Obstetrical and Pediatric Anesthesia

Two cases of hemorrhage secondary to amniotic fluid embolus managed with uterine artery embolization

[Deux cas d'hémorragie secondaire à une embolie amniotique traités par une embolisation de l'artère utérine]

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Purpose: To describe the anesthetic management of two cases of amniotic fluid embolus (AFE) and disseminated intravascular coagulation (DIC) who underwent bilateral uterine artery embolization to control their postpartum hemorrhage.

Clinical features: We report the clinical course and management of two women who suffered sudden cardiorespiratory events during labour. The first patient had a cardiac arrest whereas the second developed respiratory failure and altered neurological status. They were diagnosed as having had an AFE. Both of these events were accompanied by severe postpartum hemorrhage and DIC. They suffered prolonged bleeding and received massive transfusions. Successful management of hemorrhage was optimized by uterine artery embolization, thus avoiding ongoing problems with bleeding and possible hysterectomy. The role of uterine artery embolization is described, along with its advantages and anesthetic considerations.

Conclusion: Women with severe postpartum hemorrhage, with or without DIC, should be considered for uterine artery embolization.

Objectif : Décrire le traitement anesthésique de deux cas d'embolie amniotique (EA), et de coagulation intravasculaire disséminée (CIVD), par une embolisation utérine bilatérale réalisée pour stopper l'hémorragie postpartum.

Éléments cliniques : Nous présentons l'évolution et le traitement cliniques de deux femmes qui ont souffert d'événements cardiorespiratoires soudains pendant le travail obstétrical. La première a subi un arrêt cardiaque tandis que se sont développées chez la seconde une insuffisance respiratoire et une détérioration neurologique. Un diagnostic d'EA a été posé. Ces deux événements s'accompagnaient d'hé-

morragie postpartum sévère et de CIVD. Les patientes ont eu des saignements prolongés et ont reçu des transfusions massives. La réussite du traitement a été optimisée par l'embolisation de l'artère utérine, évitant ainsi d'autres problèmes liés au saignement et à une hystérectomie possible. Nous décrivons le rôle de l'embolisation de l'artère utérine et ses avantages et présentons des considérations anesthésiques.

Conclusion : Une embolisation de l'artère utérine doit être envisagée chez des femmes qui subissent de sévères hémorragies postpartum, avec ou sans CIVD.

AMNIOTIC fluid embolus (AFE) is one of the most devastating complications of pregnancy. It can be neither predicted nor prevented and therefore remains one of the most feared entities among those caring for pregnant patients. Similar to other embolic phenomena, the clinical presentation and manifestations are quite variable.¹ The development of a consumptive coagulopathy, with or without clinically significant bleeding, appears to be inevitable in most, if not all, patients with AFE.² Despite appropriate management of the coagulopathy, the associated morbidity and mortality remain high.¹

The following report describes two patients with the clinical diagnosis of AFE in whom the successful management of the bleeding and coagulopathy were facilitated by uterine artery embolization.

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Case 1

A 37-yr-old gravida 5 para 1 aborta 3 (G5P1A3) woman at 40 weeks gestation was admitted to hospital in early labour following an outpatient induction using dinoprostone cervical gel. Her contractions were every three minutes and her cervix was 3 cm dilated. Membranes were intact.

The previous obstetrical history included three spontaneous abortions and one uncomplicated spontaneous vaginal delivery. Her past medical history was otherwise unremarkable.

One hour after admission she had an uncomplicated epidural placed at the L3–4 level. Analgesia was initiated with 10 mL of 0.2% ropivacaine and 100 µg of fentanyl. This was followed by patient-controlled epidural analgesia (PCEA) using a 0.1% ropivacaine solution with 2 µg·mL⁻¹ fentanyl. The pump was programmed to deliver a 5-mL bolus with an eight-minute lockout interval. The background infusion was 10 mL·hr⁻¹ and the one hour limit was 40 mL.

An oxytocin infusion was then started for labour augmentation and the obstetrician ruptured her membranes. Thin meconium staining was noted. The patient remained hemodynamically stable throughout labour. Three hours postadmission, the cervix was fully dilated. Once the fetal head was 1 cm beyond the spines, oxytocin was discontinued and the patient was instructed to push. Following two pushes, she vomited, turned pale, clenched her teeth and collapsed. Simultaneously, the fetal heart rate dropped and the obstetrician began preparations for an emergency delivery.

On arrival, the anesthesiologist found a grey, cyanosed, unresponsive patient with a clenched jaw who was breathing spontaneously. The pupils were equal and not dilated. There was no posturing. The airway was managed initially with an oral airway and bag-valve-mask ventilation. A wedge was placed under the right hip and the epidural infusion discontinued. Shortly thereafter, it was confirmed that the patient was pulseless. Cardiopulmonary resuscitation was initiated while the neonatology and cardiac arrest teams were summoned. The patient was then given 120 mg of succinylcholine to facilitate intubation while cricoid pressure was applied. During this time, a 4000 g male child with Apgar scores of 4 and 8 at one and five minutes was born by vacuum delivery and resuscitated by the neonatology team.

Immediately following delivery, the electrocardiogram (ECG) was monitored. The patient was found to have pulseless electrical activity with sinus tachycardia at 125 beats·min⁻¹. Two doses of 1 mg of epinephrine were administered intravenously while the placenta was delivered by the obstetrical team. The patient's

heart rate increased to 150 beats·min⁻¹, the pulse became palpable and the blood pressure was 150/80. Pulse oximetry was not able to register a reliable waveform. At this point, the patient began to open her eyes and cough on the endotracheal tube but did not follow commands. Therefore she was sedated and paralyzed to facilitate further management.

A vaginal laceration was repaired quickly yet the patient continued to have a steady blood loss despite good uterine tone. The vaginal bleeding was continuous, soaking through the bed sheets. Blood also accumulated within the uterus and became evident when the uterus was massaged. Initially, two doses of ergonovine maleate 0.25 mg were given intramuscularly along with four doses of carboprost tromethamine 0.25 mg intramyometrially. Oxytocin was initially withheld until the patient was hemodynamically stable. Within 30 min, a solution containing 40 U·L⁻¹ of oxytocin was infused at a rate of 50 mL·hr⁻¹.

The patient was transferred to the intensive care unit (ICU) within one hour of cardiac arrest, prior to the start of any transfusion therapy. Vaginal bleeding persisted. Arterial and central venous access were obtained via the femoral vein and artery as well as via the internal jugular vein. Although the patient was clinically coagulopathic, it was felt that the risks of obtaining venous access in the neck were acceptable given that this is a compressible area. The patient was ventilated with 100% oxygen using a pressure control mode. The ECG had an S wave in lead I, as well as a Q wave and an inverted T wave in lead 3 (SIQ3T3 pattern found in pulmonary embolus) but was otherwise within normal limits. Bloodwork drawn on admission to the ICU showed a hemoglobin concentration of 75 g·L⁻¹ and platelet count 125 × 10⁹·L⁻¹. The INR of the prothrombin time was 2.4 and partial thromboplastin time (PTT) 129 sec. Arterial blood gases showed a pH of 7.15, pCO₂ 46 mmHg, pO₂ 69 mmHg and bicarbonate concentration of 15 meq·L⁻¹. A clinical diagnosis of AFE with associated disseminated intravascular coagulation (DIC) was made.

While preparations were made for uterine artery embolization, the patient received blood products consisting of 24 U of packed red blood cells, 14 U of fresh frozen plasma (FFP) and 10 U of cryoprecipitate. The transfusions were made largely on clinical grounds based on the degree of bleeding and the ensuing hemodynamic instability that had worsened after admission to the ICU.

At five hours postpartum, she was transferred to the radiology department where she underwent bilateral uterine artery embolization using polyvinyl alcohol (300–500 microns). At the time of transfer, the hemo-

globin concentration was $135 \text{ g}\cdot\text{L}^{-1}$ (indicating over transfusion of red blood cells at that point), platelets $38 \times 10^9\cdot\text{L}^{-1}$, INR 1.5, PTT 69.0 sec and fibrinogen $0.79 \text{ g}\cdot\text{L}^{-1}$. She was still bleeding when she was transferred to the radiology department and required an additional 3 U of packed red blood cells, 8 U of FFP, 16 U of cryoprecipitate and 5 U of platelets during the embolization. Again, the transfusions were made on clinical grounds and based on the previous bloodwork as the turnaround time for coagulation testing in our institution (during night time hours) is greater than one hour. At the conclusion of the procedure, the hemoglobin concentration was $78 \text{ g}\cdot\text{L}^{-1}$, platelets $54 \times 10^9\cdot\text{L}^{-1}$, INR 1.1 and PTT 36 sec. There was no further bleeding and no blood products were administered after the procedure.

During the procedure, an anesthesiologist managed the patient with the assistance of the ICU nurse and a respiratory therapist. The patient was hemodynamically stable throughout and no cardiovascular support was necessary. Infusions of midazolam and cisatracurium were used for sedation and neuromuscular blockade. Morphine, 10 mg, was administered for analgesia. The patient was ventilated with 100% oxygen using a pressure control mode with an inspiratory pressure of 14 cm H_2O and a positive end-expiratory pressure (PEEP) of 12 cm H_2O . Tidal volumes were approximately 500 mL at a rate of 30 breaths $\cdot\text{min}^{-1}$. The first blood gas showed a pH of 7.25, pCO_2 37 mmHg, PO_2 233 mmHg and bicarbonate concentration 16 meq $\cdot\text{L}^{-1}$. The ventilation was adjusted to normalize the pH.

On postpartum day one, there was no evidence of venous thrombosis in the legs by ultrasonography. A transthoracic echocardiogram was significant for right ventricular enlargement and dysfunction, right atrial enlargement and moderate tricuspid regurgitation. The right ventricular systolic pressure was 48 mmHg. The findings of right heart overload are interesting but their significance is not known as there is limited human data regarding the echocardiographic changes with AFE.

The patient was extubated on postpartum day two and eventually discharged home in good condition on day nine. She had no recall of the cardiac arrest or of her subsequent ventilation in the ICU.

Case 2

A 31-yr-old G2P1 woman was admitted to the labour floor at 38 weeks gestation for induction of labour due to pregnancy induced hypertension of two weeks' duration. Her blood pressure on admission was 130/90. Prior to this, her pregnancy had been uncomplicated.

Previous obstetric history was significant for an uncomplicated spontaneous vaginal delivery three years earlier. Her past medical history was significant for type I diabetes of 18 years duration with no end-organ damage. Her glycemic control during pregnancy had been good. She was also hypothyroid and on oral replacement therapy.

Induction of labour was initiated with dinoprostone gel and her diabetes was managed using an insulin infusion. No augmentation with oxytocin was necessary. Blood pressure was normal throughout as were laboratory tests on admission. Eight hours later, the patient was in established labour and the anesthesia service was consulted for epidural analgesia. A combined spinal epidural was performed at the L3–4 interspace. An intrathecal dose of 2.5 mg of isobaric bupivacaine and 25 μg of fentanyl was administered with good results. An epidural infusion of ropivacaine 0.1% with 2 $\mu\text{g}\cdot\text{mL}^{-1}$ of fentanyl was initiated using a PCEA pump. The pump was programmed to deliver a 5-mL bolus with an eight-minute lockout period. The background infusion was 10 mL $\cdot\text{hr}^{-1}$ and the one hour limit was 40 mL. The patient remained comfortable and her labour progressed uneventfully.

Approximately five hours after epidural placement, the patient was found to be unresponsive, diaphoretic and restless with rapid shallow breathing. Her blood pressure was 90/60 and she was tachycardic. The blood sugar concentration was 6.7 mmol $\cdot\text{L}^{-1}$. At the same time, the fetus experienced a bradycardia of 60 beats $\cdot\text{minute}^{-1}$. The cervix was fully dilated and the fetus presenting directly occiput anterior. The obstetrician and anesthesiologist were summoned urgently and the epidural infusion was discontinued.

The obstetrician quickly performed a vacuum delivery. A live male infant weighing 3830 g was cared for by the neonatology team. Apgar scores were 4, 7, and 8 at one, five and ten minutes. The placenta delivered spontaneously with no evidence of an abruption. A second degree vaginal tear was repaired.

When the anesthesiologist arrived, the delivery was ongoing. A wedge was present under the right hip. The patient was rousable, oriented to person and place but had a depressed level of consciousness, opening her eyes to only voice and painful stimuli. She was acutely short of breath with a respiratory rate of approximately 30 breaths $\cdot\text{min}^{-1}$. Blood pressure was 105/80. Heart sounds were normal and the chest was clear to auscultation. The jugular venous pressure could not be assessed. One hundred percent oxygen was administered via a bag and mask. She maintained her own airway and did not require assisted respirations. A second large-bore *iv* was started and oxygen saturation and ECG monitoring were instituted.

Over the next hour, the patient's clinical status remained unstable. She had a sinus tachycardia of 100 to 150 beats·min⁻¹, systolic blood pressures varied between 65 and 135 and oxygen saturations fluctuated between 80 and 95%. Throughout this, her level of consciousness remained unchanged from the initial presentation. The patient's circulation was supported initially with boluses of crystalloid and pentastarch as well as with ephedrine and epinephrine. A total of 50 mg of ephedrine was given along with 140 µg of epinephrine in aliquots of 20 to 40 µg. Arterial and central venous access was obtained via the femoral vessels.

The obstetrician noted a steady blood loss immediately postpartum despite repair of the laceration and good uterine tone. The patient received two doses of ergonovine maleate 0.25 mg intramuscularly and four doses of carboprost tromethamine 0.25 mg intramyometrially along with 1000 µg of misoprostol per rectum. No vaginal clots were seen at any point. Oxytocin was not administered initially due to hemodynamic instability but an infusion was instituted approximately two hours postpartum. A blood sample sent 20 min postpartum revealed a hemoglobin of 112 g·L⁻¹ and platelets of $22 \times 10^9 \cdot \text{L}^{-1}$. At one hour, the hemoglobin was 86 g·L⁻¹ and the platelets $80 \times 10^9 \cdot \text{L}^{-1}$. Unfortunately coagulation tests clotted on both occasions and were unavailable until two hours later. It was not clear why the initial platelet count was so low and a laboratory error was suspected at the time.

A clinical diagnosis of AFE and associated DIC was made. Fluid resuscitation included 7000 mL of crystalloid, 1000 mL of pentastarch, 8 U of FFP and 6 U of packed red blood cells. The transfusion was on clinical grounds, based on the initial bloodwork and rate of bleeding. Coagulopathy was initially presumed. After this resuscitation, the patient remained coagulopathic. Her INR was 1.5, PTT 72 sec, fibrinogen 0.44 g·L⁻¹ and D-dimer 35 mg·L⁻¹. The hemoglobin concentration was 93 g·L⁻¹ and the platelet count $44 \times 10^9 \cdot \text{L}^{-1}$.

Although the patient's hemodynamic status stabilized during resuscitation, neither her mental or respiratory status improved. Consequently, a rapid sequence induction was performed using midazolam, ketamine and succinylcholine. Sedation was maintained and she was transported to the ICU with her vagina packed.

In the ICU, the patient was ventilated using a pressure support mode and 60% oxygen. Chest *x-ray* on arrival was remarkable only for mild atelectasis; no airspace disease was noted. Arterial blood gas measurements showed a pH of 7.22, pCO₂ 42 mmHg, PO₂ 80 mmHg and bicarbonate concentration 17 meq·L⁻¹.

Given her on-going coagulopathy and bleeding, the radiology team was mobilized and the patient was

taken to the radiology department for uterine artery embolization with a Gelfoam® (Pharmacia and Upjohn, Kalamazoo, MI, USA) slurry.

During the procedure, an anesthesiologist managed the patient with the assistance of the ICU nurse and a respiratory therapist. She was hemodynamically stable and required no cardiovascular support. The patient was sedated with a propofol infusion of 100 to 125 µg·kg⁻¹·min⁻¹ and received 15 mg of morphine for analgesia. Neuromuscular blockade was maintained with a cis-atracurium infusion. A pressure control mode of ventilation was used with an inspiratory pressure of 10 cm H₂O and a PEEP of 10 cm H₂O. The tidal volume was approximately 350 mL at a rate of 16 breaths·min⁻¹. The initial arterial blood gas (on 100% oxygen) showed a pH of 7.16, pCO₂ 58 mmHg, pO₂ 93 mmHg and bicarbonate concentration 20 meq·L⁻¹. Ventilation was adjusted to normalize pH. During the procedure six more units of FFP and 16 U of cryoprecipitate were given on clinical grounds, based on the earlier bloodwork. The procedure concluded at seven hours postpartum. The patient was then returned to the ICU with no further bleeding. The hemoglobin concentration was 75 g·L⁻¹ and the platelets $71 \times 10^9 \cdot \text{L}^{-1}$. The INR was 1.2, PTT 37 sec and the fibrinogen concentration 1.86 g·L⁻¹.

The following day, an echocardiogram demonstrated normal left ventricular and right ventricular size and function. The valves were normal except for mild to moderate tricuspid regurgitation. There was right atrial enlargement and a right ventricular systolic pressure of 30 mmHg assuming a right atrial pressure of 10 mmHg. Doppler ultrasound examination of the leg veins was unremarkable. As stated in the first case, the significance of the signs of right heart overload is unknown. The trachea was extubated by 16 hr postpartum. The patient and her baby were discharged from the hospital on day eight with no further sequelae. The patient had very little recall of the events in the labour room.

Discussion

DIC is a common complication of AFE and, in some cases, a bleeding diathesis may be the initial clinical presentation.³ At present, the etiology remains obscure. Some authors have found substantial quantities of tissue factor in amniotic fluid and have suggested that this may be the triggering agent.⁴ This factor, derived from fetal epithelial cells, is able to bind with factor VII and cause activation of the coagulation system via the extrinsic pathway. Once the coagulation cascade has been activated, life-threatening hemorrhage may result secondary to consumption of the coagulation factors and activation of the fibrinolytic system.

At present, the treatment of the coagulopathy associated with AFE has primarily consisted of blood component therapy. In addition, ongoing hemorrhage may necessitate hysterectomy. Although uterine artery embolization has been described for the management of postpartum hemorrhage, its use in this setting has only been described once in the French literature.⁵ In a previous English language publication,⁶ embolization of the vaginal arteries was reported but was unsuccessful in avoiding abdominal hysterectomy.

Arterial embolization has been used to control gynecologic bleeding for over 20 years.⁷ Its role has recently been reviewed and evaluated.⁸ It has been used to control bleeding from arteriovenous malformations, postpartum hemorrhage, ectopic pregnancy and uterine leiomyomas as well as prophylactically in cases such as placenta percreta where postpartum bleeding is anticipated.

Uterine artery embolization is performed by interventional radiologists in the angiography suite. The procedure takes approximately one to two hours. Typically, both uterine arteries can be accessed via a single femoral artery. Although metal coils can be placed, this is seldom done, as it is quite permanent. The usual agents are either Gelfoam® (Pharmacia and Upjohn, Kalamazoo, MI, USA) or polyvinyl alcohol particles (PVA). The Gelfoam® is a gelatin sponge material that recanalizes in about two to three weeks. PVA consist of tiny alcohol coated beads that are not known to recanalize. Both products embolize distal vessels that the radiologists control by selecting different sizes of particles. This procedure is compatible with resumption of menstruation and preservation of fertility.⁹ A recent systematic review found that embolization was successful in 95% of the 138 published cases of postpartum hemorrhage. The complication rate was 8.7%.⁸ Coagulopathy is not a contra-indication and does not seem to affect efficacy.^{10–12} Occasionally, failures are rescued by a repeated embolization.^{10–12} Bleeding after hysterectomy has also been rescued by embolization.¹¹

There are many advantages to embolization therapy. It appears to be more effective than surgical ligation of vessels and preserves fertility. It is less invasive than surgery and safer in a coagulopathic patient. The complication rate is low and many of these are relatively minor. Finally, transfusion may be minimized. This procedure should be considered in all postpartum hemorrhages if the service is available and if not, transfer should be considered if the patient is stable.

Anesthesiologists should be part of the team that manages these patients in the radiology department. Anesthetic considerations for this procedure include

those of a hemorrhagic patient, off-site surgery and minimal access. Unless the patient is very stable, it is useful to have the patient sedated, the trachea intubated and the lungs ventilated. On-going transfusion therapy and regular measurements of hemoglobin concentration and coagulation parameters are also necessary.

In conclusion, we report two cases of a clinically diagnosed AFE complicated by DIC whose management was facilitated by using uterine artery embolization.

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