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ORIGINAL ARTICLE

Anesthetic management of amniotic fluid embolism – a multi-center, retrospective, cohort study

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ABSTRACT

Introduction: Amniotic fluid embolism (AFE) is a rare and potentially lethal obstetric complication, commonly occurring during labor, delivery, or immediately postpartum. There is a paucity of data regarding incidence, risk factors, and clinical management. Our primary objective in this study was to evaluate clinical presentation of AFE and delineate anesthesia management of these cases.

Methods: This 10 years retrospective multi-center cohort study was performed in five tertiary university-affiliated medical centers, between the years 2005 and 2015. All documented cases of AFE identified according to the ICD guidelines were reviewed manually to determine eligibility for AFE according to Clark's criteria. All cases confirming Clark's diagnosis were included in the cohort.

Results: Throughout the study period, 20 cases of AFE were identified, with an incidence of 4.1 per 100,000 births. Average age at presentation was 35 ± 5 years. Seventy percent of cases presented during vaginal delivery, 20% occurred throughout a cesarean delivery, and 10% occurred during a dilation and evacuation procedure. The most common presenting symptom was sudden loss of consciousness in 12 parturients (66.7%), fetal bradycardia in 11 parturients (55%), and shortness of breath in 10 parturients (50%). Perimortem cesarean section was performed in 55% of cases, although only one case was performed in the delivery suite, while all others were performed in the operating room. Echocardiography was performed in 60% of the cases and all were pathological. Furthermore, 20% of cases were connected to an extracorporeal membrane oxygenation machine. There was a 15% mortality rate of 15%. A further 15% suffered major neurological disability, 25% suffered minor neurological morbidity, and 45% survived without severe complications.

Conclusion: AFE is associated with significant maternal morbidity. This study highlights the importance of providing advanced training for the delivery suite staff for cases of maternal cardiovascular collapse secondary to AFE and increasing awareness for this rare and devastating obstetric condition.

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Introduction

Amniotic fluid embolism (AFE) is a rare and devastating obstetric complication, typically occurring during labor, delivery or immediately postpartum [1,2]. Due to the infrequency of the condition and lack of international consensus regarding diagnostic criteria, the pathogenesis and pathophysiology of the condition remains poorly understood, with a paucity of existing data regarding incidence, outcomes, and risk factors of AFE [1,3,4].

Contemporary studies estimate an incidence of AFE ranges from 2.2 to 7.7 per 100,000 deliveries [5–7]. A recent Canadian population-based study that included hospital deliveries from 1991 to 2009 yielded an incidence of 2.5 per 100,000 deliveries for amniotic fluid embolism, with 27% of cases being fatal [8]. However, the true incidence is difficult to determine, with large discrepancies in published reports and therefore Clark proposed a model composed of four criteria's necessary to diagnose AFE [9]. The model

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encapsulated the following diagnostic criteria: acute hypotension or cardiac arrest, acute hypoxia, coagulopathy or severe hemorrhage in the absence of other explanations and all symptoms presenting during labor, delivery or within 30 min postpartum.

Because of the very rare incidence, variable presentation and unclear predisposing factors, treatment recommendations are very vague. In 2016, the society for fetal maternal medicine (SMFM) attempted to provide evidence-based recommendations for diagnosis and treatment of suspected AFE [1]. These recommendations included immediate high-grade resuscitation for AFE presenting as cardiac arrest, involvement of multidisciplinary team, provision of adequate ventilator and circulatory support, treatment of coagulopathy precipitated by AFE, and immediate delivery of the fetus in cases of cardiac arrest.

The primary aim of our study was to describe clinical presentation of cases of AFE and delineate anesthesia management of these cases. Secondary outcome was to describe incidence, risk factors, and maternal outcome.

Methods

This retrospective cohort study was performed between 2005 and 2015, in five tertiary university-affiliated medical centers. The delivery rate in each participating hospitals ranged between 6000 and 16,000 births per year. Approval was obtained from the local institutional review boards for all participating centers.

Cases of AFE were identified via electronic databases in the labor and delivery rooms. Each chart was manually reviewed in order to confirm the eligibility according to Clark's criteria. Only patients with sufficient documented information to determine eligibility of AFE according to Clark's criteria were included in the study.

Demographic data collected included maternal age, weight, parity, and gravidity. Obstetric information included prior cesarean deliveries, artificial reproduction therapy, obstetric conditions (gestational diabetes, macrosomia, polyhydramnios, preeclampsia, gestational hypertension, hypercoagulability in pregnancy, placenta previa), and obstetric outcomes (spontaneous, instrumental vaginal delivery, cesarean delivery).

Collected information regarding the AFE event included timing of the event occurrence (delivery, cesarean section, postpartum, or during an abortion), place of treatment (delivery suite, surgery room, post-anesthesia care unit or other), initial presenting symptoms, diagnostic measures used to confirm the diagnosis, use of unique diagnostic tools throughout the treatment process (thromboelastogram, echocardiography, CT, chest X-ray), time period from symptom presentation to diagnosis and treatment, maternal hemodynamic status throughout the event, monitoring devices, and maternal outcomes.

Our primary outcome was to evaluate clinical presentation of AFE and delineate anesthesia management of these cases. Secondary outcomes were to evaluate the maternal outcomes following an occurrence of AFE.

Results

Incidence of AFE

Throughout the study period, a total of 20 reported cases of AFE with manual conformation according to Clark's diagnosis were identified by a member of the research team in all five participating centers.

Over the study period, the total combined delivery rate births was 484,343 in the participating centers giving an incidence of 4.1 per 100,000 births.

AFE presentation

Fourteen women had an AFE during vaginal delivery (70%), four (20%) during cesarean section, and two (10%) during a dilation and evacuation procedure. Thirty percent of AFEs occurred during morning shift, 20% during afternoon shift, and 50% occurred during night shift. The average age at presentation was 35 ± 5 years. All women were healthy except one who had inactive asthma. None of women had hypertension, diabetes, or a hypercoagulable disorder. Two women (10%) had undergone artificial reproductive therapy. One of the parturients (5%) had undergone a previous cesarean section. Two cases (10%) of fetal macrosomia and three (15%) cases of polyhydramnios were noted among the study cohort. In three of the cases (15%), the onset of AFE occurred following rupture of the membranes.

The most common presenting symptom was sudden loss of consciousness in 12 parturients (66.7%), fetal bradycardia in 11 parturients (55%), shortness of breath in 10 parturients (50%), and hypotension in nine (45%) parturients. Other presenting symptoms included cyanosis in six parturients (30%), seizures in five parturients (25%), and bleeding in two parturients (20%). Six women (30%) presented with cardiac arrest.

Nineteen women (95%) had both coagulopathy and hypotension. Seventeen women (85%) developed uterine atony and 13 (65%) developed fetal bradycardia. Ten (50%) of women developed cardiac arrest during AFE.

Treatment

All parturients had one 20 g or 18G venous line at the time of AFE. After the incident, at least two additional

17G venous lines were inserted in every parturient. Nine women (45%) had at least one high flow catheter inserted. A arterial line was inserted in 13 parturients (65%) and nine cases (45%) had a central vein catheter inserted. Nine women (55%) were attached to a hot line infusing mechanism, and seven (35%) were attached to a rapid infusion system.

Twelve parturients (60%) received adrenalin during the event. The average dose was 2.4 ± 3.8 mg. Other commonly administered medications were calcium in eight parturients (40%), noradrenalin in six (30%) and phenylephrine in four (20%). Atropine was given in three parturients (15%), two received magnesium (10%), and one parturient received (5%) bicarbonate, intralipid, sodium bicarbonate and amiodarone.

Intubation was performed in 18 (90%) of the cases. The average time from event to intubation was 5.6 ± 5.7 min. There were no cases of difficult or failed intubation.

In 11 cases, cesarean delivery was performed as part of the resuscitation process (perimortem cesarean delivery). Only in one of the cases was the resuscitation performed in the delivery suite while all other cases of resuscitation were performed in the operating room. The average time from onset of AFE to delivery of the fetus was 10.3 ± 7.0 min.

All of the parturients received treatment with packed cells and products. Average transfused volume was 9.8 ± 8.3 units packed cells, 11.8 ± 7.3 units fresh frozen plasma, 21.9 ± 11.8 units cryoprecipitate, and 14.7 ± 10.8 units of platelets. In only one case was a thromboelastogram used to guide therapy. One woman (5%) received factor 7.

Echocardiography was performed in 12 of the cases throughout resuscitation, 10 of which had transesophageal echocardiography and two had transthoracic echocardiography. All of these women had pathology consistent with AFE. Half of these women had isolated right heart failure and half had combined right and left heart failure. In three parturients, echocardiography showed a massive embolus in the right ventricle.

Four women were connected to extracorporeal membrane oxygenation (ECMO) and one woman was attached to cardiopulmonary bypass It took an average of 90–300 min from onset of presenting symptoms to connection to the ECMO system.

Maternal outcomes

Of the 20 cases, three (15%) were fatal. All parturients who survived were admitted to the intensive care unit (ICU). The average length of stay in the ICU and hospital ranged from 2 to 30 d. Five women (25%) required a hysterectomy. Of the survivors, three suffered major neurological disability, five suffered minor neurological morbidity, and nine survived without severe complications.

Of the women attached to ECMO, two parturients died within the first few hours, one parturient suffered significant neurological morbidity and the one parturient suffered minor neurological damage. The woman attached to cardiopulmonary bypass died within first hours.

Discussion

The results of the current study demonstrated the incidence of AFE as four per 100,000 women giving birth. Our estimated incidence is consistent to previously reported frequencies [10–12]. The case fatality rate we found in the current study was 15%. This rate and similar rates in recent publications [5,11,13] suggest that although AFE remains a leading causes of maternal mortality in developed countries [14], the case fatality rate is not as high as has been previously believed [5] nonetheless the condition is associated with significant maternal morbidity [15]. In the current study, a large percent of the study cohort suffered neurological damage.

The average age of women in our study was 35 ± 5, higher than the national Israeli average age at birth of 30 [16], confirming previously reported studies that advanced maternal age is a risk factor for AFE. There has been an increase in frequency of pregnancy among women of advanced maternal age; these pregnancies have shown to be associated with more pregnancy complications including preeclampsia and maternal hemorrhage [17,18].

The key factors for successful management of AFE include early recognition, prompt resuscitation with initiation of chest compressions before performing rescue breathing, and delivery of the fetus [15]. In the 2015 guidelines, the society of maternal neonatal medicine guidelines highlights the importance of prompt delivery of the fetus. They suggest a delivery in under 5 min from maternal hemodynamic collapse (perimortom cesarean delivery) [1], in order to reduce fetal morbidity and improve maternal outcomes by removing aorto-caval compression due to the gravid uterus [11]. In our cohort the average time to fetal delivery was 10.3 min. The time frame that might have been shortened had most cases of cardiopulmonary resuscitation been performed in the delivery suite and not in the operating room. Although cardiopulmonary resuscitation was initiated in half of the cases, only in

one case was the resuscitation performed in the delivery suite. These findings emphasize the importance on providing first aid and advanced cardiovascular life support courses, for the delivery suite staff and insuring they are adequately trained in their initial resuscitation, in order to save the crucial time of moving the parturient to the operating room [11].

The use of advanced therapeutic approaches such as extracorporeal membrane oxygenation [1,2,19–21], for parturient suffering cardiovascular collapse secondary to AFE have been recently described in various case reports and in a recent review. However, evidence supporting beneficial outcomes for the use of these techniques is lacking. It should be noted that at the time of the study only one of these hospitals had an ECMO machine so all experience with this modality comes from a single center.

Aggressive transfusion protocols should be initiated in cases of severe hemorrhage commonly presenting with AFE [2]. Hysterectomy may be necessary in extreme cases of uncontrollable bleeding [15]. In this report, one hysterectomy was performed in 25% of cases [11]. Thromboelastogram has been described as a useful point of care tool in case of obstetric hemorrhage [1,22]. In spite of this, TEG was used infrequently in this series. This is in spite of the fact that during the study period all centers acquired a TEG machine. However, difficulty in use and lack of dedicated staffing to operate it may explain limited use in these cases.

Bedside echocardiography monitoring displaying right ventricle dysfunction in the acute stage of AFE is imperative for early diagnosis and guiding fluid treatment in cases the sudden event of maternal cardiovascular collapse [1]. Echocardiographic guided treatment in the current report might have contributed to reduced fatality cases.

The main weakness of the current study lays in its retrospective design and small cohort size. The current analysis only demonstrated 20 cases of AFE throughout the study period, thus raising the difficulty for obtaining significant statistical results. Additionally the current study was only performed in five medical centers and not in all Israeli hospitals. Another limiting factor is that all AFE cases were confirmed by Clark's criteria and not by postmortem examination as postmortem examinations are not accepted among Israeli patients. The lack of autopsy findings seems to be a worldwide problem in cases of AFE, a recent study about maternal morbidity due to amniotic fluid embolisms in France used clinical criteria for diagnosis as autopsy data were not available [23].

This is the first study to examine anesthesia management in cases of AFE. Our finding highlights the importance of providing advanced training for the delivery suite staff for cases of maternal cardiovascular collapse secondary to AFE, increasing awareness for this condition and preparing management modalities. Increased awareness and proper training for such cases will hopefully result in reduced fatality rate and improved maternal outcomes for this rare and devastating complication. This is the first step in developing a prospectively collected Israeli registry of amniotic fluid embolism.

Disclosure statement

No potential conflict of interest was reported by the authors.

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