Trends in Anaesthesia and Critical Care 24 (2019) 32–39

Contents lists available at ScienceDirect

Trends in Anaesthesia and Critical Care

journal homepage: www.elsevier.com/locate/tacc

Review

Abnormally adherent placenta: Current concepts and anesthetic management

Rajeshwari Subramaniam [a,*], Vatsla Dadhwal [b], Shivanand Gamanagatti [c]

[a] Room 5014 A, 5th, Floor Teaching Block, Department of Anaesthesiology, Pain Medicine and Critical Care, All India Institute of Medical Sciences, New Delhi, 110029, India
[b] Division of Maternal and Fetal Medicine, Department of Obstetrics and Gynecology, All India Institute of Medical Sciences, New Delhi, 110029, India
[c] Department of Radio-Diagnosis, All India Institute of Medical Sciences, New Delhi, 110029, India

ARTICLE INFO

Article history:
Received 29 May 2017
Received in revised form
12 March 2018
Accepted 7 May 2018

Contents

* Corresponding author.
E-mail addresses: drsrajeshwari@gmail.com (R. Subramaniam), vatslad@hotmail.com (V. Dadhwal), shiv223@gmail.com (S. Gamanagatti).

https://doi.org/10.1016/j.tacc.2018.05.001

1. Introduction

Placenta accreta refers to the situation of the placenta being abnormally adherent to the uterine myometrium, in the absence of a normal decidua. Concomitant with the increase in Cesarean section (CS) there has been an obvious rise in the incidence of placenta accreta and its variants, in the past three decades [1–3]. The direct implication of this condition is the potential of massive maternal hemorrhage at the time of delivery and placental separation. Regarding placenta percreta, maternal mortality may be as high as 7% and fetal mortality 9% [4,5]. Abnormal placentation is one of the two leading causes of peripartum hemorrhage and currently the most common indication for peripartum hysterectomy. Parturients with abnormal placentation should be diagnosed in time and delivery planned with multidisciplinary consultation and involvement at an institution with appropriate expertise and resources, for optimal maternal and fetal outcome.

2. Classification

Placental villi may be attached to the myometrium in varying degrees. Depending on the depth of invasion, abnormal placentation can be divided into three categories: placenta accreta, where the villi are embedded directly into the myometrium; placenta increta when the villi invade through the full depth of the myometrium; and placenta percreta in which the villi penetrate through the uterine serosa and may invade the surrounding abdominal wall and organs (Fig. 1a and b).

3. Incidence

Over the last 30 years, the incidence of placenta accreta has increased 10-fold. In developed countries, reported rates range from 1: 530 to 1: 2500 deliveries [6]. This parallels the increasing rate of CS. Incidence of CS ranges from 6% in underdeveloped to a mean of 27.2% in developed countries. Latin America and Caribbean have the highest incidence (40.2%) [7]. In a small study from India the incidence was reported as 1:2684 in 2011 which had increased to 1:530 in 2016 [8]. In a population-based study involving maternity units of 221 UK hospitals, 134 women were identified with placenta accreta, increta, or percreta: only 50% (66/133) were suspected to have this condition antenatally [9]. Cho et al. studied the trends in peripartum hysterectomy in Korea over the period 2005–2008. This survey found that although the rates of Cesarean section and peripartum hysterectomy dropped slightly over the 3 years, the rates of uterine artery embolization (UAE) also rose significantly [10].

4. Risk factors

Abnormal placentation has a strong association with many risk factors. A strong association with prior cesarean birth has been demonstrated [11]. Silver et al. [11] found that the incidence of abnormal placentation increased in proportion with the number of cesarean sections (0.24%, 0.31%, 0.57%, 2.13%, 2.33%, and 6.74%) in women undergoing their first, second, third, fourth, fifth, and sixth or more cesarean deliveries, respectively. Incidence of peripartum hysterectomy showed a similar trend (0.65% first, 0.42% second, 0.90% third, 2.41% fourth, 3.49% fifth, and 8.99% sixth or more). These figures are graphically depicted in Fig. 2a and b. Advanced maternal age is cited as an independent risk factor. Other risk factors include multiparity, smoking and previous uterine interventions [12].

5. Fetal and maternal morbidity

Obstetric hemorrhage and peripartum hysterectomy associated with placenta accreta can give rise to hypovolemic shock, massive transfusion-related complications [13], transfusion related acute lung injury (TRALI), requirement of high vasopressor and/or ventilator support and multi-organ failure. Incidence of severe maternal morbidity especially with bladder involvement may approach 20% [14] with occasional maternal mortality [5,15]. Patients with accreta are also at risk for thromboembolism, amniotic fluid embolism (AFE), and injury to adjacent viscera: bladder, ureters, bowel, large vessels, or pelvic nerves. Vesico-vaginal fistula and fecal fistula may be diagnosed later in the postoperative period. Hospital readmission and reoperation may occur for retained placenta/delayed hemorrhage in patients managed conservatively with uterus-sparing techniques. Neonatal complications are consequent to preterm birth, most commonly at 34–36 weeks of gestation.

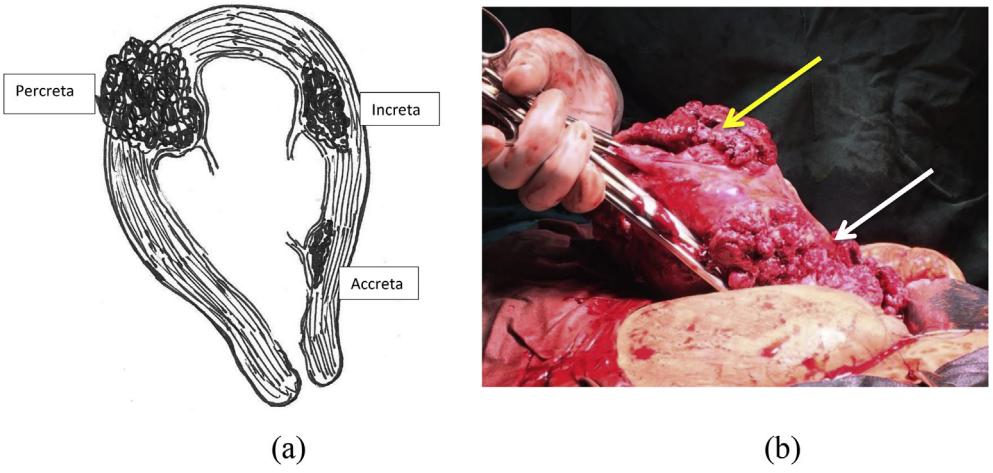
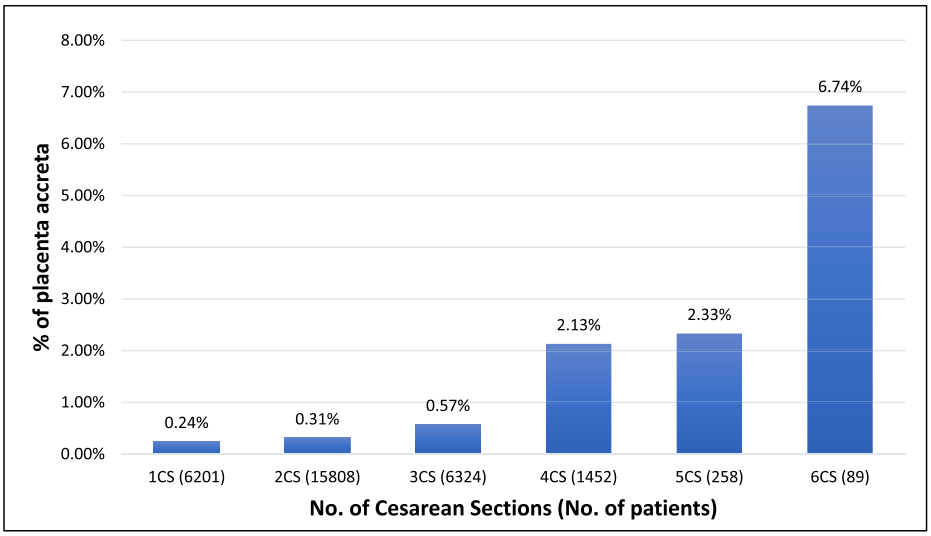


Fig. 1. a. Types of abnormally adherent placenta.
Fig. 1b. Placenta percreta at the time of peripartum hysterectomy. Top (yellow) arrow shows fundal hysterotomy for delivery of the neonate; bottom (white) arrow shows placenta protruding out of the lower segment. (For interpretation of the references to colour in this figure legend, the reader is referred to the Web version of this article.)



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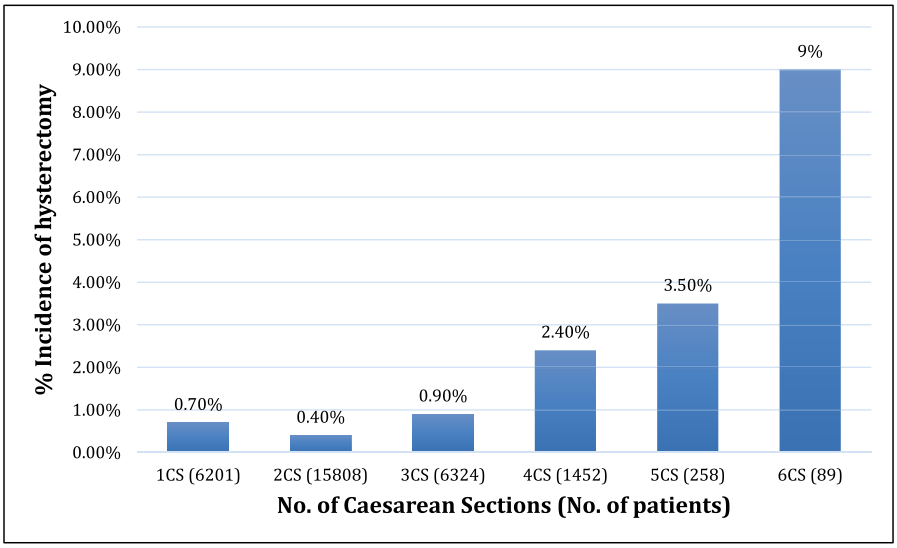


(b)

Fig. 2. has been divided into 2a and 2b. Data from Silver et al. [11] has been used to construct graphs for visual appeal. 2a depicts percentage of placenta accreta with increasing number of cesarean sections, and 2b depicts percentage incidence of hysterectomy with increasing cesarean sections.

6. Pathophysiology [14]

The two possible etiological factors in the occurrence of placenta accreta have been postulated as abnormal decidualization or pathological over-invasiveness of the trophoblast. A localized defect in the natural barrier (consequent to CS, uterine curettage etc) may allow the trophoblast to break through the decidua and invade the uterine wall.

Abnormal placentation may occur due to the absence of the Nitabuch layer, which marks the boundary for trophoblastic invasion. Preferential implantation of the embryo has been postulated to occur in relatively avascular tissues with lower oxygen tension. Partial dehiscence of the existing scar may favor deeper invasion by the trophoblast resulting in placenta increta or percreta. Placental messenger RNA, has been postulated as a biomarker for serosal invasion. Elevated maternal serum levels of alpha fetoprotein and free β-HCG within the triple screening test have been reported to be associated with an increased risk of placenta accreta [16].

7. Diagnosis

Abnormal placentation can be readily diagnosed on second trimester ultrasound (US), but the degree of invasion may be difficult to ascertain. Ultrasound has a high sensitivity (77–93%) and specificity (71–96%) for detecting abnormal placentation [5]. Classic findings on ultrasound are loss or irregularity of hypoechoic plane in myometrium beneath placental bed, abnormal placental lacunae, bladder wall interruption, myometrial thinning (<1 mm) overlying placenta, placental bulge into neighboring organs and focal exophytic mass ie placental tissue breaking through uterine serosa. 2D Doppler shows uterovesical and subplacental hypervascularity, bridging vessels extending from placenta across

myometrium beyond serosa into bladder or other organs and high velocity flow in placental lacunae feeder vessels [17]. USG and Doppler are sufficient for diagnosis in most cases. In a recent meta-analysis covering nearly 4000 patients, Jauniaux and Bhide [18] found that positive correlations were found in the largest prospective studies between the cumulative rates of the more invasive forms of accreta placentation and the sensitivity and specificity of ultrasound imaging. They concluded that ultrasound is highly sensitive and specific in the prenatal diagnosis of accreta placentation when performed by skilled operators.

Since the difference between a placenta increta and percreta may be in millimeters, the only applicable imaging technology with this degree of resolution is magnetic resonance (MR) imaging. This has a sensitivity of 80–88% and a specificity of 65–100% in diagnosing percreta. The most useful indicators of abnormal invasion as seen on MRI are dark intraplacental bands, heterogeneous signal intensity in the placenta, focal areas of uterine bulging, and loss of the interface with adjacent organs. MRI is useful in cases of posterior placenta and for confirmation of parametrial invasion and possible ureteric involvement [19]. There are concerns that gadolinium-based contrast material may cross the placenta, be excreted into the amniotic fluid and subsequently swallowed by the fetus. MRI should not be used in pregnancy unless really necessary [20]. Antenatal diagnosis of placenta accreta has been seen to reduce peripartum blood loss and the need for transfusion [7,21].

8. Obstetric management

Obstetric management in patients with abnormal placentation centers around three main issues:

1. **Timing of delivery**: Most series of patients with abnormal placentation illustrate the fact that meticulous, planned elective delivery, carried out by a multidisciplinary team decreases blood loss, requirements for blood products and perioperative morbidity and mortality. It is imperative to avoid an unanticipated emergent delivery. Appropriate anesthetic, urological, surgical and interventional radiology consultations should have been obtained and discussed. Time of delivery should be individualized; in general, elective CS is performed at approximately 34–37 weeks [5,22,23]. Watchful day-to-day monitoring of maternal and fetal condition is essential. The blood bank should be notified the day before planned delivery.
2. **Management of the placenta and uterus** [24,25]:
   a. An elective CS and planned peri partum hysterectomy is the traditional approach to the management of abnormal placentation. Uterine incision is made away from the placenta and may require an upper segment or trans fundal incision [5]. Pre-operative ultrasound is helpful in mapping.
   b. Uterus sparing techniques: are used in patients with high desire to retain fertility and are hemodynamically stable. In this 'Expectant approach', the cord is ligated high and the whole placenta left undisturbed. Adjunct methods are employed to reduce time to placental resorption.
      i. Methotrexate: facilitates resorption of the retained, poorly perfused placenta.
      ii. Endovascular procedures: Internal iliac/aortic/uterine artery cannulation with balloon angiocatheters reduces blood loss and avoid a hysterectomy.
      iii. Uterotonics, compression sutures and balloon tamponade, have also been used to decrease postpartum hemorrhage, and hasten placental resorption or sloughing and expulsion.
      iv. Hysteroscopic excision of retained placenta
      v. En-bloc excision of placenta and attached myometrium (Vinas procedure [27])

However, a significant number of parturients develop complications like delayed hemorrhage and disseminated intravascular coagulation necessitating hysterectomy, removal of retained placenta and transfusion later. Delayed hysterectomy is required in nearly 40–58% cases as reported in some series [26].

9. Interventional radiology in placenta accreta

Massive hemorrhage in abnormal placentation is due to development of extensive pelvic collateral circulation in the pregnant uterus. Whether one opts for the standard treatment, that is cesarean hysterectomy or uterine conserving treatment, there is need for a technique to minimize blood loss.

Radiological techniques can be used for the management of life threatening obstetric hemorrhage as well as a prophylactic measure to reduce the volume of blood loss at the time of and after surgery. Intraoperative balloon occlusion of the aorta, common iliac, internal iliac and uterine arteries decreases uterine blood flow, leading to reduced intraoperative blood loss, clearer field at surgery and less complications. Uterine artery embolization has been used after delivery of the fetus and before proceeding for hysterectomy.

Reduction in pelvic blood flow is accomplished endovascularly initially with the use of occlusion balloons placed in the common iliac arteries, the internal iliac arteries, the anterior divisions of the internal iliac arteries or the aorta. Each approach has its advantages and disadvantages. The anesthesiologist should be aware that when the patient comes to the operating room (OR) after placement of the catheters (Fig. 3), she should **NOT** be positioned for regional anesthesia. This has led to catheter dislodgement and subsequent massive hemorrhage [30]. Occlusion balloons are inflated from the point of cord clamping (after delivery of the baby) to eliminate the risk of placental ischemia before fetal delivery. The common objective among these techniques is to achieve selective occlusion of the arterial supply to the uterus while trying to minimize the risk of ischemic complications to the rest of the pelvic organs and the lower limbs. It may spare the patient a hysterectomy and thus preserve fertility. High-risk CS are sometimes performed in interventional radiology suites ('hybrid ORs') in an attempt to increase the success of the arterial occlusion by avoiding delay and decreasing likelihood of migration of the angiographic balloon catheters.

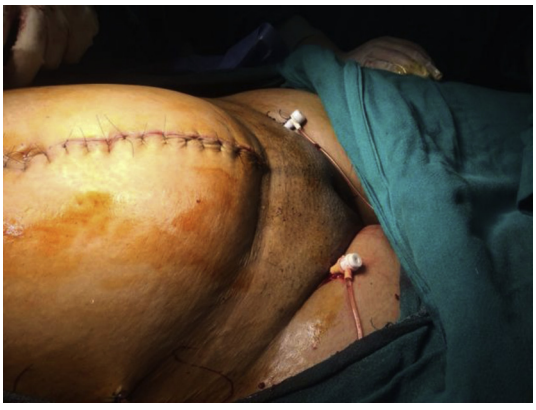
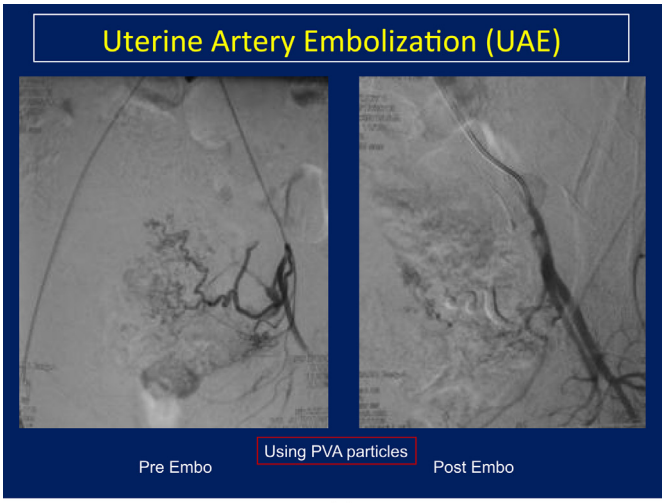


Fig. 3. . Sheaths in the groin through which balloon catheters are inserted.



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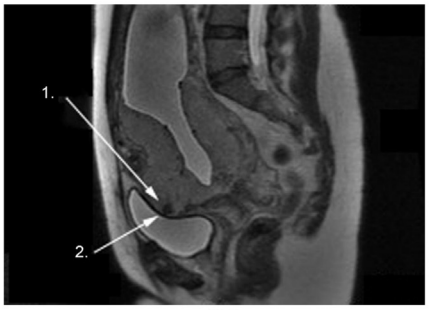

(b)

Fig. 4. a: Uterine artery embolization 3 h post partum.
Fig. 4b: Internal iliac artery balloon inflation followed by embolization and placement of coils.

9.1. Internal iliac artery occlusion (Fig. 4b)

Internal iliac artery balloon occlusion (IIABO) is the most common technique in patients with placenta accreta [28–31]. A major advantage of this technique over uterine artery balloon insertion is a significant reduction in the exposure of both the patient and the fetus to ionizing radiation. The mean fluoroscopic time for UAE may amount to almost 22 min compared to 2–3 min for IIABO. In the series by Thon [30] IIABO produced favorable conditions in 54% patients. In one patient subsequent positioning for neuraxial block led to catheter dislodgement, massive hemorrhage and cardiac arrest. Cali et al. [31] found that embolization resulted in significant reduction in blood loss only in cases of placenta percreta. IIABO may not provide complete hemostasis as rich collateral feeding vessels arising from cervico-vaginal branches of the uterine arteries, superior vesical, inferior epigastric, or femoral and deep circumflex iliac arteries supply the abnormal placenta. IIABO may also not reduce bleeding to a satisfactory degree in some cases since arterial supply from external iliac artery to the placental tissue may be missed due to selective cannulation of internal iliac artery segment alone.

9.2. Uterine artery occlusion/embolization (Fig. 4a)

Uterine artery occlusion has been demonstrated to have a success rate of over 90% for the treatment of postpartum hemorrhage, and also has been used prophylactically for abnormal placentation prior to operative delivery [10,32].

9.3. Common iliac artery occlusion

Minas et al. [33] describe the use of common iliac artery (CIA) occlusion in patients with placenta accreta, all of whom required hysterectomy after delivery. Duration of balloon occlusion ranged from 60 to 70 min. BC occlusion of the CIA may provide good bleeding control by reducing blood supply not only from uterine arteries but also from a number of collaterals.

9.4. Aortic occlusion

Intraoperative aortic balloon occlusion has been described [34,35] as a relatively safe method for treating placenta previa and/or placenta accreta during scheduled and emergency CS. Prophylactic occlusion of the infra-renal aorta may provide a higher degree of pelvic devascularization than occlusion of the internal iliac or uterine artery by simultaneously occluding the collateral circulation, which might be more extensive in the late gestational period. Technically, aortic occlusion may be a less difficult procedure than the occlusion of smaller arteries such as the internal iliac/uterine arteries. The balloon can be easily placed and verified by the operating team. This technique in useful in the emergency setting and also reduces radiation dosage to mother and fetus.

However, endovascular interventions may also be associated with significant complications which include catheter migration, Iliac artery rupture resulting in massive hemorrhage and transfusion, iliac thrombosis, inadvertent embolization of the external iliac arteries, uterine necrosis, leg ischemia and necrosis of the buttocks [30,36]. Fetal bradycardia necessitating immediate cesarean section was reported in 2 cases [37].

10. Anesthetic management

10.1. The anesthetic consultation and planning

Anesthesia consultation is typically obtained for a patient with abnormal placentation towards the end of second trimester, or if the patient is admitted for safe confinement, especially when there is a risk of sudden hemorrhage (placenta previa with accreta/percreta). These patients are under day-to-day surveillance and awaiting sufficient fetal maturity, usually up to 34 weeks. This is the time of multidisciplinary interaction and planning and involves good communication between obstetric surgeons, interventional radiology, obstetric anesthetists, hematology and blood bank services. Plans are also finalized regarding place of delivery (vide infra) and transport of the newborn. The patient (and family) is explained the overall management plan starting from placement of epidural catheters prior to interventional radiology, placement of invasive monitors prior to induction, regional or general anesthesia, need for transfusion, ICU admission and mechanical ventilation. In patients with percreta involving bladder and bowel it may be necessary to discuss the high surgical risk with complications of massive transfusion, organ support and prolonged ICU stay.

10.2. Location of delivery

Because of the multidisciplinary involvement in these patients, delivery should be planned at centers which have immediate access to multiple specialists apart from obstetrical surgeons and anesthesiologists (vascular and urological surgeons, interventional radiologists, neonatologists, intensivists, and hematologists). These patients may be better managed in 'main' or 'surgical' ORs [25] which are larger and can accommodate extra equipment like

portable image intensifiers ('C' arm), rapid infuser/cell savers and extra personnel, instead of maternity suites which may not be geared for procedures of this magnitude. Further, obstetric patients with non-reassuring airways, obesity, or severe cardiac/pulmonary lesions, in addition to abnormal placentation are also better managed in this surrounding. Provision for post operative care in an ICU should be made.

10.3. Surgical technique

One of the necessary surgical steps in abnormal placentation (percreta) involves separation of bladder adhesions and finding a plane for uterine incision. Thus in contrast to routine CS, induction-delivery interval can be very prolonged.

10.4. Anesthetic technique [38,40]

Ioscovich [38] in a survey of 26 Israeli hospitals found that in cases of isolated placenta previa regional anesthesia was used by majority of anesthesiologists, whereas an antenatal diagnosis of abnormal placentation, especially percreta prompted increasing use of GA. Epidural analgesia allows the parturient to be pain-free even after a major and prolonged laparotomy. At our institution the epidural catheter is placed before the patient goes to the radiology suite.

For CS in placenta accreta the choice of GA or RA is dictated by many factors.

10.5. Disadvantages of RA as sole technique

RA-induced sympathectomy can potentiate maternal hypotension especially where hemodynamic instability sets in due to blood loss [3]. Vigorous visceral handling may also not be well tolerated by the awake, anxious patient under regional anesthesia. Separation of bladder adhesions are time-consuming (up to 2 h) and single-shot spinal anesthesia may not provide adequate coverage for these extended procedures.

Rarely epidural hematoma may occur as a consequence of altered coagulation status following management of unanticipated massive peripartum hemorrhage [39].

The incidence of conversion from RA to GA has been ranging from 25 to 35%, In a recent series 9/65 patients received RA, of which 2 needed conversion to GA due to uncontrollable bleeding [32,40].

Urgent induction of GA in the parturient with hemodynamic instability is daunting. Crystalloid resuscitation may lead to airway edema and set the stage for difficult intubation.

Regional anesthesia may be an acceptable alternative for otherwise healthy patients with a minimal degree of invasion of placenta accreta. Patients selected for conservative management (i.e. balloon occlusion and hysterectomy-sparing) are also candidates for regional anesthesia.

Epidural or combined spinal–epidural techniques are preferable to single-shot spinal anesthesia.

Lilker et al. [32] noted that epidural catheters inserted prior to placement of pre operative femoral artery sheaths for uterine artery balloon catheter (BC) in these patients improves patient comfort, and can also be utilized for pre-operative cystoscopy and ureteric stenting.

10.6. Advantages of GA [5,6,24,25,41–43]

Due to the high probability of a hysterectomy in a scenario complicated by massive hemorrhage, hemodynamic instability, prolonged procedures with large abdominal incisions to tackle bladder/bowel involvement, placement of bulky packs to tamponade bleeding and the possibility of aortic cross clamp as a life-saving measure, elective general anesthesia seems a valid choice [24]. Further, invasive lines can be placed expeditiously; verbal communication between team members can take place without worrying about the patient's reaction and anxiety.

10.7. Concerns with GA

Since the induction-delivery interval is prolonged due to time taken for bladder dissection and uterine incision there is enough time for equilibration of anesthetic levels in the fetus. The neonate, therefore, is more likely to be depressed [41].

10.8. Delayed GA

In this method, delivery of the baby is performed under regional anesthesia, followed by conversion to general anesthesia for performance of the hysterectomy [5]. This approach should only be considered in the setting of a favorable patient airway examination. A non-reassuring airway is preferably secured electively.

11. Invasive monitoring, vascular access and OR management

Central line insertion in the pregnant patient is more likely to result in arterial injury as the internal jugular vein overlies the carotid artery to a greater extent. Use of ultrasound for central line insertion is strongly recommended [6,41]. Pre-induction placement of central venous access in patients at 'high' risk', e.g. placenta percreta is a better option rather than attempting to do so during ongoing blood loss, when hemodynamic instability combined with coagulopathy may not provide safe conditions. Complications have most often occurred during subclavian insertion [40].

Apart from placement of vascular monitoring, wide-bore intravenous (IV) access is mandatory. At our institution a 6/7-Fr sheath in the internal jugular vein is inserted using ultrasound guidance after local anesthetic infiltration, and connected to a 'Rapid Infusor' (Belmont Inc.) primed with crystalloid and colloid. Blood, FFP and platelet-rich plasma are kept ready in the blood bank with a designated attendant to fetch them when necessary. The epidural catheter is activated if cystoscopy and ureteric stenting is required. A radial arterial line is placed and followed by induction of general anesthesia with rapid sequence induction. The OR is extremely busy and congested and number of people and distractions should be minimized. A temperature probe and urinary catheter are placed after induction. After the delivery of the neonate, and the balloons are inflated, and the image intensifier switched on in readiness for embolization if needed. Hysterectomy is performed if there is evidence of brisk bleeding. Otherwise an expectant approach is taken, the placenta left undisturbed and the uterine incision closed. Patients usually can be extubated in the OR.

12. Transfusion practices [3,6,9,25,38]

Transfusion requirements for patients with placenta percreta tend to be high as the placenta fails to separate normally and abnormal placental beds continue to bleed after delivery. Blood loss in peri-partum hysterectomy may range from 1500 to 15,000 ml, with a mean of 3000 ml.

Fitzpatrick et al.(2014) [9] determined that antenatal diagnosis, when made, resulted in better preparedness and reduced blood loss and transfusion requirements. Decision not to attempt removing the placenta further reduced blood loss.

Massive transfusion protocol is now the norm in treating hemorrhage resulting from placenta percreta, and adequate

arrangement of packed cells, fresh frozen plasma, platelets and cryoprecipitate must be made and the blood bank informed in time. Crystalloid AND colloid use should be minimized, and care taken to optimize FFP to RBC ratio, as this hemorrhage resembles that it trauma [6].

In the data presented by Ioscovich [38]and Perez-Delboy [25], the majority of obstetric units used a massive transfusion protocol to deal with hemorrhage in placenta accreta(included all varieties). Both studies encouraged the use of TEG, point-of-care TEG, cell saver and rapid infusor systems. Use of point-of-care coagulation testing enables rapid assessment of coagulation status and precise therapy, leading to sparing of unnecessary transfusion. Cryoprecipitate is invaluable in increasing fibrinogen levels, depletion of even up to 60% normal levels contributes to coagulopathy [44]. FFP is not very effective in increasing fibrinogen concentrations, and may lead to transfusion-related acute lung injury (TRALI).

d) Tranexamic acid: The WOMAN trial has established the utility of early administration of tranexamic acid, an antifibrinolytic agent, for the treatment of bleeding obstetric patients and has been seen to reduce mortality by 31% if administered within 3 h of birth [45].

e) Early use of factor VIIa. Use of recombinant factor VIIa should be the last resort for the management of massive obstetric hemorrhage. Recombinant factor VIIa use has been associated with thromboembolic events [25].

13. Conclusion

In conclusion, the abnormally adherent placenta is associated with increased morbidity in the mother, mainly related to the rapidity and extent of hemorrhage, sequela of massive transfusion and use of vasopressor and ventilator support. To a large extent, accurate pre operative diagnosis can be made by late II trimester/ early III trimester and increases preparedness of the treating team. These patients should be cared for in a tertiary care center with multidisciplinary involvement. It is good practice to have a detailed written, individualized plan in place which can be activated both for scheduled as well as emergency procedures. It may be possible to avoid peri partum hysterectomy in a significant number of patients with the use of pre operative endovascular procedures, with or without embolization, and not attempt to remove the placenta. Classification of patients into high- and low-risk groups based on ultrasound findings has been advocated may result in conservation of resources and judicious use of regional anesthesia [46].

Appendix A. Supplementary data

Supplementary data related to this article can be found at https://doi.org/10.1016/j.tacc.2018.05.001.

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