history was remarkable for a thyroidectomy at 18 years of age, a cholecystectomy, a ruptured appendix, and arthritis involving the left hip and sacroiliac joints. An electrocardiogram (ECG) showed a normal sinus rhythm with a rate of 72 b/min. Admitting laboratory values were all within normal limits. Following informed consent by her family, she was taken to the operating room and underwent a total left hip arthroplasty without complication. Following the procedure, she was taken to the recovery room with a Hemovac® drain and intravenous (IV) lines in place and functioning.

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On the first postoperative day she had multiple minor complaints, none of which was referable to her hip. Vital signs were stable and she was afebrile. The Hemovac drained 145 mL of bloody fluid. The chest remained clear to auscultation and the heart rhythm remained regular.

On the second postoperative day she was found disoriented, with color, but a poor respiratory effort. Chest examination revealed coarse ronchi and decreased breath sounds at the bases, bilaterally. Oxygen was administered by nasal cannula, and a chest X-ray and arterial blood gasses were ordered. In a short period of time following this, she went into respiratory arrest. A full code was ordered and vigorous resuscitative measures were performed for 1½ h. A rhythm was obtained, although her blood pressure never returned to an adequate level. As the death was sudden and unexpected, an autopsy was performed at the medical examiner's office.

The postmortem examination revealed a well-nourished, well-developed white female who appeared her stated age. The body was cool to touch and there was fixed rigor present in the head, neck, and extremities. Blanchable red-blue livor was present posteriorly and there was a dusky purple discoloration over the neck and facial regions. She measured 161 cm (63.5 in.) in length, and weighed 52.3 kg (115 lbs).

The ace wrap and dressing over the left hip was removed; the sutured wound was opened and appeared clean with drainage tube in place.

Internal examination revealed a 300-g heart that had an increased amount of subepicardial fat, but a normal distribution pattern. The heart valves were thin, pliable, and delicate except for the tricuspid and mitral valves which showed marked thickening along the anterior edges of the leaflets, along with thickening of the chordae tendineae. Sectioning of the myocardium showed fat infiltration along with questionable fatty emboli along the right ventricular wall, laterally. Upon removal of 20 mL of blood for toxicological studies from the inferior vena cava, a

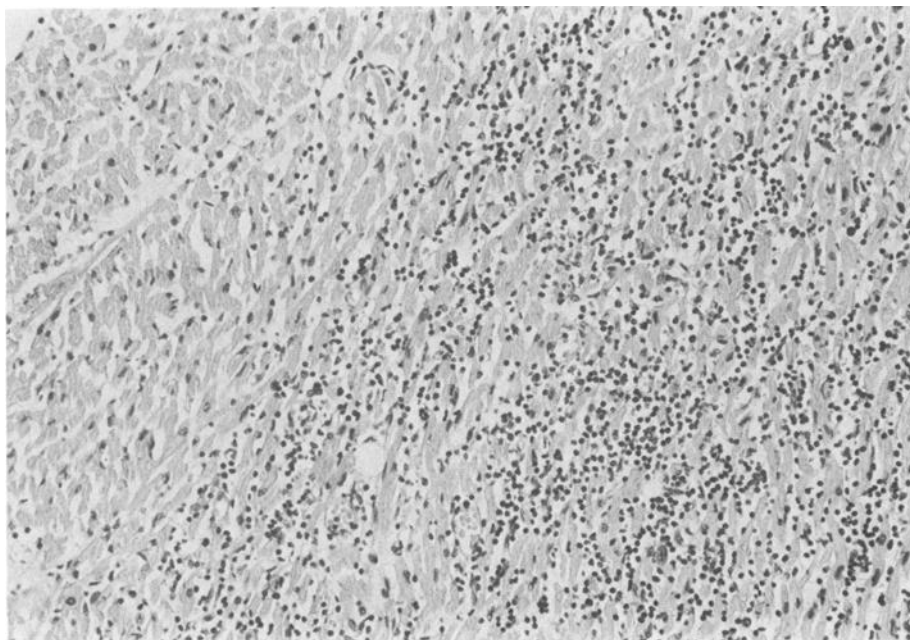


FIG. 1—Section from the left ventricle showing a diffuse chronic inflammatory infiltrate of small mature lymphocytes extending throughout the wall; similar changes were found throughout the right ventricular wall ($\times 1000$).

large amount of fatty tissue was found within the syringe. Microscopic evaluation showed the tissue to consist of immature bone marrow elements intermixed with bone marrow fat and collections of red blood cells. The heart sections showed marked fatty infiltration as well as areas of arachnoidal fibrosis extending throughout. In the epicardium, extending down into the underlying myocardium and endocardium, were abundant small collections of mature lymphocytes. These changes were found in multiple sections taken from both the left and right ventricles (Fig. 1). No viral or bacterial particles were found. A section through the posterior papillary muscle within the left ventricle showed an infarct with was less than 24 h old (Fig. 2).

The left lung weighed 725 g; the right 815 g. Both were heavy, wet, and congested. On multiple sectioning, abundant small yellow fatty emboli exuded freely from the cut vessel surfaces. The majority were found within the right lower lobe. Microscopically, multiple bone marrow thromboemboli were found within the lumens of many small and medium-sized vessels (Figs. 3-5). In a section from a firm area which was palpated in the right lower lobe, a patchy acute bronchopneumonia was present (Figs. 6 and 7). Again, no viral or bacterial particles were identified, nor was there any foreign material to provide evidence of an aspirational pneumonia.

The musculoskeletal system showed anterior fractures of ribs 1 through 5 on both the left and right, along with a transverse sternal fracture at the third intercostal space.

Discussion

On analyzing the postmortem findings, it is apparent that the trauma this lady sustained while walking her dog predisposed her to an acute right lower lobe patchy bronchopneumonia (which is most likely an aspirational type of pneumonia because of the location), and exacerbated her already present severe heart disease, resulting in death.

The bone marrow emboli in the pulmonary vasculature and the inferior vena cava blood are believed to be acute, secondary to vigorous resuscitative attempts, following her respiratory ar-

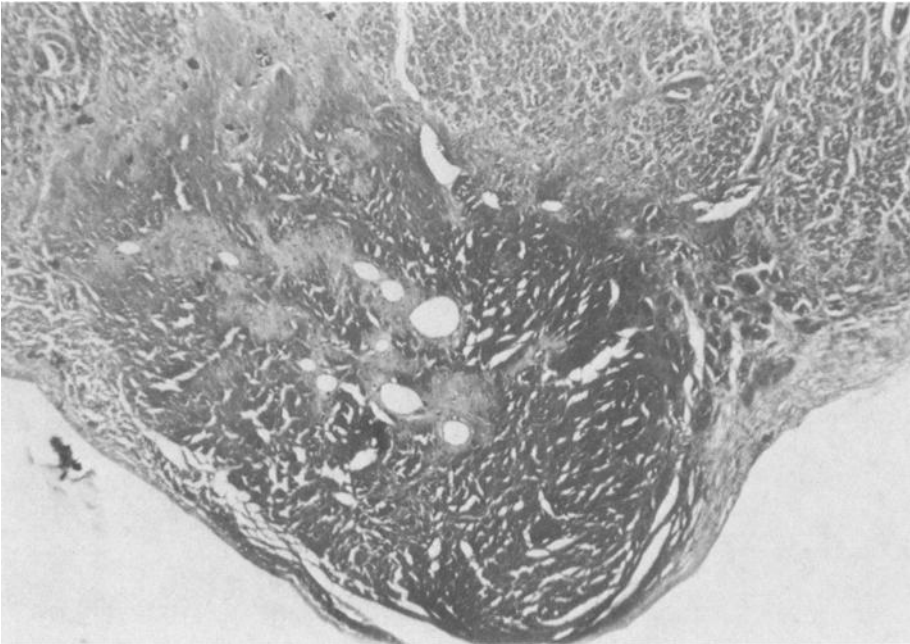


FIG. 2—Early necrotic changes consistent with an acute myocardial infarct, less than 24 hours old, were found in the left posterior papillary muscle ($\times 400$).

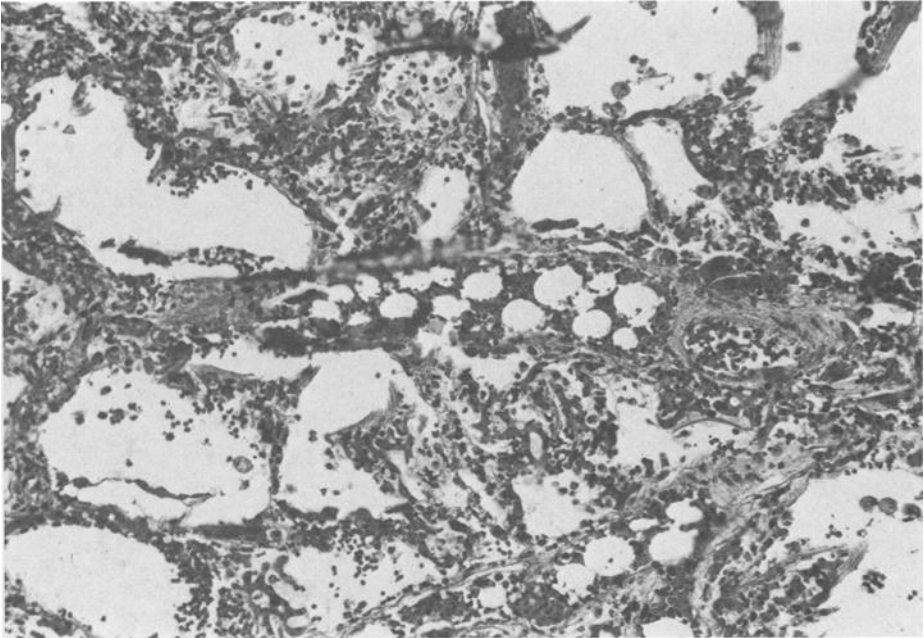


FIG. 3—Section shows one of the many bone marrow emboli which were found throughout the lungs ($\times 400$).

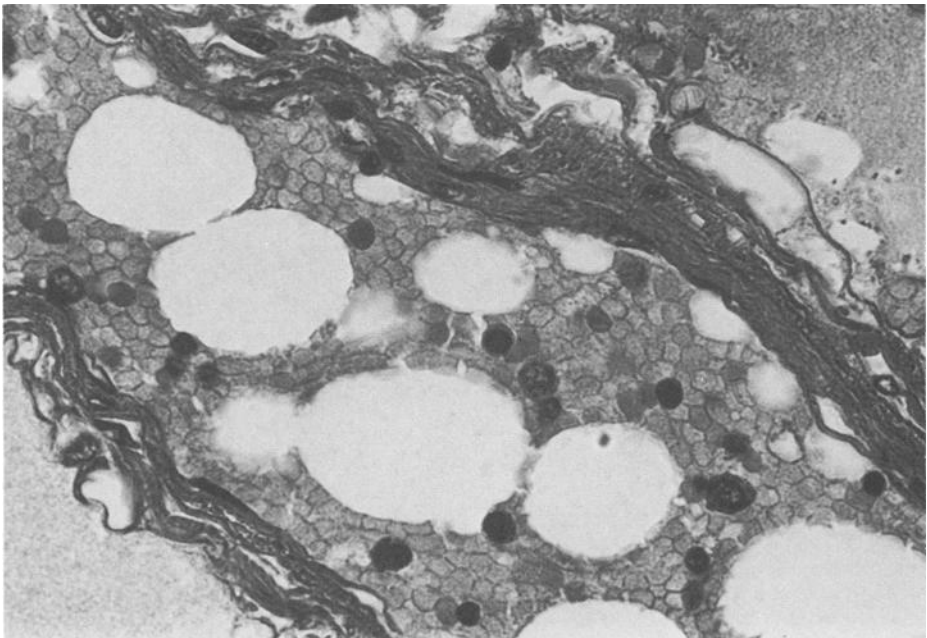


FIG. 4—Higher magnification of the bone marrow emboli depicting the immature marrow elements intermixed with fat "ghost" cells ($\times 1000$).

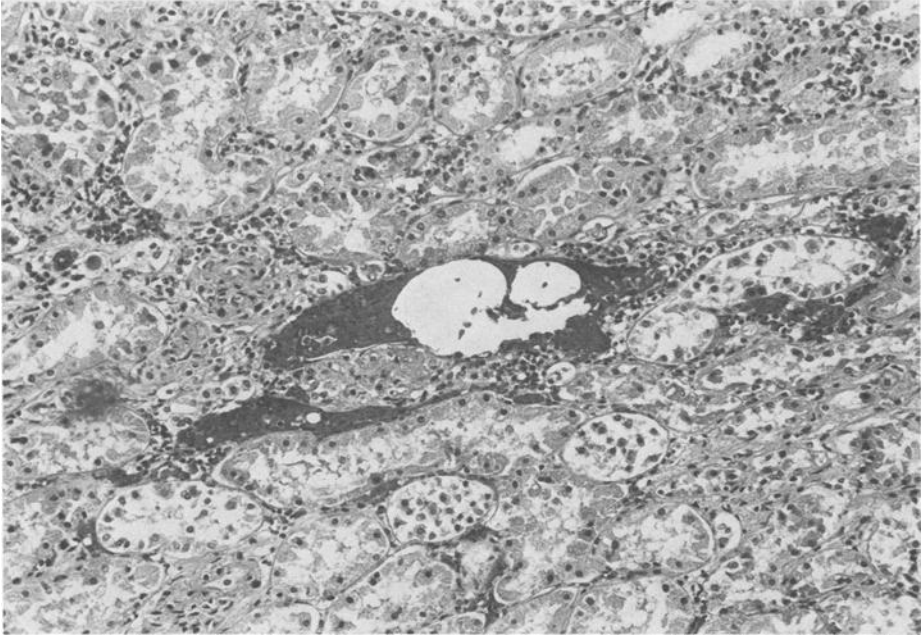


FIG. 5—Section of a fat emboli in a kidney submitted for comparison with Figs. 3 and 4. ($\times 400$).

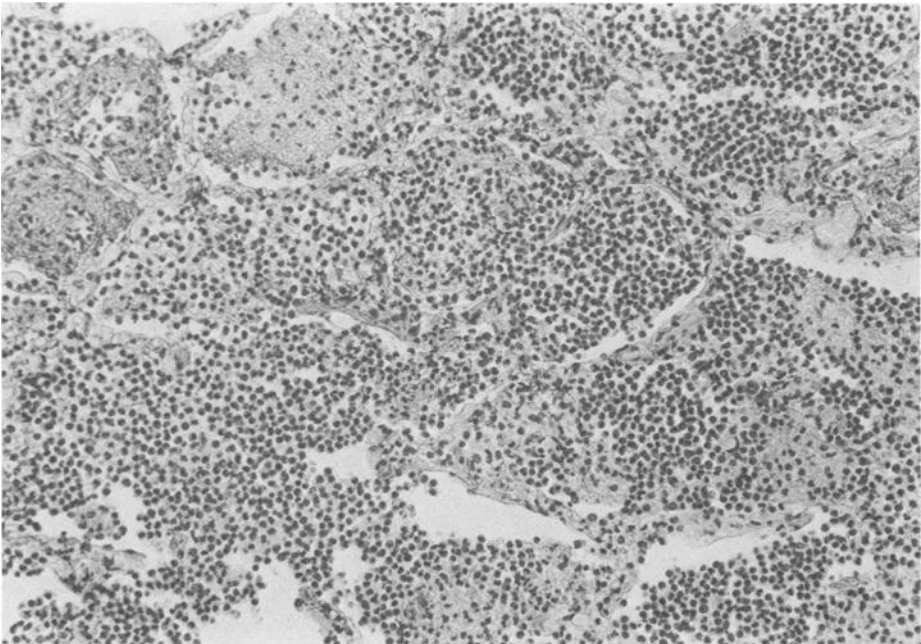


FIG. 6 —Section from the right lower lung lobe showing a diffuse inflammatory infiltrate present in the alveolar spaces ($\times 400$).

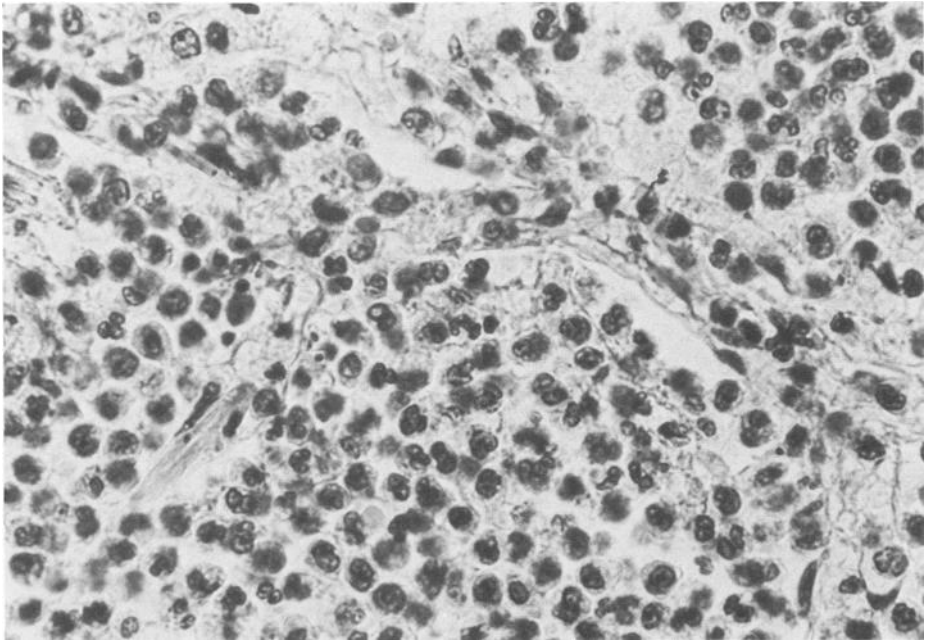


FIG. 7—Higher magnification of Fig. 6 shows the infiltrate to consist predominantly of polymorphonuclear cells. No viral or bacterial organisms were identified. No foreign material was present. ($\times 1000$).

rest. Fat emboli were essentially ruled out following microscopic evaluation, but bone marrow emboli were present throughout the pulmonary vasculature (one embolus was found in the kidney). The emboli were medium in size, and consisted of immature hematopoietic cells intermixed with fat. There were neither degenerative nor organizational changes.

In a study by Schinella [2] on bone marrow emboli and their fate in the vasculature of the human lung, 21 cases were selected in which bone marrow emboli were found to be the specific cause of death and were evaluated histologically. He reports a gradual organizing process followed by degenerative changes. In an embolus less than one day old he observed that the emboli had partial or complete fibrin covering with 3-4+ fragmentation. One-day-old emboli showed endothelialization with early degenerative changes in the hematopoietic cells and fat. Fibrin covering was present in only one case. Two-day-old emboli displayed more advanced endothelialization with focal pyknosis of hematopoietic elements, and fatty degeneration with an early infiltrate by large pale blue histiocytes. Three to four-day-old emboli showed almost complete endothelialization with loss of most of the marrow hematopoietic elements. There was also considerable fat degeneration and infiltration by large histiocytic cells. Reviewing the literature also shows similar findings by Rappaport et al [3] and Lubarsch [4].

Because of the negative microscopic findings and the presence of bilateral anterior fractures of ribs 1 through 5, and a transverse sternal fracture at the third intercostal space, we feel that the bone marrow emboli found diffusely throughout the lungs and in the inferior vena cava blood are acute in nature and related to vigorous resuscitative attempts rather than to the trauma sustained during her fall or during repair of the subcapitol femoral fracture three days prior.

The medicolegal complications of a case of this nature are generally considered to be on the grounds of negligence. The allegations of negligence would not only be directed toward the owner of the dog and the civic jurisdiction, but would also involve the hospital and the attend-

ing physicians. In this case, this was not just an allegation but a real threat on the part of the next of kin. Another theoretical aspect of this kind of case would be related to a possible conspiracy charge where the medical examiner, because of a hospital appointment, could be considered biased in favor of the hospital and physicians. In such a situation, it should be suggested that the family have a pathologist of their own choosing act as an observer during the postmortem examination and then review all pathological materials. With the exception of the origin of the trauma, all subsequent medicolegal actions were terminated.

CAVE CANEM! (Beware of the dog!)

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