JOURNAL OF FORENSIC SCIENCES

J Forensic Sci, July 2012, Vol. 57, No. 4
doi: 10.1111/j.1556-4029.2012.02098.x
Available online at: onlinelibrary.wiley.com

CASE REPORT

PATHOLOGY/BIOLOGY

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Medical Responsibility in the Operating Room: The Example of an Amniotic Fluid Embolism

ABSTRACT: Amniotic fluid embolism (AFE) continues to be one of the most feared complications of pregnancy. A healthy 32-year-old woman died during delivery after a normal 39-week third pregnancy. The family filed a complaint with a criminal court as the causes of death appeared unclear. No risk factor associated with AFE was identified. Clinical presentation was typical, including sudden onset of cardiovascular and respiratory symptoms. Autopsy confirmed the histological diagnosis of amniotic embolism and excluded an iatrogenic cause of death or anesthetic malpractice. This article highlights the value of both antemortem records and histological features in establishing the diagnosis of AFE and demonstrates the fundamental importance of autopsy in an unexpected death related directly or indirectly to a medical procedure.

KEYWORDS: forensic science, amniotic fluid embolism, pregnancy complication, medical malpractice, expert opinion

Maternal death during delivery is rare, but traumatic for the medical teams. When a patient dies during anesthesia or immediately following a surgical procedure, the liability of the anesthetic and gynecological teams may be sought. This attitude is generally explained by the fact that it is impossible for the medical team to establish the immediate cause of death with any certainty. The death of the mother is experienced as a tragedy, especially as the women giving birth are young and healthy (1). In the volatile situation that follows unexpected death, the risk of legal proceedings is high, and autopsy may be indicated to investigate the causes of death and the possibility of medical liability. When death occurs during anesthesia and surgery, it has been observed that the relatives and/or their counsel frequently tend to consider the medical chart data as inadequate or untrustworthy (2,3).

Case Report

A healthy 32-year-old woman was admitted to the obstetrics department for delivery after a normal 39-week third pregnancy. She had already given birth to two children 7 and 5 years before. Her medical history revealed an allergy to penicillin, appendicectomy during childhood, and two peridural anesthesias for Cesarean deliveries. The pregnancy had been regularly followed without complications. More frequent uterine contractions of 2-day duration and rupture of the bag of waters led to a consultation in the maternity unit. Gynecological examination showed fixed cephalic presentation and cervical dilation of 2 cm. Fetal heartbeat recording was normal. The preanesthetic consultation had taken place during the eighth month of pregnancy, and no contraindication to peridural anesthesia had been found. Coagulation tests were normal. The patient was settled in the delivery room in a left lateral decubitus position, and subcutaneous local anesthetic was given with 3 mg xylocaine by lumbar puncture. Under sterile conditions, the epidural space was located using the loss-of-resistance technique. An epidural needle (18-gauge Tuohy needle) attached to a syringe of saline was inserted through spinal ligaments as pressure was applied to the syringe plunger. The L4-5 lumbar vertebral space was chosen. Before the epidural space was entered, the patient suddenly complained of a feeling of malaise with sweating and presented convulsions and cardiocirculatory arrest caused by ventricular fibrillation. No spinal anesthetic agent had been administered before the patient collapsed. Rapid sequence general anesthesia was induced using sodium pentothal (4 mg/kg) and suxamethonium (1 mg/kg), with orotracheal intubation with a 7.5-cm diameter tube and mechanical ventilation with FiO_2 of 100%. External cardiac massage was started by the anesthetist, and a second anesthetist was called in. As soon as the ventilation parameters were controlled, blood samples were obtained and hysterotomy was carried out by a subperitoneal approach. A baby boy was extracted and entrusted to the pediatrician. The infant did not present complications. Several episodes of cardiac arrest by ventricular fibrillation were resistant to external defibrillation and the administration of 0.42% sodium bicarbonate. Death was declared at the end of the delivery. The patient's family filed a complaint, and the autopsy was performed approximately 15 h after death.

Macroscopic Autopsy Findings

At the postmortem examination, edematous lungs were the only remarkable macroscopic findings. Examination of the brain after fixing in formalin did not reveal any cause of the convulsions or intracerebral hematoma. No macroscopic emboli were seen on dissection of the iliac veins and the vena cava. Some punctate

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Received 25 Sept. 2010; and in revised form 23 May 2011; accepted 12 June 2011.

epicardial hemorrhages were noted, related to asphyxia during cardiac arrest, but the heart was not dilated. No intracardiac shunt was detected, and the foramen ovale was not patent. The renal parenchyma showed slight vascular congestion. Laminectomy found no rupture of the dura mater. The uterus showed an intact and closed healing surgical incision. We did not note any utero-vaginal ruptures of the reproductive tract.

Microscopic Autopsy Findings

On histological examination, diffuse edematous alveolitis and moderate vascular congestion were observed. They were associated with some focal hemorrhages, macrophagic alveolitis, and images of essentially subpleural alveolar rupture that was nonspecific and could be attributed to resuscitation maneuvers and external cardiac massage. Histological examination was performed on formalin-fixed paraffin-embedded tissues stained with hematoxylin and eosin and showed emboli in the pulmonary artery, amniotic debris, and filaments of keratin and mucoid substance. Special staining with modified toluidine blue did not reveal mastocytes.

Laboratory Investigations

Blood samples obtained in the operating room while the patient was undergoing attempted resuscitation showed the characteristic features of disseminated intravascular coagulation (DIC), normal hemoglobin levels for pregnancy stage, and the absence of any abnormalities in electrolyte levels that could have caused the convulsions or heart rate disturbances. Serum tryptase and histamine were not measured. Standard postmortem toxicology screening was negative.

Discussion

Autopsy and Assessment of Amniotic Fluid Embolism

Autopsy is ordered to answer the question: What was the cause of death? This investigation was carried out in the forensic medicine department of our university hospital. The medical expertise of a forensic pathologist is required to seek a cause that is not related to the principal pathology and that could be responsible for the death. In the present case, inadvertent dural puncture during peridural anesthesia could have caused an iatrogenic complication. Because of this possibility, laminectomy was performed during the autopsy. No spinal or cerebral hematomas were found. Although they are rare, immediate complications of dura puncture are described in the literature (4). Hematoma is thought to develop because of cerebrospinal fluid leakage, resulting in sagging of the brain and traction and eventual rupture of the bridging cerebral veins (5), related to the large size of the Tuohy needles used, which range from 16 to 18 gauge.

AFE continues to be one of the leading causes of maternal death (6), with an estimated frequency from 1 in 8000 to 1 in 30,000 pregnancies (7). The maternal mortality rate is high at up to 61%, although a decrease has been observed (8). In a case with this clinical presentation, diagnosis of AFE, especially at the onset, is very difficult and requires a high index of suspicion. AFE typically occurs during labor and delivery, but can also present in the immediate postpartum period. About 70% of AFEs are diagnosed before delivery depending on the studies, with a range from 63 to 76% (7,8). Cardiac arrest is a very uncommon event in pregnancy, and nonhemorrhagic shock requires immediate management of collapse by a multidisciplinary team. For this reason, anesthetists are trained in critical care (9) and initiation of specialized resuscitation. Premonitory symptoms before the collapse have been described as breathlessness, distress, panic, chest pain, feeling cold, nausea, vomiting, and a feeling of pins and needles (10). There is no pathognomonic clinical presentation of AFE apart from a brutal and protean onset of maternal distress. Clark et al. (6) found the most common presentation associated with hypotension and signs of nonreassuring fetal status (100%), pulmonary edema or respiratory symptoms (93%), cardiac arrest (87%), cyanosis (83%), and coagulopathy (83%). Uncontrollable genital bleeding or oozing, as the first clinical sign of AFE, was generally present after delivery or during induction of labor and may occur in over 50% of cases (11), but was absent in our patient despite DIC. DIC has been noted in up to 85% of AFE with or without bleeding, as in our case (12). Although each of the disorders listed has symptoms consistent with AFE, sudden onset of dyspnea or rapid hemodynamic changes should lead the physician to suspect AFE especially when no other medical condition or explanation for the symptoms is observed (13). All these signs can be associated or occur separately and in different degrees, and as maternal distress is not always appropriately monitored when it occurs, this may account for the difficulty in describing the initial phase of AFE. Moreover, several obstetric and nonobstetric life-threatening emergencies may present with a similar clinical picture. Regarding the clinical presentation of AFE, acute onset of cardiorespiratory symptoms includes thrombotic or air pulmonary embolism, acute coronary syndrome, and cardiac arrhythmia; infectious causes such as sepsis or septic shock; obstetric causes such as acute hemorrhage, placenta abruption, uterine rupture, eclampsia, or peripartum cardiomyopathy; anesthetic causes such as high spinal anesthesia, aspiration of gastric content, or local anesthetic toxicity; or causes of immunologic nature, drug-induced allergic anaphylaxis, or reaction to blood transfusion (14). In our case, we did not observe any risk factors for AFE such as multiple pregnancy, maternal age 35 years or older, Cesarean or instrumental vaginal delivery, eclampsia, polyhydramnios, placenta previa or abruption, cervical laceration or uterine rupture, or fetal distress that could be detected during the preanesthesia consultation.

There are no specific biologic parameters for the diagnosis. A consumptive coagulopathy commonly develops with AFE, and DIC can affect 85% of patients. Isolated DIC causing maternal hemorrhage may be the first sign in a small number of patients (12). These changes may be observed with the HELLP syndrome (hemolysis, elevated liver enzymes, low platelet count). Diagnosis is difficult because resuscitation maneuvers and hypoxia during maternal distress may lead to such changes (15).

Macroscopic autopsy findings are rarely dramatic and include pulmonary and cerebral edema, congestion of internal organs, and conjunctival, epicardial, or pleural effusion (16). In the systemic circulation, identification of fetal squames is not enough for a definitive diagnosis (17), and unfortunately, reliable differentiation between maternal and fetal cells is difficult. Discrepancies are noted in the literature concerning the specificity of the detection of squamous cells in maternal pulmonary arterial circulation, because they have been observed in both women with AFE and nonpregnant women (18).

The histological detection of AFE requires the use of multiple tissue section and special stains. The components of the embolism may be identified in routine hematoxylin and eosin stain sections, by showing fragments of vernix caseosa, squamous cells, lanugo hair, mucin (meconium), and trophoblastic cells. These stains are not always readily evident in microscopic sections and may be overlooked (19). Other stains may be used to improve histological

identification of AFE, such as Alcian blue technique, and also Attwood's stain, a special stain procedure, which may facilitate identification of squamous cells in amniotic fluid (19).

Despite the use of such special staining techniques, identification of fetal tissues in lung sections may be difficult and it is necessary to take as many samples as possible from all lung lobes for histological examination. Immunohistochemical techniques have countered the inadequacy of the routine staining methods. An immunohistochemical demonstration of an increase of pulmonary mast cells or amniotic-fluid-derived mucin may be additional criteria for a postmortem diagnosis of AFE (20).

Because of advances in knowledge of the pathophysiological mechanisms involved in AFE and the similarities with anaphylactoid syndrome, it has been suggested that some biologic markers should be measured in maternal peripheral blood. There has been a recent emphasis on increased serum levels of tryptase. This enzyme is the major protein component of mast cell secretory granules (20), but the specificity of its measurement is still debated. Some authors have found that tryptase was elevated in women with AFE (21), but others have not (17). Tryptase peaks at about 6 h after the onset of the event, unlike histamine whose peak serum levels are more transient. Other diagnostic serum markers such as decreased levels of C3 and C4 complement, increased zinc coproporphyrin (a characteristic component of meconium), and increased sialyl-Tn (an antigen present in meconium and detectable through the use of TKH2 antibodies) have been observed in AFE. Although they are promising, they need further investigation because these laboratory tests are not available in the majority of hospitals.

Discussion of Medical Responsibility

Discussion of medical responsibility does not serve a purpose unless autopsy has diagnosed a cause of death and has not revealed any iatrogenic condition. In our clinical case, no accidental puncture of the dura mater or spinal hematoma was found that could have caused the maternal distress. The question to be answered is whether the obstetrician/gynecologist and the anesthetist had adhered to the standard of care expected, both when the patient was in the delivery room and when anesthesia was induced. For a physician to be held liable following a medical procedure, three mandatory conditions must be met. The plaintiff must prove that the defendant owed a duty of care to the plaintiff, that the defendant breached this duty by failing to adhere to the standard of care expected, and that this breach of duty caused an injury to the plaintiff (22). Malpractice is a deviation from the standard of care, which is defined as a level at which average, prudent, similarly qualified providers in a given community would have managed the patient's care under the same or similar circumstances (23). This is the first stage in the reasoning of the clinical pathologist and contributes to the arguments for exoneration of the medical staff from accusations by relatives, when medical malpractice during parturition is suspected (11).

In the course of the mission, the expert in forensic pathology may meet several difficulties. First, he or she must put themselves in the conditions of the medical procedure at the time of the complication and must avoid interference from elements of the legal procedure, notably the arguments of the plaintiff's lawyers. To this end, retrospective analysis of the antemortem information contained in the preanesthetic assessment of the patient and preoperative record of the events is of vital importance (24). The arguments of the expert in forensic pathology concerning the cause of death must be based on a search of the recent literature. In our case, an independent anesthetist provided much useful advice concerning standards of care. Lack of specialization of the expert physician has been highlighted in the literature and may have major consequences for the medical team. A publication by a Canadian anesthetist gave an impressive example of "medical experts," whose lack of experience of AFE led to a 4-year legal battle accusing several doctors of substandard care (11,25). It is of primary importance to make physicians more aware of the value of autopsy in cases of death immediately following a medical procedure, even if a complaint has not been filed. Some may believe that autopsy is useful only in the event of malpractice litigation. Experts in forensic medicine have observed that the number of autopsies has decreased (2), while the rate of discrepancies between clinical diagnosis and postmortem findings at autopsy reached 20% (26). An early autopsy gives more informative results and may reassure the physician as to the adequacy of management if a pathology unrelated to the medical procedure is diagnosed postmortem. Moreover, according to a North American evaluation of autopsy reports in litigation cases, there is no rational basis for fear of autopsy findings by doctors sued for medical malpractice (27). In our case, the cause of death was diagnosed without difficulty in view of the postmortem histological findings and the antemortem clinical and laboratory data in the patient's medical record. Finally, we stress the importance of collaboration between both clinicians and pathologists to argue the exact causes of death.

Conclusion

Autopsy assumes its full importance in an unexpected death of undetermined cause, related directly or indirectly to a medical procedure, when medical liability may be in question. Prior to autopsy, as much antemortem information should be available as possible, such as the clinical records or statements from the various medical staff involved, and including if possible blood samples taken before death. After AFE, investigation of maternal death, which usually requires little modification of standard autopsy protocol, is significant in arguing the exact causes of death and avoiding malpractice claims.

Acknowledgment

Sincere appreciation is expressed to Nina Crowte for her assistance in manuscript preparation.

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