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Application of Cell-salvage during Cesarean Section

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THE use of cell salvage in obstetrics has been controversial because of theoretical concerns of aspirating and reinfusing amniotic fluid. Amniotic fluid is known to contain lanugo hair, vernix caseosa, meconium, fetal cellular debris, and tissue factor, any or all of which can cause the symptoms of amniotic fluid embolism resulting in cardiovascular collapse and disseminated intravascular coagulopathy. Support for the use of cell salvage in obstetric hemorrhage is scant[1] but justification for its use can be argued in the case of life-threatening postpartum hemorrhage. In this case report, the uncomplicated application of cell salvage in a high-risk obstetric patient is discussed.

Case Report

A 40-yr-old woman, gravida 2 para 1, presented to the operating room for elective cesarean section. The pregnancy was complicated by a complete placental previa. Her surgical history included a previous cesarean section with a placental previa that involved bleeding (estimated to be 3,000 ml), multiple transfusions, disseminated intravascular coagulopathy, and congestive heart failure. She had also undergone uterine myomectomy previously. Her medical history included class A_2 diabetes mellitus and morbid obesity (118 kg, 1.73 m). Her airway examination revealed a Mallampati class III airway with full neck range of motion and full dentition. With this history it was thought that she was at high risk of having a placenta accreta and significant perioperative blood loss.

A combined spinal–epidural anesthetic was performed with a 25-gauge Sprotte needle through an 18-gauge Tuohy needle. After injection of 12 mg hyperbaric bupivacaine, an epidural catheter was placed. A T_4 level was obtained and a cesarean section was performed. At amniotomy, the amniotic fluid was suctioned to the wall suction and then switched to suction connected to the cell saver. This was done to minimize the amniotic fluid contamination of the salvaged blood. A viable female infant was delivered who was subsequently given APGAR scores of 7 and 9 at 1 and 5 min, respectively. No meconium was noted at delivery. The placenta was delivered with little difficulty; however, attempts to externalize the uterus for repair were hindered by multiple adhesions of the bowel to the uterus. These adhesions led to continuous wound oozing. During the course of uterine repair, approximately 1,800 ml blood was lost and salvaged into a reservoir with a 40-μm screen. This blood was washed with a Medtronic Sequestra 1000 (Medtronic, Minneapolis, MN). The Latham-design centrifuge bowl was filled at a speed of 500 ml/min, the wash rate was 300 ml/min, and the total normal saline wash volume was 1,500 ml. During the wash, the centrifuge speed was intermittently slowed from 5,600 to 4,800 rpm. This was performed to achieve a better-quality wash by reordering the cell pack. Salvage resulted in 250 ml blood with a hematocrit concentration of 65% being returned to the patient. In addition to the washed blood, the patient also received 4 l of Ringer's lactate solution. No colloid solution for volume resuscitation was administered. Laboratory values were obtained serially during the procedure and postoperatively. Hemoglobin level was measured *via* a B-Hemoglobin photometer (Hemocue AB, Ängelholm, Sweden), prothrombin time and partial thromboplastin time were measured using a Coaguchek (Boehringer Mannheim, Indianapolis, IN; table 1). Platelet function and dynamic assessment of coagulation function was performed using both a Litton Datamedix Thromboelastograph D (Haemoscope, Skokie, IL; table 2) and a Sonoclot II Surgical analyzer (Sienco, Morrison, CO; table 3). The surgical procedure lasted 2 h 10 min with no dosing of the epidural catheter needed to extend the anesthetic.

Postoperatively, fever developed in the patient (38°C) on the first postoperative day, which extended through the third postoperative day. Blood and urine cultures were obtained. The urine culture was positive for *Escherichia coli*. The blood culture was negative. Her presumptive diagnosis was endomyometritis attributed to an inability to express the uterus at the end of the surgical procedure. The patient was treated with antibiotics at the time of culture with subsequent resolution of the fever. She was discharged to home on the fourth postoperative day with a hemoglobin level of 9.6 gm/dl.

Table 1. Values of Hemoglobin (Hgb), Prothrombin Time (PT), and Partial Thromboplastin Time (PTT)

Time	Hgb (g/dl)	PT (s)	PTT (s)
Preop	13.7	12.0	<18
Postdelivery	11.6	11.9	<18
1 h	12.1	12.1	<18
6 h	12.6	12.6	<18
24 h	10.8		
Discharge	9.6		

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Key words: Amniotic fluid embolism; autotransfusion; obstetrics.

Table 2. TEG Parameters

Time	r (min)	MA (min)	K (min)	r + K (min)	α (°)	Clot Lysis Index (%)
Postdelivery	7	70.5	2	9	64	94.3
1 h	7	71.5	2	9	63	93.7
6 h	12	58.5	4.25	16.3	43.5	91.7

r = reaction time (normal range 6–8 min); MA = maximum amplitude (normal range 50–70 mm); K = clot formation time (normal range 3–6 min); r + K = coagulation time (normal range 10–12 min); α = clot formation rate (normal range 50–60°); Clot Lysis Index = amplitude at 60 min/MA × 100 (normal range >85%).

Discussion

This patient's history suggested that significant, and potentially life-threatening, perioperative blood loss could occur. Anecdotal reports of cell-salvage use in the obstetric patient led us to believe that with careful cell washing, this patient could be safely treated with this technology. Because the application of this technology had not been previously reported, careful monitoring of this patient's hemodynamic and coagulation function was applied. No significant changes in blood pressure or heart rate were seen during or after the transfusion, nor were changes in coagulation function observed.

When applying cell-salvage technology in the obstetric patient, an understanding of the risks needs to be considered. When first analyzing this issue, the first question to ask is, "How effective is the cell washing?." Recently, Bernstein and colleagues[2] demonstrated that active tissue factor is totally eliminated from blood contaminated with amniotic fluid. This was the first study that looked at the effectiveness of washing blood contaminated with amniotic fluid. Amniotic fluid–derived tissue factor is thought to be a potent initiator of coagulation and a component of amniotic fluid embolism leading to disseminated intravascular coagulopathy. Unfortunately, tissue factor may be one of many components that lead to the syndrome of amniotic fluid embolism.[3] Therefore, washing of this tissue factor would not guarantee that amniotic fluid embolism would not occur.

Several studies[4,5] assessing the removal of free hemoglobin, bromocreosol green dye, and heparin from salvaged blood would suggest that if one factor is effectively removed, than the other factors are equally removed. Therefore, if tissue factor is effectively removed from blood contaminated with amniotic fluid, these previous studies would suggest that the other components of amniotic fluid would also be similarly removed or reduced significantly in concentration.

In the efficacy studies referenced,[4,5] the authors used the elimination of 95–98% of contaminants as a goal. By using separate suction devices, one for amniotic fluid obtained at amniotomy and the other for blood obtained during all other times, the contamination of the salvaged blood is minimized. The smaller the overall contamination of the salvaged erythrocytes, the lower the resultant concentration in the washed product. This would add an additional factor of safety to the technique.

The alternative to cell-salvaged blood is the traditional transfusion of allogeneic blood. Allogeneic blood carries risks of its own, including immunosuppression, alloimmunization,[6] and viral infection.[7] Probably the most important effect is that of immunosuppression. Some studies have shown that a 5- to 10-fold increase in

Table 3. Sonoclot Results

Time	SonACT (s)	Clot Rate (units)	Peak Time (min)	Peak Height (%)	Rate of Descent	Platelet Activity
Preop	106	26	13	100	None	Minimal
Postdelivery	118	22	14	80	None	Minimal
1 h	102	25	9.5	90	10	Normal
6 h	76	22	17	90	None	Minimal

The sonoclot test is a viscoelastographic measurement of overall clot formation. It allows for the measurement of initiation of clot formation as is represented as SonACT. As fibrinogen is actively converted to fibrin monomer, the first upslope of the curve is measured for the slope of the line. Normal conversion of fibrin should be 25–35 units/min and is represented by the clot rate. As fibrin monomer crosslinks to fibrin polymer, and as platelet activation occurs, there is shortening of the fibrin mesh, resulting in a peak of activity at greater than 80 units on the vertical scale (Peak height) at approximately 12–14 min (Peak rate). As the pseudopods of the activated platelets contract their myosin fibrils, clot retraction occurs. Platelets have the only contractile elements in a blood clot. The strength of platelet aggregation and contraction is depicted as a narrow peak followed by a declining slope. Decreased platelet activity is found with minimal contraction and declining slope of less than 5 units (Rate of Descent). If fibrinolysis is occurring, the rate of decline will be more rapid and will continue past the point of 50% peak height on the vertical axis. Many things may affect the activity of platelets and clot retraction. Sonoclot is very sensitive in detecting abnormalities.

postoperative infection occurs in patients who have received allogeneic blood products. In the patient who has undergone cesarean section, who already experiences a high rate of infection of 5–25%,[8] an increase such as this significantly increases peripartum morbidity.[9]

Although this case report does not, by any means, prove the safety of cell salvage in obstetrics, it supports its consideration in the face of life-threatening obstetric hemorrhage. Currently, the paucity of data regarding this technique in the obstetric setting makes meaningful risk–benefit analysis impossible. Extensive prospective studies of its safety still need to be performed.

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Epidural Anesthesia in a Parturient with a Lumboperitoneal Shunt

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LUMBOPERITONEAL shunts are used to treat pseudotumor cerebri in patients with intractable headaches or progressive visual dysfunction unresponsive to conservative management (diuretics, steroids, serial lumbar punctures).[1,2] Thirteen parturient patients with lumboperitoneal shunts for pseudotumor cerebri have been described.[1–6] Most had normal pregnancy outcome, but labor pain management was not addressed. We report a case of epidural anesthesia in a parturient patient with preeclampsia and a lumboperitoneal shunt for pseudotumor cerebri.

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Key words: Cerebrospinal fluid shunt; labor; pregnancy; pseudotumor cerebri.

Case Report

A 26-yr-old women, gravida 7, paragravida 1, was admitted at 32 weeks' gestation with severe preeclampsia. Her history included pseudotumor cerebri successfully treated 5 yr before with placement of a lumboperitoneal shunt at the L3–4 interspace. The preanesthetic evaluation revealed that she was obese (120 kg; body mass index, 41.5 kg/m^2) and had an adequate airway anatomy and a normal platelet count ($201 \times 10^9/l$).

Five days later, because of worsening clinical status, labor was induced with oxytocin. Repeated examination by the same anesthesiologist revealed significant changes in her airway since the initial evaluation. Her tongue obstructed the view of the soft palate and