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Chapter 9

Peripartum Hysterectomy

Zouhair O. Amarin

Additional information is available at the end of the chapter

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Abstract

Peripartum hysterectomy is uncommon in modern obstetrics. It is mostly performed as an emergency procedure to control life-threatening haemorrhage. Despite recent technical advances in medicine, it is associated with high rates of morbidity and mortality. Peripartum hysterectomy constitutes a life-saving procedure.

Keywords: Hysterectomy, Peripartum, Postpartum haemorrhage

1. Introduction

Peripartum hysterectomy can be defined as the removal of the corpus uteri alone or with the cervix at the time of a caesarean section or within the puerperium. The removal of the uterus at caesarean section is referred to as caesarean hysterectomy, while the removal after vaginal birth is called postpartum hysterectomy. The operation may be performed as an emergency or as a planned procedure [1,2].

Although uncommon in modern obstetrics, peripartum hysterectomy is one of the most devastating complications in obstetrics. It represents a catastrophic end to a pregnancy to all women in general and to those wanting to maintain their fertility in particular [3,4].

Despite advances in medicine and surgery, peripartum hysterectomy is associated with high rates of morbidity, near miss and mortality. It is mostly performed as an emergency procedure to control torrential life-threatening haemorrhage and remains a life-saving procedure [1,2,5].

2. History

Peripartum hysterectomy was proposed in 1768 by Joseph Cavallini in animal experiments. In 1823, James Blundell approved caesarean hysterectomy on a work based on rabbits. The first documented caesarean hysterectomy was performed by Horatio Storer in 1869. The patient died 68 h after surgery. In 1876, Eduardo Porro performed the first caesarean hysterectomy in which both the mother and baby survived. His patient was a 25-year-old primiparous dwarf. A constricting wire was passed around the cervix to control haemorrhage, and the uterus was excised. The abdominal wound was closed with silver wire. Various modifications followed, such as those of Godson in 1884 and Lawson in 1890 [6].

3. Incidence

In modern obstetrics, there are considerable differences in the incidence of emergency peripartum hysterectomy in different parts of the world, with higher figures in low-resource countries, while developed countries generally report lower rates [7,8]. The variations may be related to the standard of antenatal care, unbooked emergencies, obstetric care, differing rates of caesarean delivery, different patterns of parity, maternal age and the earlier recourse to hysterectomy due to the lack of adequate blood and blood banking facilities. In addition, certain conservative procedures involving interventional radiology may not be available in most developing countries [9].

In a recent review of relevant articles in English literature, the incidence of emergency peripartum hysterectomy ranged from 0.24 to 8.7 per 1000 deliveries [10].

4. Risk factors

Emergency peripartum hysterectomy was found to be more common following caesarean section than vaginal deliveries. In addition, there is a significant association between emergency peripartum hysterectomy and previous caesarean section and placenta praevia. The risk of emergency peripartum hysterectomy increases with the number of previous caesarean sections. There is an increased incidence of previous caesarean section in patients with placenta praevia and in patients with adherent placenta [11-23].

To estimate the magnitude of increased maternal morbidity associated with increasing number of caesarean deliveries, Silver et al. in a prospective observational cohort of 30,132 women who had caesarean delivery without labour in 19 academic centres over 4 years found that placenta accreta was present in 15 (0.24 %), 49 (0.31%), 36 (0.57 %), 31 (2.13 %), 6 (2.33 %) and 6 (6.74 %) women undergoing their first, second, third, fourth, fifth and sixth or more caesarean deliveries, respectively. Hysterectomy was required in 40 (0.65 %) first, 67 (0.42 %) second, 57 (0.90 %) third, 35 (2.41 %) fourth, 9 (3.49 %) fifth and 8 (8.99 %) sixth or more caesarean deliveries.

Furthermore, in women with praevia, the risk for placenta accreta was 3 %, 11 %, 40 %, 61 % and 67 % for first, second, third, fourth and fifth or more repeat caesarean deliveries, respectively [24].

The incidence of emergency peripartum hysterectomy is rising worldwide in view of the rising caesarean section rate and the concomitant rise in placenta praevia and placenta praevia accreta and multiple births [25].

5. Indications

Besides the predominant reported indications for emergency peripartum hysterectomy that include uterine atony, placenta praevia, placenta praevia accreta and uterine rupture, other reported risk factors include precipitate labour, induction, prolonged labour, dystocia, cephalopelvic disproportion, augmentation, foetal macrosomia, multiple pregnancy, retained products of conception, previous endometrial curettage, coagulopathy, thrombocytopenia, maternal obesity, advanced maternal age, previous primary postpartum haemorrhage, gestational diabetes and abruptio placentae, particularly the concealed variety that is associated with Couvelaire uterus. All were identified as independent risk factors for uterine atony [11-23].

Elective peripartum hysterectomy may be performed in patients with an antepartum diagnosis of placenta accreta or stage IA2 and IB1 cervical carcinoma [2]. Severe postpartum infection unresponsive to medical therapy and placental site vessel subinvolution are other potential indications for the procedure [26,27].

5.1. Postpartum haemorrhage

Severe post partum haemorrhage remains a significant cause of maternal morbidity and mortality in both developed and developing countries [28,29]. The rate of postpartum haemorrhage requiring blood transfusion was reported to occur in 1.7% deliveries [30]. Maternal complications of postpartum haemorrhage include hypovolaemic shock, disseminated intravascular coagulopathy (DIC), renal failure, hepatic failure and acute respiratory distress syndrome (ARDS) [31,32]. The most severe complication of haemorrhage is maternal death.

Haemorrhage, in general, is classified into four categories [33] (Table 1). Postpartum haemorrhage is measured by the loss of greater than 500 ml of blood following vaginal birth or 1000 ml of blood following caesarean section [34]. Postpartum haemorrhage can be minor (500–1000 ml) or major (more than 1000 ml). Major postpartum haemorrhage could be divided to moderate (1000–2000 ml) or severe (more than 2000 ml). A blood loss of more than 2000 ml is regarded as ‘life threatening’.

Category	I	II	III	IV
Blood loss (ml)	<750	750–1500	1500–2000	>2000
Blood loss (%)	<15 %	15–30 %	30–40 %	>40 %
Pulse rate/min	<100	>100	>120	>140
Blood pressure	Normal	Hypo	Hypo	Hypo
Respiratory rate/min	14–20	20–30	30–40	>35
Urine output (ml/hour)	>30	20–30	5–15	<5
Signs and symptoms	None	Fatigue, pallor	Confusion	Life threatening
Action: stop loss	Observe	IV fluid	Blood transfusion	Blood transfusion

Table 1. Classification of haemorrhage

Haemorrhagic shock is a life-threatening condition that results when more than 20 % of the body's blood is lost. Symptoms include anxiety, blue lips and fingernails, low or no urine output, profuse sweating, tachypnoea, dizziness, confusion, chest pain, loss of consciousness, hypotension, tachycardia and weak pulse [35].

A Cochrane review addressed the use of uterotonics in the third stage of labour. It indicated that, for women delivering vaginally, oxytocin 5 IU by intramuscular injection is the regimen of choice for routine prophylaxis against postpartum haemorrhage. In the context of caesarean delivery, oxytocin 5 IU by intravenous injection is the recommended routine for prophylaxis against postpartum haemorrhage; the drug should be given slowly to avoid the risk of profound hypotension [36].

Drug	Route	Dose	Frequency
Oxytocin	IV	10–40 U in 1 L N saline	Continuous
Oxytocin	IM	10 U	
Ergometrine*	IM	0.5 mg	Every 2–4 h
PGF2α**	IM or intra-myometrially	0.25 mg	Every 15–90 min. Max. 8
PGE2	Vaginal or rectal	20 mg	Every 2 h
PGE1	Rectal	1 mg	

* Contraindicated in women with hypertension

** Contraindicated in women with asthma

Table 2. Pharmacological management of postpartum haemorrhage

To arrest postpartum haemorrhage, algorithms have been proposed to aid its systematic management. Procedures for immediate management of postpartum haemorrhage include the use of pharmacological uterotonic drugs (Table 2), uterine massage or bimanual uterine

compression on an empty bladder, the initiation of blood and blood components therapy (Table 3), repair of genital tract lacerations, evacuation of retained products of conception, the implementation of uterine or internal iliac arteries or anterior division of internal iliac arteries embolisation (Figure 1), uterine tamponade techniques (Table 4) (Figure 2), uterine compression sutures (Figure 3), systematic pelvic devascularisation (Figure 4), internal iliac artery ligation (Figure 5) and recombinant-activated factor VII for category III and IV postpartum haemorrhage [37-44] . Consideration should be given to the possibility that placenta praevia percreta may extend into the bladder and other pelvic organs. Clinicians need to be aware of the appropriateness and the timing of instituting interventions.

Product	Volume	Contents	Effect [per unit]
Packed red cells	240 ml	RBC, WBC, plasma	Increase PCV 3 % points, Hb 1 g/dl
Platelets	50 ml	Platelets, RBC, WBC, plasma	Increase platelet 5,000–10,000/μl
Fresh frozen plasma	250 ml	Fibrinogen, antithrombin III, V, VIII	Increase fibrinogen by 10 mg/dl
Cryoprecipitate	40 ml	Fibrinogen, VIII, XIII, VWF	Increase fibrinogen by 10 mg/dl

Table 3. Blood component therapy

Modality	Method
Packing	4-inch gauze in 5 ml of sterile saline
Foley catheter	Insert one or more bulbs, instil 60–80 ml of saline
Sengstaken–Blakemore tube	
Tamponade balloon	Instil 300–500 ml of saline

Table 4. Uterine tamponade techniques for postpartum haemorrhage

Postpartum haemorrhage is a leading indication for emergency peripartum hysterectomy. Peripartum hysterectomy is generally performed in the setting of category IV life-threatening haemorrhage during or after abdominal and vaginal deliveries that cannot be controlled by the above medical and conservative surgical measures.

5.2. Uterine rupture

Uterine rupture is associated with maternal and perinatal mortality and morbidity worldwide, particularly in developing countries. The most common cause of uterine rupture is tear of a previous caesarean section scar after a trial of labour in a patient with a previous caesarean section. Rupture of an unscarred uterus is rare. It may occur in obstructed, multiparous labour and in response to inappropriate use of oxytocic agents. Its incidence decreases with improvement in obstetric practice [45].

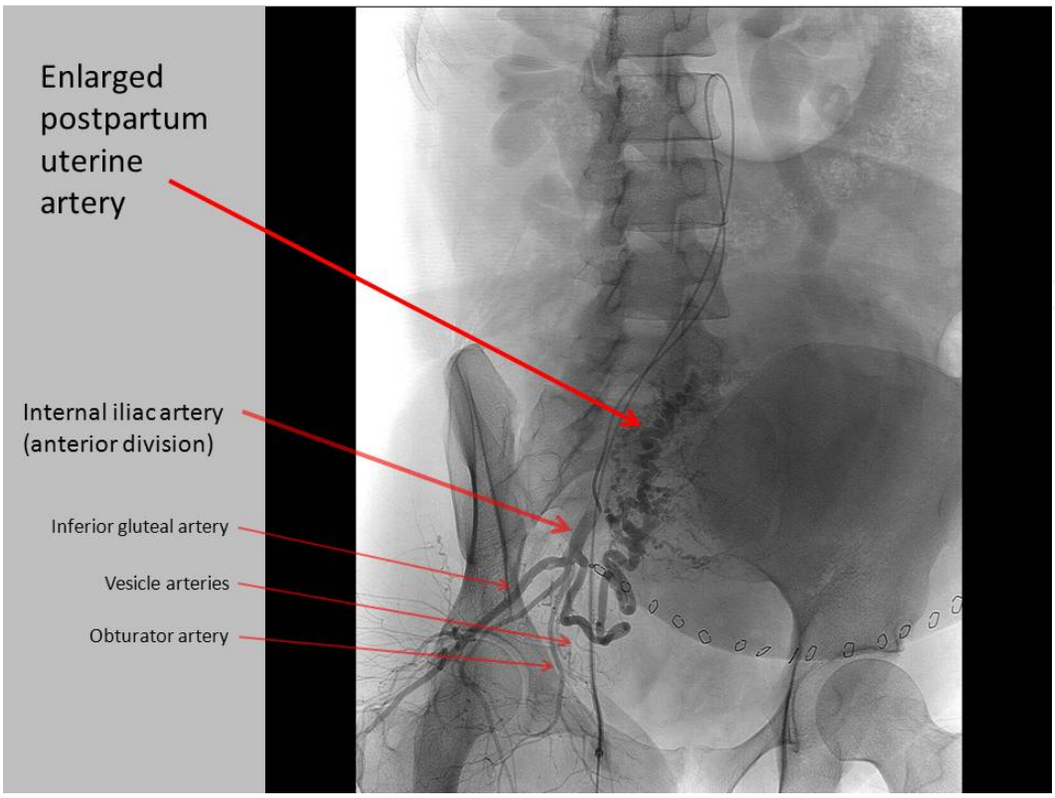

Figure 1. Internal iliac artery, anterior division angiogram. An enlarged uterine artery is present post-caesarean section. Courtesy of The Pump and the Tubes. A journal of all things vascular

Figure 2. Uterine tamponade. Courtesy of Bt-Cath® With Easyfill™ Inflation System. Utah Medical Products, Inc.

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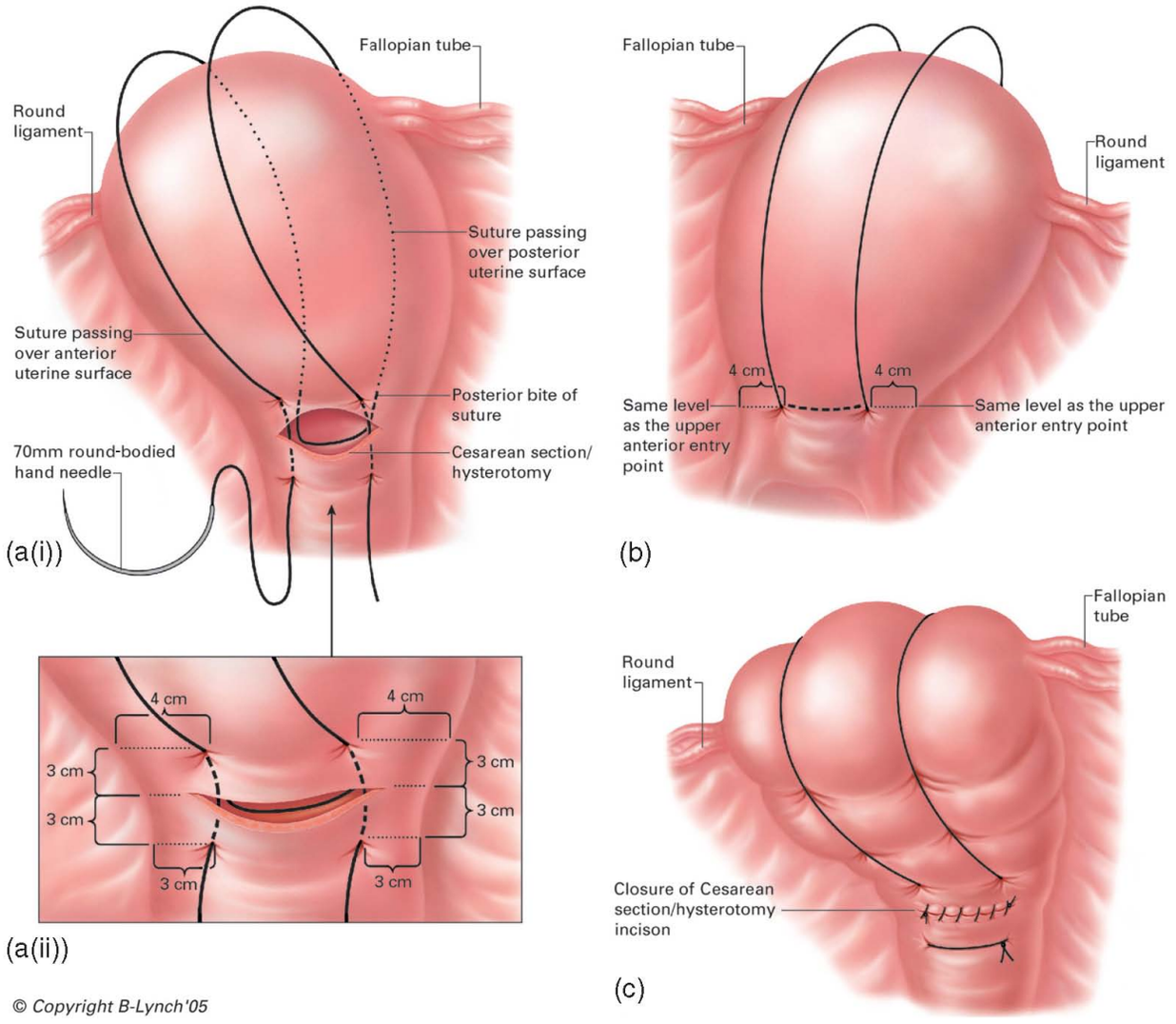

Figure 3. Uterine compression sutures. Courtesy of B-Lynch

Traumatic rupture can occur with internal version, classical application of the anterior blade of Kielland's forceps, manual removal of the placenta, manual exploration of the uterus and during curettage for secondary postpartum haemorrhage. Other causes of traumatic ruptures of the uterus are relatively rare and tend to occur at the fundus and usually result only from the most violent accidents [46].

5.3. Extension of the lower uterine segment incision

Caesarean hysterectomy may be necessary in cases of lateral extension of the lower uterine segment incision, when the caesarean section is performed with the foetal head deeply impacted in the pelvis in the second stage of labour. The tear may extend to branches of the uterine arteries. Haemostasis may be challenging; injuries to the ureters are possible. Broad ligament haematoma is not uncommon.

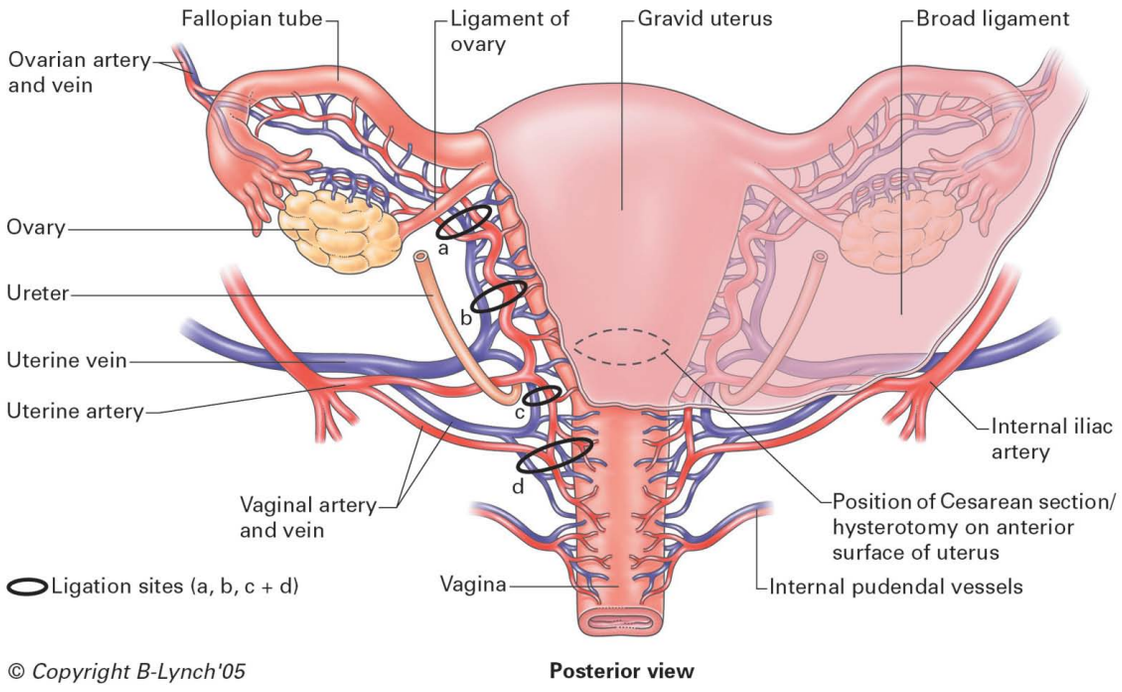

Figure 4. Stepwise devascularisation. Courtesy of B-Lynch

5.4. Uterine sepsis and placental site vessel subinvolution

Emergency peripartum hysterectomy may be necessary in cases of extensive uterine sepsis where antibiotic treatment is not effective and in the rare cases of placental site vessel subinvolution [27], in which uterine bleeding is protracted.

5.5. Abnormal placentation

The problems of uterine atony and uterine rupture have been greatly reduced through the use of potent uterotonic agents and the utilisation of modern obstetric care [47]. With the rising caesarean section rate and the rising incidence of placenta praevia and accreta and the more severe forms of increta and percreta, associated with previous caesarean sections, recent studies have indicated a change in the trend towards abnormal placentation (Figure 6) as the most common indication for emergency and planned peripartum hysterectomy [48-50]. In the absence of risk factors, early diagnosis of placental abnormalities is difficult. Unfortunately, the diagnosis is frequently established only after unsuccessful removal of the placenta at delivery.

5.5.1. Ultrasonography in the diagnosis of abnormal placentation

For the antenatal diagnosis of placenta accreta, transvaginal and transabdominal ultrasonography are complementary diagnostic techniques. Transvaginal ultrasound is safe for patients with placenta praevia. Normal placentation is characterised by a hypoechoic boundary between the placenta and the bladder. Features suggestive of placenta accreta include thinning

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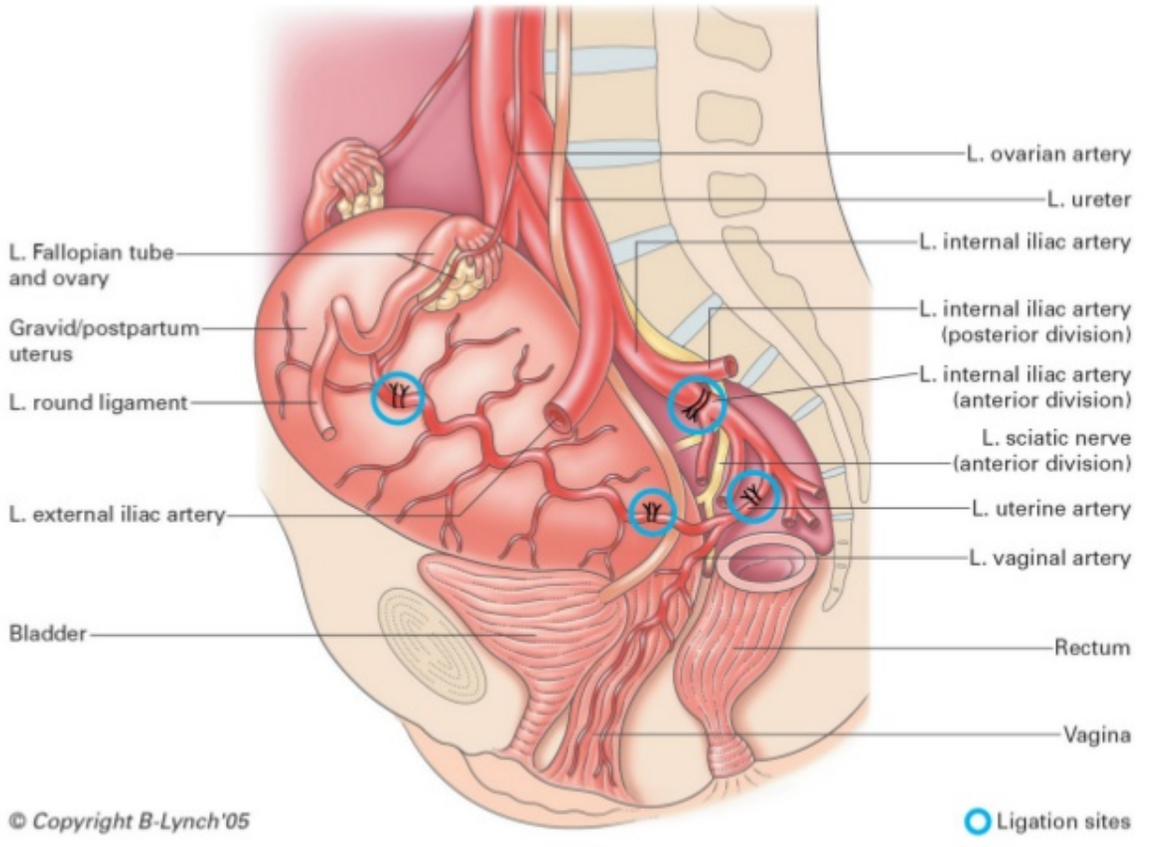

Figure 5. Systematic pelvic devascularisation and internal iliac artery ligation. Courtesy of B-Lynch

of the myometrium overlying the placenta (Figure 7), protrusion of the placenta into the bladder and irregularly shaped placental lacunae. The presence of lacunae 'moth-eaten or Swiss cheese appearance' within the placenta is predictive of placenta accreta (Figure 8). The use of colour Doppler, power Doppler or three-dimensional imaging may improve the diagnostic sensitivity (Figure 9), compared with that achieved by grayscale ultrasonography alone [51].

Overall, one study demonstrated that grayscale ultrasonography may be sufficient to diagnose placenta accreta, with a sensitivity of 91.4 % (95 % CI, 77.6–97.0 %), specificity of 95.9 % (95 % CI, 92.2–97.9 %), a positive predictive value of 80.0 % (95 % CI, 65.2–89.5 %) and a negative predictive value of 98.4 % (95 % CI, 95.5–99.5 %) [52]. Another study concluded that ultrasound for the prediction of placenta accreta may not be as accurate as previously described, with reported sensitivity, specificity, positive predictive value, negative predictive value and accuracy of 53.5 %, 88.0 %, 82.1 %, 64.8 % and 64.8 %, respectively [53].

5.5.2. Magnetic resonance imaging in the diagnosis of abnormal placentation

Magnetic resonance imaging (MRI) is considered to add little to the diagnostic accuracy of ultrasonography. However, when there are ambiguous ultrasound findings or a suspicion

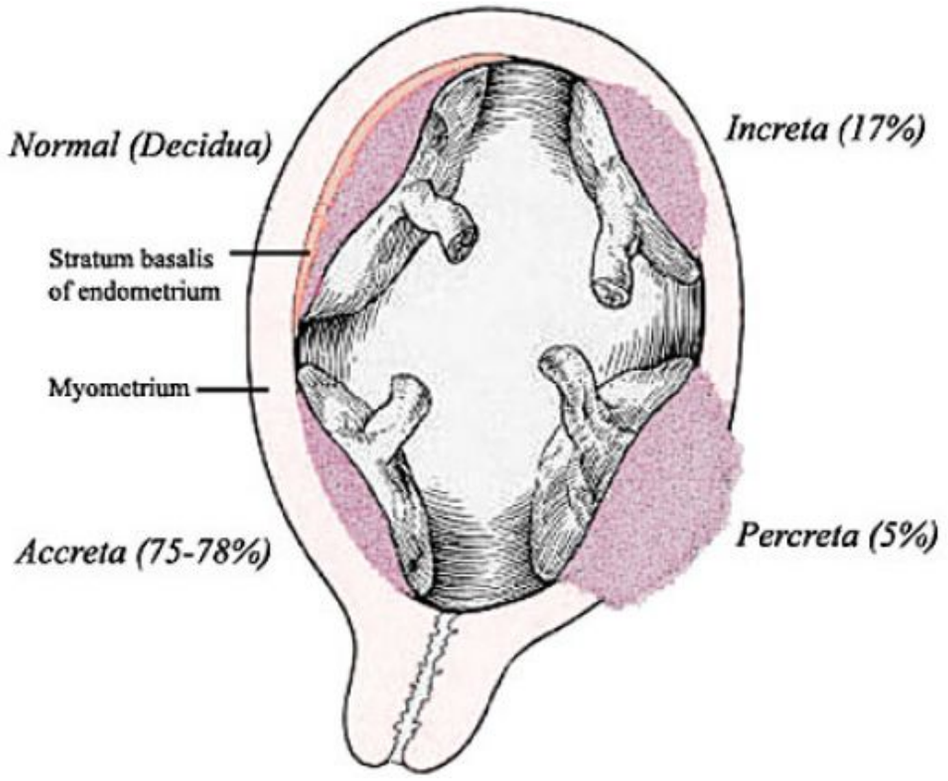

Figure 6. Diagram illustrating placenta accreta, increta and percreta. Courtesy of Callen P

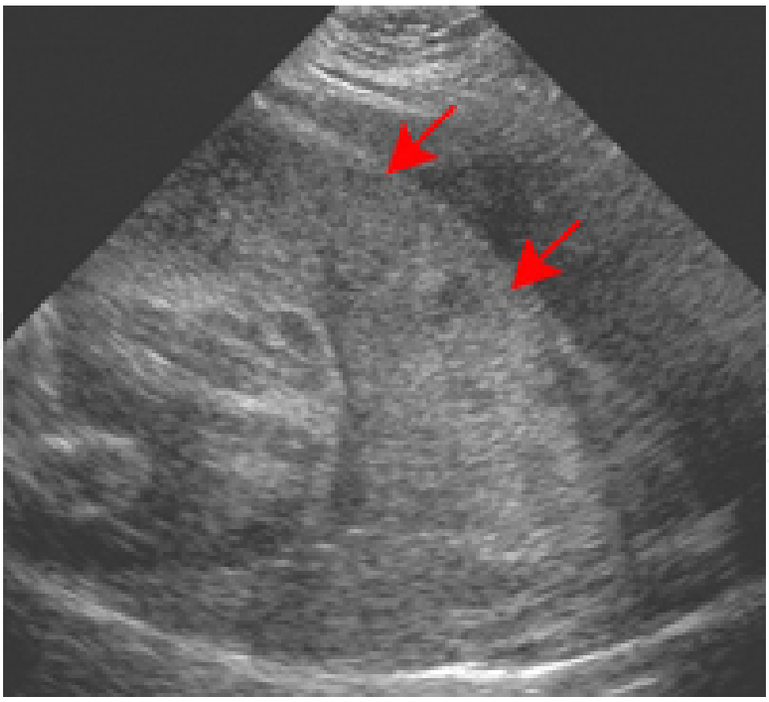

Figure 7. Sonogram demonstrating absence (arrows) of the intervening myometrium between the placenta and uterine serosa. Courtesy of Callen P

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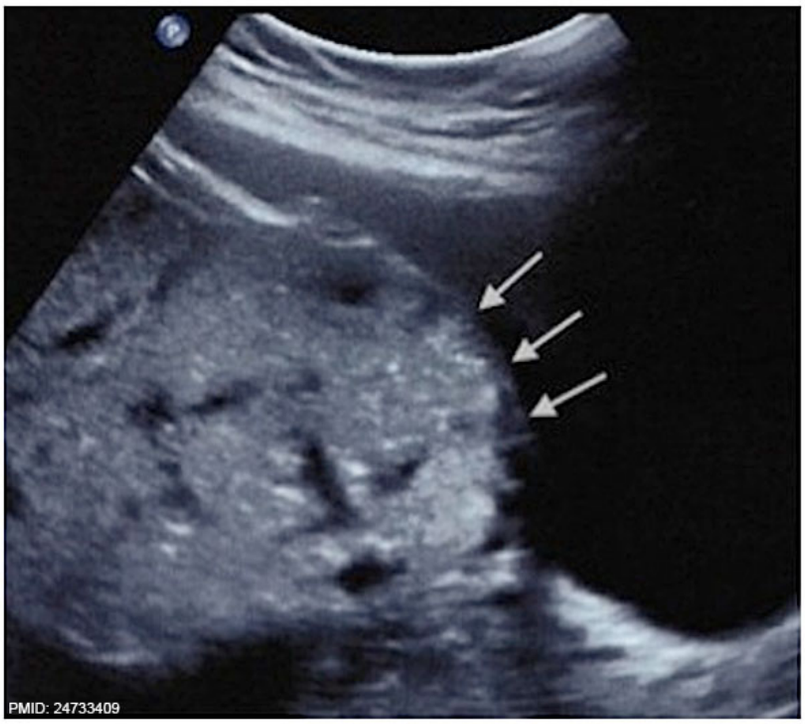

Figure 8. Sonogram demonstrating numerous vascular lacunae (arrows) within the placenta in a patient with placenta accreta Ultrasound of placenta and bladder wall interface indicating placenta accreta. Courtesy of Riteau et al.

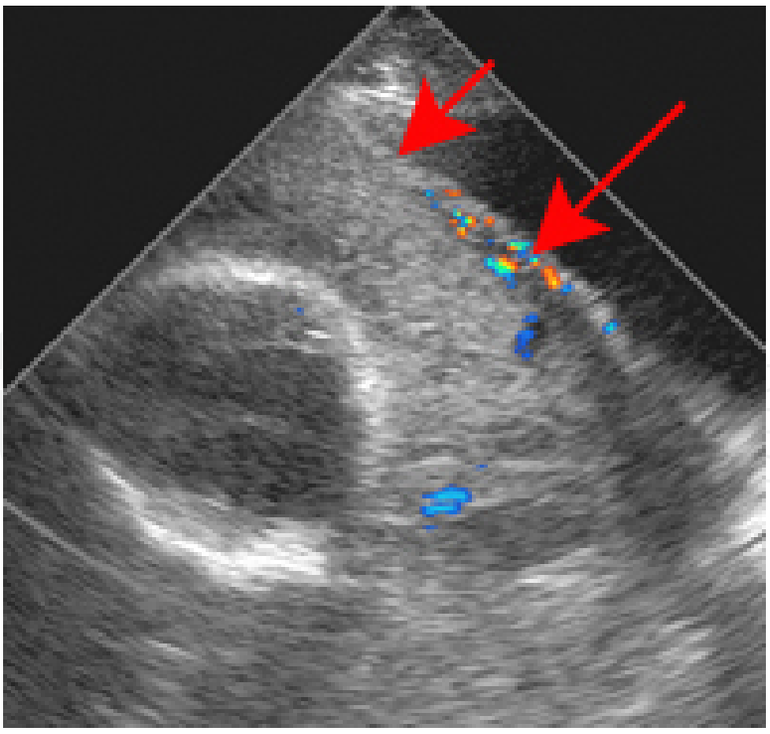

Figure 9. Colour Doppler image demonstrating absence of intervening myometrium (short arrow) and abnormal bladder–uterine wall vascularisation (long arrow). Courtesy of Callen P

of a posterior placenta accreta, with or without placenta praevia, ultrasonography may be insufficient. In general, MRI may better outline the anatomy and degree of invasion (Figure 10) [54].

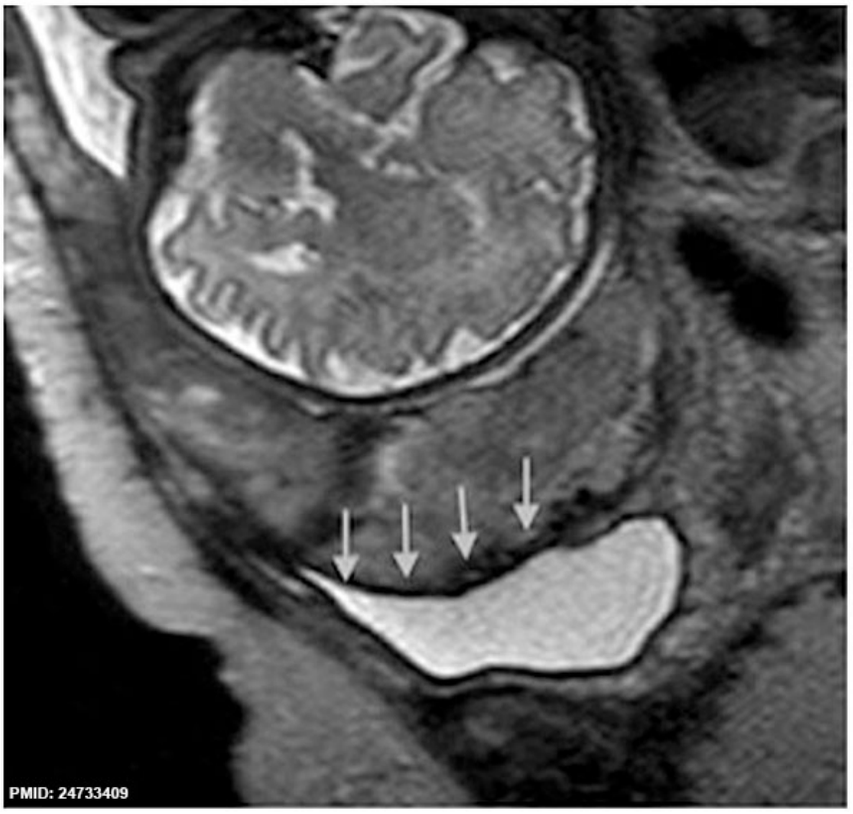

Figure 10. Sagittal magnetic resonance images indicated a bulge at the bladder wall indicating a major anterior placenta praevia accreta with bladder wall involvement. Courtesy of unsw.edu.au

Controversy surrounds the use of gadolinium-based contrast enhancement even though it adds to the specificity of the placenta accreta diagnosis by MRI. The use of gadolinium contrast enables MRI to more clearly delineate the outer placental surface relative to the myometrium. However, it is recommended that intravenous gadolinium should be used only if absolutely essential [55].

6. Prophylactic arterial occlusion

Recently, prophylactic arterial occlusion has been described as a strategy to reduce bleeding during planned hysterectomy (Figure 11). The efficacy and safety of this procedure is unknown. One small-scale study suggested that the successful use of a staged embolisation hysterectomy procedure for placenta accreta is associated with decreased maternal morbidity [56]. Another study using prophylactic intravascular balloon catheters did not benefit women

with placenta accreta undergoing caesarean hysterectomy [57]. The use of these procedures should not delay recourse to surgery.

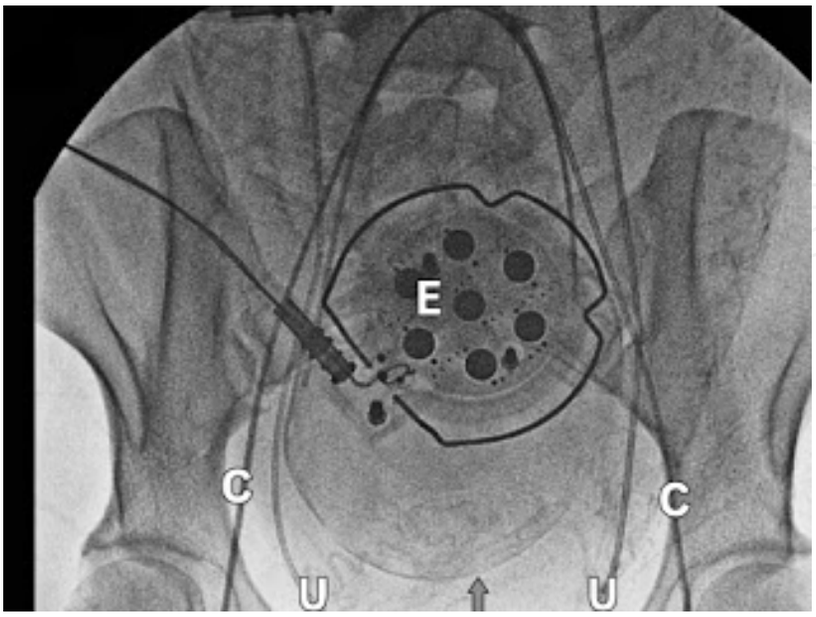

Figure 11. Placing arterial catheters (C) and ureteral catheters (U) preoperatively; E is the external foetal monitor. Courtesy of Ochsner 201

7. Preparation

Surgical planning is necessary. Once the decision is made to embark on surgical haemostasis, the most appropriate choice of procedure will depend on available resources and the expertise of available staff. Obstetricians should be prepared for the potential need to perform emergent peripartum hysterectomy. There is a high chance that a patient with uterine rupture, placenta accreta, increta or percreta will undergo hysterectomy [58]. At least 4 U of blood and blood products must be made available in suspected cases of accreta.

The acute loss of blood and the unplanned nature of surgery render the conditions for postpartum haemorrhage less than ideal to perform the procedure. Peripartum hysterectomy is associated with increased rates of both intraoperative and postoperative complications. Compared with nonobstetric hysterectomy, peripartum hysterectomy is associated with higher rates of morbidity and mortality. The mortality of peripartum hysterectomy is more than 25 times that of hysterectomy performed outside of pregnancy, with the higher rates in regions with limited medical and hospital resources [15]. Therefore, peripartum hysterectomy is considered a major dramatic life-saving surgical venture and represents the most challenging complication that an obstetrician will face.

Adequate resuscitation and prompt decision-making for hysterectomy would contribute to decreasing maternal morbidity and mortality, as timing is critical to an optimal outcome. It

has been established that there is a relationship between the duration of time that passes prior to deciding to perform an emergency hysterectomy and the likelihood of coagulopathy, severe hypovolaemia, hypothermia and acidosis. Early recourse to hysterectomy is recommended, especially where bleeding is associated with placenta accreta or uterine rupture [59].

For peripartum hysterectomy, an experienced senior obstetrician with an experience in obstetric hysterectomy should be present at surgery. Of concern however is the limited experience of performing emergency hysterectomy among some obstetricians. Emergency peripartum hysterectomy being performed by an experienced surgeon is reported to significantly reduce maternal morbidity in general, operating time, number of units of blood transfusion and hospital stay in particular [60,61].

8. Other strategies for the management of abnormal placentation

Although hysterectomy has traditionally been advised for the management of placenta accreta, it is associated with considerable maternal morbidity and mortality. Therefore, new strategies have been attempted to manage this condition conservatively, so that fertility can be preserved and some of the complications of peripartum hysterectomy averted. Such strategies include leaving the placenta in situ, combined with uterine artery embolisation or uterine compression sutures, and the use of methotrexate to inhibit trophoblast growth. However, these conservative approaches may be limited by the high risk of bleeding, infection and poor placental absorption [62-64].

9. Transfusion-related acute lung injury as a major complication

Transfusion-related acute lung injury (TRALI) is a rare but potentially fatal complication of blood product transfusion, manifesting as acute respiratory distress syndrome (ARDS). It is characterised by acute respiratory distress following transfusion. All plasma-containing blood products have been implicated including rare reports of IVIG and cryoprecipitate. The symptoms typically develop during or within 6 h of a transfusion [32].

Transfusion-related acute lung injury patients present with the rapid onset of dyspnoea and tachypnoea. There may be associated fever, cyanosis and hypotension. Chest x-rays show bilateral patchy infiltrates, which may progress to the complete 'white out' oedema of acute respiratory distress syndrome.

It is hypothesised that transfusion-related acute lung injury may be precipitated by the infusion of donor antibodies directed against recipient leucocytes. The infusion of donor anti-HLA or anti-HNA antibodies is thought to directly cause complement activation, release of cytotoxic agents, endothelial damage and capillary leak. The majority of patients require ventilatory support [32].

Patients at high risk of caesarean hysterectomy should be scheduled for delivery at a time when appropriate ancillary staff with high-risk anaesthetists, interventional radiologists, urologists

and resources is readily available. It is preferable to avoid emergency deliveries after the onset of labour, as the ancillary staff may not be available at a very short notice. Transfer of care to a tertiary care centre may be necessary if these resources are not locally available [65].

10. Counselling

Patients at risk for peripartum hysterectomy should be counselled about the likelihood of the procedure, what the procedure involves, complications, issues related to ovarian conservation and possible need for recovery in an intensive care unit. Forward planning for delivery highlights the importance of antenatal checks and screening to minimise blood loss, morbidity and mortality. After the initial postoperative recovery, women should receive a comprehensive outline of events from experienced obstetricians [66].

The fertility-ending nature of emergency obstetric hysterectomy can be devastating as some women that receive an emergency peripartum hysterectomy are primigravid. After the initial postoperative recovery, those women should be comprehensively counselled.

11. Types of hysterectomy and anaesthesia

Peripartum hysterectomy may be either subtotal or total. It has been recommended that the decision on the type of hysterectomy should be individualised. Subtotal hysterectomy may be preferable because it may be technically easier with shorter operating time, less blood loss, less urological injury and low morbidity, added to the fact that the cervix may be difficult to identify, especially if the patient has laboured and whose cervix is fully effaced, dilated and soft. This is important in the setting of severe acute haemorrhage [67,68].

In cases of placenta praevia, where the entire placental bed has to be removed, and if the lower segment, cervix and paracolpos are involved in the haemorrhage, total hysterectomy will be necessary for haemostasis. Similar approach is adopted for cases of placenta praevia accreta that is invading the cervical stroma.

In the preoperative preparation for peripartum hysterectomy, in suspected cases of accreta, 4 U of both packed red blood cells and plasma have to be cross-matched. Cryoprecipitate and platelets should be available. General anaesthesia is considered to be more appropriate when there is continuing bleeding and the cardiovascular stability is compromised.

When the cardiovascular is stable and there is no evidence of coagulation failure, regional anaesthesia can be used. This may be particularly appropriate where a working epidural has been in place during labour. A vertical skin incision should be considered to provide better exposure.

The technique of peripartum hysterectomy is similar in principle to that of abdominal hysterectomy in gynaecology, except for the anatomical and physiological changes in preg-

nancy that render the uterine and ovarian vessels enlarged and distended and the pelvic tissues oedematous and friable.

12. Intraoperative and postoperative complications

In some cases of peripartum hysterectomy, traumatised tissues at the base of the pelvis may continue to bleed following surgery despite ligation of obvious bleeding pedicles. This bleeding is usually associated with disseminated intravascular coagulation (DIC). In such cases, the application of pelvic pressure packs may provide haemostasis until haematological stability is achieved. Vascular embolisation may be considered in the interim [69].

In general, emergency procedures are associated with a higher rate of postoperative complications than planned procedures. Furthermore, compared with nonobstetric hysterectomy, peripartum hysterectomy is accompanied by substantial morbidity and mortality. The principal complications are febrile episodes, haemorrhage, urinary tract injuries, coagulopathy, paralytic ileus or bowel obstruction, wound sepsis/dehiscence, vaginal cuff bleeding, pulmonary embolism and the need for re-exploration because of persistent bleeding.

13. Morbidity and mortality

In a population-based analysis to examine the morbidity and mortality of peripartum hysterectomy in comparison with nonobstetric hysterectomy, bladder and ureteral injuries were more common for peripartum hysterectomy, 9 % compared with 1 % and 0.7 % compared with 0.1 % respectively, (P<.001). Rates of reoperation (4 % compared with 0.5 %), postoperative haemorrhage (5 % compared with 2 %), wound complications (10 % compared with 3 %) and venous thromboembolism (1 % compared with 0.7 %) were all higher in women who underwent peripartum hysterectomy. In multivariable analysis, the odds ratio for death from peripartum compared to nonobstetric hysterectomy was 14.4 (95 % confidence interval 9.84–20.98) [38].

During peripartum hysterectomy, scarring from previous caesarean sections may obliterate the utero-vesical pouch and make the dissection of the bladder from the uterus injury prone. Furthermore, the ureters may be sectioned, clamped or stitched because of heavy bleeding that interferes with proper exposure. The reported incidence of urological injuries with peripartum hysterectomy is high [38]. Within the context of the emergency situation and the available resources, it is best to diagnose and deal with any bladder or ureteric injury at the time of the hysterectomy. Any tear in the bladder should be repaired with two layers of 3/0 polyglactin (Vicryl) or equivalent suture. After repair of any bladder injury, the bladder can be filled with methylene blue or sterile milk to ascertain that this has been accomplished successfully. Perioperative cystoscopy with ureteral stent placement may be considered.

14. Technique

In the intraoperative stage of peripartum hysterectomy, the application of tourniquet around the uterine cervix can be attempted to reduce blood loss. This is facilitated by the use of transillumination, where the avascular spaces in the broad ligament, roughly opposite the level of a transverse lower caesarean incision, are identified and a catheter passed through on each side to encircle the lower uterine segment just above the cervix. The catheter should be twisted and tightly clamped. This would compress the uterine arteries. In addition, the application of straight clamps adjacent to the uterus to include the round ligaments, the Fallopian tubes and the utero-ovarian ligaments will serve to control the collateral blood flow to the uterus from the ovarian arteries. These two manoeuvres should occlude the main collateral ovarian and uterine artery supply to the uterus.

It is recommended that all pedicles should be doubly ligated in all types of hysterectomy. In peripartum hysterectomy, the vascular pedicles are particularly thick and oedematous. At first, a transfixing suture is applied, followed by an all encompassing ligature. Check should be made to ensure that there is no haematoma formation at the base of the pedicle.

In cases of hysterectomy for placenta praevia accreta, increta and percreta, the foetus is delivered through a classical uterine incision, and the intact placenta is left in situ while the hysterectomy is completed (Figure 12).

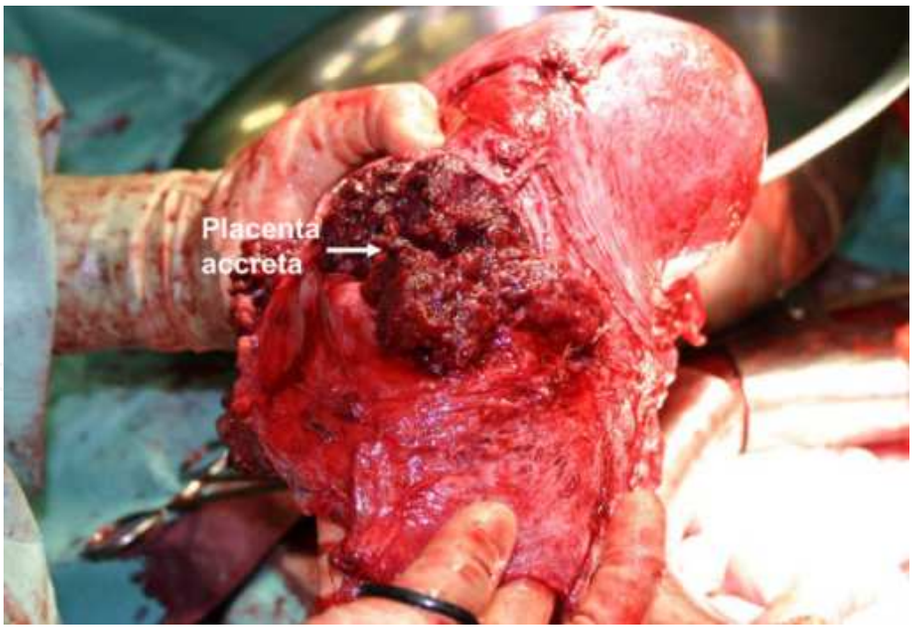

Figure 12. Hysterectomy specimen opened. Note placenta praevia percreta left in situ. © 2015 Callen P. Courtesy of Tikkanen, J Med Case Rep

At caesarean hysterectomy, a finger can be placed through the uterine incision and the cervical rim palpated. It is the safest to enter the vagina posteriorly, identify the rim of the cervix and then proceed anteriorly.

In general, No. 1 polyglactin (Vicryl) or equivalent is used throughout the peripartum hysterectomy procedures. Perioperative antibiotic prophylaxis should be continued for 24–48 h. Both mechanical and pharmacologic prophylaxis for deep venous thrombosis should be instituted. Thromboprophylaxis with heparin should be started as soon as one is satisfied that haemostasis is secure, at least 4 h postoperatively. The ovaries are almost always conserved. Peripartum hysterectomy is not a contraindication to breastfeeding. Women may use a breast pump temporarily until they are fit enough to breastfeed [70].

For an optimal management strategy for placenta accreta, it has been suggested that avoiding attempted placental removal at caesarean hysterectomy in women with suspected placenta accreta is associated with reduced maternal morbidity. Furthermore, some studies have recommended that patients with placenta accreta, increta or percreta who have no attempt to remove any of their placentae, with the aim of conserving their uterus, have reduced levels of haemorrhage and a reduced need for blood transfusion [62-64].

15. Recommendations

To provide a standardised approach to patients with postpartum haemorrhage, it is recommended that each labour unit should have a protocol for cases with estimated blood loss exceeding 1000 ml. Management involves four components that must be initiated simultaneously: communication, resuscitation, arresting the bleeding and monitoring and investigation, for optimal patient care. The following is a general guide for the management of major postpartum haemorrhage of more than 1000 ml and continuing to bleed OR clinical shock.

- Notify the senior obstetrician in charge, the department of anaesthesia, blood bank and laboratory.
- Establish two 14-gauge intravenous canula access; 20 ml blood sample should be taken for full blood count, coagulation screen, urea and electrolytes and cross match (4 U).
- For atony, administer oxytocin 10 IU by slow intravenous injection, followed by 40 IU in 500 ml of Hartmann's solution or normal saline at 125 ml/hour. If no intravenous access, give 10 IU intramuscularly. Oxytocin may be combined with other pharmacological agents; ergometrine 0.5 mg by slow intravenous or intramuscular injection (contraindicated in women with hypertension); carboprost 0.25 mg by intramuscular injection repeated at intervals of not less than 15 min to a maximum of eight doses (contraindicated in women with asthma); direct intramyometrial injection of carboprost 0.5 mg; misoprostol 1000 μg rectally (Table 2).
- Initiate uterine massage and/or manual uterine compression.
- Administer oxygen (10–15 l/min) by face mask or intubation, regardless of maternal oxygen concentration.
- Transfuse blood as soon as possible. If cross-matched blood is still unavailable, give uncross-matched group-specific blood or 'O RhD negative' blood. Four units of fresh frozen plasma

is given for every 6 U of red cells or prothrombin time/activated partial thromboplastin time more than 1.5 x normal (total 1 l). Platelet concentrates is administered if platelet count is less than 50 x 10^9/L and cryoprecipitate if fibrinogen is less than 1 g/L. The clinical picture should be the main determinant for the need for blood transfusion. Time should not be wasted waiting for laboratory results (Table 3).

- Until blood is available, infuse up to 3.5 L of warmed crystalloid Hartmann's solution (2 l) and/or colloid (1–2 l) as rapidly as required.
- Inspect the vagina and cervix for lacerations and repair them as necessary; evacuate any retained products of conception.
- If pharmacological measures fail to control the haemorrhage, initiate surgical haemostasis sooner rather than later. The following surgical interventions may be attempted, depending on clinical circumstances and available expertise:
  - Selective arterial embolisation
  - Uterine balloon tamponade (Table 4, Fig. 1)
  - Haemostatic brace suturing, such as B-Lynch or modified compression sutures
  - Bilateral ligation of uterine arteries
  - Bilateral ligation of internal iliac (hypogastric) arteries
  - Hysterectomy
- For the constant and close monitoring and support, unstable patients may need to be catered for in an intensive care unit.
- Common tests and their normal values include coagulation screen, electrolytes, liver function tests, acid-base and blood gases and kidney function tests (Table 5-9).

Test	Normal values
Platelet count (Plt)	140–450 x 10^3/μL
Mean platelet volume (MPV)	7.4–10.4 fL
Prothrombin time (PT)	1–15 s
International normalised ratio (INR)	0.9–1.2
Activated partial thromboplastin time (APTT)	18–45 s
Thrombin clotting time (TCT)	11–18 s
Fibrinogen	1.7–4.2 g/L
Antithrombin	0.15–0.39 mg/mL
Bleeding time	2–9 min
Viscosity	1.5–1.7 cP

Table 5. Coagulation-bleeding screen

Test	Normal value
Sodium (Na)	135–147 mEq
Potassium (K)	3.5–5 mEq
Bicarbonate (HCO_3)	24–30 mEq
Chloride (Cl)	100–106 mEq

Table 6. Electrolytes

Test	Normal value
ALT	5 to 56 U/L
AST	6 to 40 U/L
ALP	42 to 128 U/L
Total protein	35 to 84 g/L
Albumin	35 to 50 g/L
Globulins	25 to 35 g/L
Total bilirubin	0.1 to 1.0 mg/dL
Direct/conjugated bilirubin	0.0 to 0.4 mg/dL
GGT	9 to 48 U/L
LD	122 to 222 U/L
PT	9.5 to 13.8 s

Table 7. Liver function tests

Reports of balloon tamponade describe the intervention as the 'tamponade test'. Control of postpartum haemorrhage following inflation of the balloon indicates that laparotomy is not required. Continued postpartum haemorrhage following inflation of the balloon is an indication to proceed to laparotomy. This serves to affirm place of balloon tamponade as first-line procedure in the 'surgical' management of postpartum haemorrhage. The balloon should be left in place for 4–6 h, and, preferably, it should be removed during daytime hours. The balloon should be deflated and left in place for few minutes to ensure that bleeding does not reoccur [71,72].

The logistics for performing arterial occlusion or embolisation may not be readily available. This makes uterine balloon tamponade a more appropriate first-line treatment. Nevertheless, interventional radiology may be considered in cases of antenatal diagnosis of malplacentation, in the form of placenta praevia and placenta accreta, increta or percreta, where intra-arterial catheters, with the view of either occlusion or embolisation, can be placed prior to the performance of caesarean section. Follow-up studies of women who had undergone arterial embolisation or internal iliac artery ligation for control of postpartum haemorrhage suggest that these interventions do not impair subsequent menstruation, fertility and pregnancy outcomes [73,74].

Test	Arterial/venous	Normal values
pH	Arterial	7.35 to 7.45
	Venous	7.31 to 7.41
(H^+)	Arterial	36 to 44 nmol/L
		3.6 to 4.4 ng/dl
Base excess	Arterial and venous	-3 to +3 mEq/L
Oxygen partial pressure (pO_2)	Arterial	10 to 14 kPa
		75 to 105 mmHg
	Venous	4.0 to 5.3 kPa
		30 to 40 mmHg
Oxygen saturation (SpO_2)	Arterial	94 to 100 %
	Venous	Approximately 75 %
Carbon dioxide partial pressure (pCO_2)	Arterial	4.4 to 6.0 kPa
		33 to 45 mmHg
	Venous	5.5 to 6.8 kPa
		41 to 51 mmHg
Absolute content of CO_2	Arterial	23 to 30 mmol/L
		100 to 132 mg/dl
Bicarbonate (HCO_3)	Arterial and venous	18 to 23 mmol/L
		110 to 140 mg/dL
Standard bicarbonate (SBC)	Arterial and venous	21 to 28 mmol/L or mEq/L
		134 to 170 mg/dL

Table 8. Acid–base and blood gases

Test	Normal value
Blood urea nitrogen (BUN)	6 to 20 mg/dL
Creatinine	0.6 to 1.3 mg/dL
Urine creatinine (24-hour sample)	500 to 2000 mg/day. 11 to 26 mg/kg weight
Creatinine clearance	88 to 137 ml/min

Table 9. Kidney function tests

It recommended that these postpartum guidelines should be implemented at an estimated blood loss well below approx 2000 ml as the aim is to prevent haemorrhage escalating to the point where it is life threatening. In the face of relentless bleeding, up to 1 L of fresh frozen plasma and 10 U of cryoprecipitate (two packs) may be given while awaiting the results of coagulation studies. Factor VIIa therapy may be used as an adjuvant to standard pharmacological and surgical treatments, in a dose of 90 μg/kg, which may be repeated within 15–30 min in the absence of clinical response. Fibrinogen should be above 1 g/L and platelets greater than 20 x 109/L before Factor VIIa is given.

These recommendations are primarily for clinicians working in specialist-led obstetric departments; they are less appropriate for settings where resources are limited. It is recommended that the main therapeutic goals of management of massive blood loss are to maintain:

- Haemoglobin more than 8 g/dl
- Platelet count more than 75 x 10^9/L
- Prothrombin less than 1.5 x mean control
- Fibrinogen more than 1.0 g/L

Intraoperative cell salvage for autologous red cell transfusion is being investigated for use in obstetrics. The insertion of a central line will provide a means of accurate central venous pressure (CVP) monitoring and act as a route for rapid fluid replacement. In addition to central venous pressure line, a direct arterial pressure line should be used for cardiovascular monitoring in cases of major haemorrhage.

Increasing caesarean rates would lead to an increase in the number of peripartum hysterectomies for abnormal placentation. Because serious maternal morbidity and mortality increases progressively with increasing number of caesarean deliveries, the number of intended family size should be considered when counselling regarding elective primary caesarean delivery and elective repeat caesarean operation versus a trial of labour [73-76].

Peripartum hysterectomy is a challenging procedure. Its role in modern obstetrics is evolving. Improving management of postpartum haemorrhage should decrease peripartum hysterectomy for uterine atony. Peripartum hysterectomy merits a multidisciplinary approach.

Author details

Zouhair O. Amarin*

Address all correspondence to: zoamarin@hotmail.com

Faculty of Medicine, Mutah University, Karak, Jordan

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