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No. 383-Screening, Diagnosis, and Management of Placenta Accreta Spectrum Disorders

This Clinical Practice Guideline has been prepared by the authors and reviewed by the Society of Obstetricians and Gynaecologists of Canada (SOGC)'s Maternal Fetal Medicine; Diagnostic Imaging and Guideline Management and Oversight committees and approved by the Board of the SOGC.

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KEY MESSAGES

1. The incidence of placenta accreta spectrum disorders is steadily rising in many countries.
2. Placenta accreta spectrum disorder in the setting of prior Caesarean section deliveries arises from pregnancy implantation within the niche created by this surgery.
3. Ultrasound may be used to screen for, and to diagnose, pregnancies with anterior placenta previa that are complicated by placenta accreta spectrum disorders.
4. Magnetic resonance imaging may complement multimodal ultrasound in the diagnosis and staging of placenta accreta spectrum disorders.
5. Placenta accreta spectrum disorder is a potentially life-threatening disorder that demands regional interdisciplinary team-based care.

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All people have the right and responsibility to make informed decisions about their care in partnership with their health care providers. In order to facilitate informed choice, patients should be provided with information and support that is evidence-based, culturally appropriate, and tailored to their needs.

This guideline was written using language that places women at the centre of care. The SOGC is committed to respecting the rights of all people – including transgender, gender non-binary, and intersex people – for whom the guideline may apply. We encourage health care providers to engage in respectful conversation with patients regarding their gender identity and their preferred gender pronouns to be used as a critical part of providing safe and appropriate care. The values, beliefs, and individual needs of each patient and their family should be sought and the final decision about the care and treatment options chosen by the patient should be respected.

Abstract

Background: Placenta accreta spectrum (PAS) disorders are a potentially life-threatening complication of pregnancy that demand coordinated interdisciplinary care to achieve safer outcomes. The rising incidence of this disease is due to a growing number of uterine surgical procedures, including the rising incidence of pregnancy following Caesarean section.

Objective: To provide current evidence-based guidelines on the optimal methods used to effectively screen, diagnose, and manage PAS disorders.

Methods: Members of the guideline committee were selected on the basis of their ongoing expertise in managing this condition across Canada and by practice setting. The committee reviewed all available evidence in the English medical literature, including published guidelines, and evaluated diagnostic tests, surgical procedures, and clinical outcomes.

Evidence: Published literature, including clinical practice guidelines, was retrieved through searches of Medline and The Cochrane Library to March 2018 using appropriate controlled vocabulary and key words. Results were restricted to systematic reviews, randomized controlled trials, and observational studies written in English. Searches were updated on a regular basis and incorporated in the guideline to July 2018.

Values: The quality of evidence in this document was graded using the criteria described in the Report of the Canadian Task Force on Preventive Health Care.

Results: This document reviews the evidence regarding the available diagnostic and surgical techniques used for optimal management of women with suspected PAS disorders, including anaesthesia and practical considerations for interdisciplinary care.

Benefits, Harms, and Costs: Implementation of the guideline recommendations will improve awareness of this disease and increase the proportion of affected women receiving interdisciplinary care in regional centres.

Conclusions: Interdisciplinary team-based care providing accurate diagnostic services, coordinated planning, and safer surgery deliver effective care with improved clinical outcomes in comparison with alternative management.

Summary Statements:

1. The incidence of placenta accreta spectrum disorders is steadily rising in many countries, likely due to the increasing proportion of women becoming pregnant following a variety of surgical procedures to the uterus, including multiple Caesarean sections.
2. Placenta accreta spectrum disorders in the setting of prior Caesarean section deliveries arises from pregnancy implantation within the niche created by this surgery near the cervicoisthmic junction of the uterus. This early presentation as a "Caesarean section scar pregnancy" may be diagnosed by ultrasound methods.
3. Ultrasound may be used to screen for, and to diagnose, pregnancies with anterior placenta previa that are complicated by placenta accreta spectrum disorders. The effectiveness of ultrasound in this context depends upon awareness of clinical risk factors, imaging quality, operator experience, gestational age, imaging modalities, and adequate bladder filling.
4. Magnetic resonance imaging may complement multimodal ultrasound in the diagnosis and staging of placenta accreta spectrum disorders, though its effectiveness is currently limited by the relative contraindication to the use of a gadolinium contrast enhancing agent.
5. Placenta accreta spectrum disorders are potentially life-threatening and demand regional interdisciplinary team-based care to deliver the safest outcomes for mothers and infants.

Recommendations:

1. Pregnant women with clinical risk factors for placenta accreta spectrum disorders and anterior placenta previa at the 18–20-week fetal anatomical ultrasound should be referred for specialist imaging to diagnose or exclude this disorder (II-2A).
2. Women with a diagnosis of placenta accreta spectrum disorder should be referred to a regional centre dedicated to the interdisciplinary management of this condition (II-3A).
3. Protocol-based interdisciplinary care from diagnosis to surgery will optimize both intraoperative and postoperative outcomes (II-3A).
4. Antenatal admission to a designated regional management centre may be indicated, especially following an antepartum hemorrhage, or based on considerations of geography or transport conditions (III-B).
5. For otherwise healthy women with no history of vaginal bleeding, the optimal timing of elective Caesarean section delivery is around 34–36 weeks gestation (II-3B). Surgery should be considered earlier for repeated episodes of antepartum hemorrhage or contractions to reduce the risks of emergent unplanned surgery and should ideally be preceded by a course of corticosteroids to enhance fetal lung maturation if prior to 35+0 weeks gestation (II-2A).
6. Regional anaesthesia may be safer than general anaesthesia as it is associated with reduced blood loss and is preferred by patients and their partners (II-2A). A massive transfusion protocol should be in place to respond to significant blood loss (III-B).
7. Intravenous tranexamic acid should be administered at the commencement of surgery because it reduces intraoperative blood loss (I-A).
8. Surgery should be performed in the modified lithotomy position, using midline access, sufficiently high so as to deliver the fetus without incising through the placenta; preoperative or intraoperative ultrasound can be used to guide the optimal uterine incision (III-B). No attempt should be made to remove the placenta if it shows no signs of separation as this may cause substantial hemorrhage (III-B).
9. Presently there is insufficient evidence to recommend giving or withholding uterotonic drugs after delivery of the fetus (III-C).
10. Presently there is insufficient evidence to recommend either approach (preoperative balloon placement or intraoperative ligation) designed to arrest blood flow from the internal iliac arteries prior to hysterectomy (II-1C).
11. Focal central disease may be amenable to wedge resection, with complete removal of the placenta and repair of the uterus (the triple-P procedure) (II-3B).
12. Classical Caesarean section and non-removal of the invasive placenta is an acceptable method of delivery but is associated with a protracted course of recovery and a persistent risk of hysterectomy (II-3B).
13. Women who retain their fertility following a diagnosis of placenta accreta spectrum disorder should be instructed to access specialist ultrasound early in any future pregnancy so that all management options are available should a Caesarean section scar pregnancy be found (III-B).
14. Prenatal diagnosis of the more severe forms of placenta accreta spectrum disorder, expressed as a Caesarean section scar pregnancy, may permit management using minimally invasive surgical techniques (II-3B).
15. Though many women with placenta accreta spectrum disorder in well-resourced countries receive safe care, more research and knowledge translation are needed to effectively deliver all management options at the population-based level (III-B).

INTRODUCTION

Normal early human placental development is characterized by implantation of the blastocyst in to the transformed inner decidual layer, the pregnancy-transformed endometrium, within the body of the uterus. The normal underlying myometrial layer accommodates the pregnancy as fetal growth occurs in an exponential manner. The maternal-fetal interface of the decidua prepares Nitabuch's layer, a detachment zone that permits placental expulsion during the third stage of labour.

Placenta accreta spectrum (PAS) disorders is the contemporary term chosen to encompass a variety of clinical pregnancy complications resulting from varying combinations of abnormal placental implantation that may be accompanied by deficiency of the uterine wall. Focal deficiencies of the decidua at the site of implantation will result in direct contact between the anchoring placental tissues and the myometrium, such that the normal detachment zone is unable to form. This phenomenon, termed *placenta accreta*, results in failure of placental detachment at delivery. Defects in the decidua may be accompanied by loss of underlying myometrium, induced by various forms of prior uterine surgery or trauma. Adherent placentation accompanied by deficient myometrium is referred to as *placenta increta*, while complete loss of myometrium to the uterine serosa or beyond, in this context, is referred to as *placenta percreta*. Abnormal placental implantation may furthermore induce aberrant neovascularization of the maternal circulation within the uterine wall. PAS disorders are usually associated with placenta previa, a scenario in which all components (loss of decidua and myometrium, together with neovascularization) are more pronounced, and may rarely result in the placenta invading into the bladder or other vital structures.

The greatest risk with PAS disorders occurs at the time of delivery. If undiagnosed and/or manual removal of the placenta is attempted, potentially catastrophic maternal hemorrhage can ensue, leading to a significant risk of maternal morbidity and mortality. With elective antenatal diagnosis, women with this disorder can be optimally prepared so as to institute definitive management in a timely manner thereby minimizing adverse outcomes.[1]

Collectively, the spectrum of PAS disorders now affects around 1 in 500 pregnancies in developed countries,[2,3] where the prevalence of pregnancy following prior uterine surgery has steadily risen in the past three decades. Consequently, all types of maternity care providers must be aware of the risks and consequences of pregnancy complicated by PAS disorders.

Table 1 provides a key to evidence statements and grading of recommendations.

EPIDEMIOLOGY AND RISK FACTORS

Established risk factors for PAS disorders are summarized in Table 2.[4,5]

Trends in rising rates of Caesarean section (CS; approximately 32.3% across North America),[6] advanced maternal age (a risk factor for the prevalence of prior uterine surgery and placenta previa),[4] and potentially the technique of CS[7–9] have compounded the population-based risk of PAS disorders. Currently, with increasing incidence in developed countries, it is estimated that 1 in every 403–533 pregnancies is now complicated by PAS disorders.[2,3]

Summary Statement

1. The incidence of placenta accreta spectrum disorder is steadily rising in many countries, likely due to the increasing proportion of women becoming pregnant following a variety of surgical procedures to the uterus, including multiple Caesarean sections.

The underlying diverse etiology implies that the extent of the disease may be varied in depth, be multifocal, and therefore differ considerably between individual patients. The general types of PAS disorders, and their typical presentations, are summarized in Table 3.

MATERNAL BIOMARKERS IN FIRST AND SECOND TRIMESTER

Currently, there is limited literature regarding the patterns of maternal biomarkers in pregnancies complicated by PAS disorders compared to those without. These reports generally comprise small retrospective case-control studies with varied comparison groups and are insufficient to inform the institution of formal screening programs.

There may be lower levels of first and second trimester maternal serum beta-human chorionic gonadotropin in PAS disorder pregnancies.[10,11] Additionally, several studies have demonstrated increased levels of first trimester maternal serum pregnancy-associated plasma protein-A.[11,12] Maternal serum levels of first or second trimester alpha-fetoprotein in women with PAS disorders show wide variation with inconsistent results.[10,12,13]

Overall, there is currently insufficient evidence to recommend the utilization of either first or second trimester maternal

Table 1. Key to evidence statements and grading of recommendations, using the ranking of the Canadian Task Force on Preventive Health Care

Quality of evidence assessment*	Classification of recommendations†
I: Evidence obtained from at least one properly randomized controlled trial	A. There is good evidence to recommend the clinical preventive action.
II-1: Evidence from well-designed controlled trials without randomization	B. There is fair evidence to recommend the clinical preventive action.
II-2: Evidence from well-designed cohort (prospective or retrospective) or case-control studies, preferably from more than one centre or research group	C. The existing evidence is conflicting and does not allow to make a recommendation for or against use of the clinical preventive action; however, other factors may influence decision-making.
II-3: Evidence obtained from comparisons between times or places with or without the intervention. Dramatic results in uncontrolled experiments (such as the results of treatment with penicillin in the 1940s) could also be included in this category	D. There is fair evidence to recommend against the clinical preventive action. E. There is good evidence to recommend against the clinical preventive action.
III: Opinions of respected authorities, based on clinical experience, descriptive studies, or reports of expert committees	L. There is insufficient evidence (in quantity or quality) to make a recommendation; however, other factors may influence decision making.

* The quality of evidence reported in these guidelines has been adapted from The Evaluation of Evidence criteria described in the Canadian Task Force on Preventive Health Care.[38]

† Recommendations included in these guidelines have been adapted from the Classification of Recommendations criteria described in The Canadian Task Force on Preventive Health Care.[38]

Table 2. Risk factors for placenta accreta spectrum disorders

Risk factor	Odds ratio (95% CI)	Explanation
Maternal age ≥35 years[4]	4.6 (3.2–6.7)	Linked to confounding factors, rather than isolated maternal age
In vitro fertilization[4]	3.1 (1.6–5.8)	Altered implantation increasing risk of lower uterine segment/cervical location
Placenta previa[4]	292 (196–400)	Thin lower segment that is the most common site of uterine scarring due to prior CS
CS[4]	Any previous CS 8.8 (6.1–12.6) 1 prior CS 6.6 (4.4–9.8) 2 prior CS 17.4 (9.0–31.4) ≥3 prior CS 55.9 (25.0–110.3) Prior CS not previa 3.7 (2.3–5.8)	A niche may form at the site of a CS, which is deficient in decidua ± myometrium. Niche size may be influenced by type of uterine closure and frequency of prior CS
Previous minor uterine surgery (i.e. dilatation and curettage, hysteroscopic surgery)[5]	3.4 (1.3–8.9)	These procedures may cause focal loss of endometrium and myometrium, especially if performed during pregnancy
Myomectomy	Only case reports in literature	Deficient myometrium ± endometrium may result from these types of surgery
Fibroid embolization	Only case reports in literature	Focal endometrial and myometrial necrosis may result, especially if permanent microspheres are used
Intrauterine adhesions	Only case reports in literature	Diagnosis implies significant uterine scarring, most often from previous intrauterine surgery or infection

CI: confidence interval; CS: Caesarean section.

biomarkers to screen for PAS disorders; however, this area of research remains a focus of several groups globally.

PRENATAL SCREENING AND DIAGNOSIS USING ULTRASOUND

First Trimester

PAS disorders occurring in the first trimester following a prior CS delivery is described as a CS scar pregnancy. The origin of this type of disease is due to implantation within a niche at the cervicoisthmic junction of the uterus created by prior CS delivery.[14,15] A diagnosis of CS scar pregnancy may be established either at a dating ultrasound or at the 11–13 week nuchal translucency examination. The expanding placenta and gestation project anteriorly through the deficient myometrium and may cause the empty but decidualized uterine fundus to become retroverted. There are two subtypes of CS scar pregnancy, classified by either intact (type 1) or deficient

Table 3. Clinical presentations of placenta accreta spectrum disorders

Type of disorder	Presentation
A. Normal placental location	
Placenta accreta	Failure of normal placental detachment and delivery, either following vaginal delivery or at CS
Placenta increta/percreta	These may present similarly to placenta accreta as a multifocal disease spectrum. At CS other disease features (myometrial defects, neovascularization of the external uterine wall, extension of placenta beyond the uterus) may be evident.
B. Placenta located in the anterior lower uterine segment	
	Acute lower abdominal pain and vaginal bleeding in the first trimester (CS scar pregnancy) Ultrasonographic features of PAS disorder associated with placenta previa in the second trimester Antepartum hemorrhage with placenta previa in the second or third trimesters Macroscopic hematuria with bladder involvement Acute abdominal pain (hemoperitoneum) Bulging hypervascular lower uterine wall at CS (intraoperative diagnosis)

CS: Caesarean section; PAS: placenta accreta spectrum.

(type 2) myometrium over the apex of the placenta posterior to the bladder.[15] CS scar pregnancy may present with acute abdominal pain due to hemoperitoneum and/or vaginal bleeding.[16,17] The natural history of a CS scar pregnancy is to evolve into a PAS disorder.[18] In women at increased risk (previous uterine surgery and low-lying placenta), a recent prospective study of 1256 patients demonstrated that ultrasound screening at 12-16 weeks for features of PAS disorders, was highly predictive of definitive diagnosis at delivery - detecting all 13 cases in the population, with one false positive result.[88]

Summary Statement

2. Placenta accreta spectrum disorder in the setting of prior Caesarean section deliveries arises from pregnancy implantation within the niche created by this surgery near the cervicoisthmic junction of the uterus. This early presentation as a "Caesarean section scar pregnancy" may be diagnosed by ultrasound methods.

Second Trimester

The diagnosis of placenta previa is established easily at the time of the 18–20-week fetal anatomical ultrasound examination.[19] The potential for PAS disorders should be considered in women with clinical risk factors as previously described. Multimodal ultrasound, including imaging with an adequately filled bladder, can achieve a high (>90%) positive predictive value for confirmed placenta previa with PAS disorder at delivery.[20] The overall diagnostic accuracy of ultrasound in detecting the presence of PAS disorders is reported as: sensitivity, 90.7% (95% confidence interval (CI) 87.2%–93.6%); specificity, 96.9% (95% CI 96.3%–97.5%).[21] Ultrasound may have a more limited role for the diagnosis of non-previa PAS disorders, which therefore remain largely a clinical diagnosis at the time of delivery or may be amenable to diagnosis with magnetic resonance imaging (MRI) if there is a high clinical suspicion.[22] The ultrasound features associated with PAS disorders in the second trimester are outlined in Table 4. It can be pertinent for the managing team to discuss specific diagnostic imaging findings with the reporting radiologist or sonologist, so as to better stratify risk and plan individual care. Overall, the negative predictive value of ultrasound is high (84%)[21]; therefore, where specialist ultrasound is negative for PAS disorders, the location of ongoing pregnancy care and delivery may be determined by the referring physician after discussions with the specialist regional centre.

Third Trimester

The diagnosis of a PAS disorder may be made at any stage in the third trimester, but there is no diagnostic advantage in delaying the examination if invasive placentation is suspected in the second trimester. The diagnostic accuracy of ultrasound in the late third trimester may be challenged by difficulties in maintaining a full bladder for optimal assessment. Transvaginal ultrasound imaging, combined with colour Doppler, can be helpful in this context.

Summary Statement

3. Ultrasound may be used to screen for, and to diagnose, pregnancies with anterior major placenta previa that are complicated by placenta accreta spectrum disorder. The effectiveness of ultrasound in this context depends upon awareness of clinical risk factors, imaging quality, operator experience, gestational age, imaging modalities, and adequate bladder filling.

Intraoperative Diagnosis

Where a PAS disorder is found at a CS delivery in a community setting, especially via a Pfannenstiel incision, consideration may be given to intraoperative consultation including image transfer; so long as the uterus has not

Table 4. Ultrasound findings with placenta accreta spectrum disorders in the second trimester

Ultrasound modality	Findings
Real-time grey scale	• Placenta previa • Forward bulge of thickened placenta towards the posterior bladder wall • Placental lacunae, loss of the normal hypoechoic placental-myometrial junction (clear space) • Myometrial thinning <1 mm • Replacement of lower segment myometrium with dark vascular spaces • Interruption of the hyperechoic bladder serosal line • Intravesical placental tissue or hemorrhagic clot • Transvaginal imaging is safe and can determine cervical length, cervical involvement, and interrogate for inferior and posterior lower uterine segment features.
Color/power Doppler	• Neovascularization at the placental-myometrial-bladder interface • Maternal pulsatile signals within the placenta (particularly adjacent to or within lacunae) • Color Doppler must be conducted at low-velocity (<10 cm/sec) settings in order to detect low-flow areas.
Pulsed Doppler	• Maternal arcuate artery pulsatile blood flow directly entering the placenta.

been incised, the abdomen may be closed and the patient transferred to a designated regional centre.[23]

Recommendation

1. Pregnant women with clinical risk factors for placenta accreta spectrum disorder and anterior placenta previa at the 18–20-week fetal anatomical ultrasound should be referred for specialist imaging to diagnose or exclude this disorder (II-2A).

ROLE OF MAGNETIC RESONANCE IMAGING

MRI is considered safe in pregnancy, especially after the first trimester, though it is costly, may induce claustrophobia, and is challenging to perform in obese women and in all women after 34 weeks gestation.[24,25] If utilized, MRI should be performed at 1.5T, in all three planes, using both T1 and T2 relaxation modes.[26] The examination is only rarely performed with contrast (gadolinium) enhancement due to safety concerns, though contrast improves diagnostic accuracy in women with suspected PAS disorders.[25,27] MRI is reported to more accurately stage the extent of the disease, especially when placental extension into either the bladder, posterior uterus, cervix, and/or parametrium is suspected. The overall diagnostic accuracy of MRI in detecting the presence of PAS disorders is reported as follows: sensitivity, 94.4% (95% CI 86.0–97.9%); specificity, 84.0% (95% CI 76.0–89.8%).[28] MRI can be used selectively in units where ultrasound imaging and interpretation are of high volume and quality. Conversely, MRI may be more accurate when a PAS disorder is suspected in the absence of placenta previa, especially with a posterior or fundal placental location.[22] Interestingly, one recent retrospective study of 78 cases of PAS disorders[29] demonstrated that the addition of MRI to ultrasound imaging resulted in a correct, clinically meaningful change in diagnosis in only 19% of cases; it resulted in an incorrect change in diagnosis in 17% and an incorrect confirmation of ultrasound diagnosis in 21%. Unexpectedly, for cases of posterior and lateral placentation or suspected severe PAS disorder on ultrasound, MRI offered no identifiable benefit. As with ultrasound imaging, the diagnostic accuracy is enhanced when MRI is supervised and reported by experienced specialists.[30]

Summary Statement

4. Magnetic resonance imaging may complement multimodal ultrasound in the diagnosis and staging of placenta accreta spectrum disorder, though its effectiveness is currently limited by the relative contraindication to the use of a gadolinium contrast enhancing agent.

REGIONAL ORGANIZATION OF CARE

Given the potentially life-threatening nature of PAS disorders, especially in the presence of placenta previa, careful consideration should be given to refer pregnant women with a diagnosis of PAS disorder for comprehensive care in a designated regional centre. Published cohort studies from large-volume centres in Canada, the United States, Australia, Europe, and the Middle East all support this approach.[31–34] These studies have demonstrated reduced maternal morbidity, with lower rates of large volume blood transfusion, intensive care admission, and reoperation.[35–37] Even within centres of excellence, morbidity decreases with experience over time and with the ability to add care elements to care plans, reflecting the importance of dedicated centres, with sufficient volume to

Table 5. Suggested components of a Canadian regional centre specialized in the diagnosis and elective management of placenta accreta spectrum disorders

PAS disorder regional centre components
Level II obstetric ultrasonography with experience in PAS disorders
Magnetic resonance imaging with radiologist experienced in PAS disorders
Level III maternity unit
Adult intensive care unit
Obstetric anaesthesiology
Hematology
Timely provision of massive blood transfusion protocol
Cell salvage and perfusionist services
Specialist surgical teams available for timely intraoperative consultation, particularly involving urology, vascular surgery and general surgery
Interventional radiology
Level II neonatal intensive care unit
Adequate-volume surgeon caseload*

* The authors acknowledge regional limitations in available PAS disorder case load; however, the international literature on perioperative complication rates from all gynaecological surgery significantly favours high-volume (>1 case per month) surgeons within regional centres.[39,40] It should be noted that surgical skills and experience may be translated from other related procedures with similar technical difficulty and acuity. PAS: placenta accreta spectrum.

maximize patient safety.[31,38] Table 5 lists the suggested components of a PAS disorder regional centre.

Summary Statement

5. Placenta accreta spectrum disorder is a potentially life-threatening disorder that demands regional interdisciplinary team-based care to deliver the safest outcomes for mother and infant.

Recommendation

2. Women with a diagnosis of placenta accreta spectrum disorder should be referred to a regional centre dedicated to the interdisciplinary management of this condition (II-3A).

ANTENATAL CARE PRIOR TO SURGERY

Multidisciplinary care is ideally provided in a hospital-based setting, coordinated either by maternal-fetal medicine specialists or obstetricians with a special interest in these disorders. Protocol checklists have been published to promote uniform care.[41,42] The following special considerations are emphasized.

1 *Optimization of hemoglobin levels.* The appropriate use of intravenous iron, coupled with prenatal vitamins, can be guided by determination of the complete blood count (CBC) and ferritin levels.
2 *Maternal serologies.* Determination of serologic status should be determined for hepatitis B, hepatitis C, and human immunodeficiency virus (HIV).
3 *Pap test history.* Recent Pap test results should be obtained to determine if a total hysterectomy is required due to cervical intraepithelial neoplasia.
4 *Prior surgery records.* Surgical notes of prior uterine surgeries, especially if unusual or involved blood transfusion, should be obtained where possible.
5 *Social work review.* This is encouraged especially for women who have traveled a longer distance for care, have larger families, or who voice concerns regarding support.
6 *Mental health review.* Women should be encouraged to voice mental health concerns, in view of the serious nature of the diagnosis and treatment.
7 *Maternal-fetal surveillance.* Ultrasonographic fetal growth surveillance can be incorporated into serial visits. However, since placental function is typically normal and affected women are parous, the risks of hypertensive disorders of pregnancy and fetal growth restriction are low.
8 *Response to the risk of antepartum bleeding.* Women should be counselled to avoid travel away from easy access to regional care, and for safety reasons should avoid foreign travel and remote locations. Provision of documentation of the diagnosis and planned location of care may aid ambulance transfer of stable patients.
9 *Anaesthesia consultation.* The process of care from entry into the operating room, during surgery, and the postoperative period, including pain relief, is reviewed. Regional anaesthesia via epidural with or without spinal is an acceptable choice which may confer benefits,[43,44] though preparation for general anaesthesia is required.
10 *Surgical consultation.* Detailed discussions with team members should focus on the following key points: preoperative cystoscopic assessment of the posterior bladder wall with or without ureteric stenting, requirement for midline laparotomy, classical CS avoiding the placenta, decision to perform hysterectomy, utility of internal iliac artery (IIA) ligation, option of salpingectomy or tubal ligation with either spontaneous

delivery of the placenta or successful wedge resection (triple-P procedure[45]) of focally invasive PAS disorders, postoperative recovery including extended use of an epidural infusion for 24 hours.

11 *Blood conservation measures.* Alternative methods that may reduce surgical blood loss include the preoperative placement of occlusion balloons in the territory of the IIAs, intravenous tranexamic acid, and conservation of intraoperative blood loss using cell salvage equipment.

12 *Plan of supportive care following discharge.* Anticipated length of inpatient stay is now typically 2–3 days. Discussion of ongoing medical/nursing/mental health support nearer to home, if applicable, including telemedicine support.

13 *Infant care.* Care of the late preterm (34–36 week) infant, including retrotransfer to a level II facility nearer to place of residence. Support to establish lactation and breastfeeding if desired.

Recommendation

3. Protocol-based interdisciplinary care from diagnosis to surgery will optimize both intraoperative and postoperative outcomes (II-3A).

The timing of elective surgery is a balance between the advancement of gestation to reduce the impact of infant morbidity from late prematurity and the ongoing risk of major antepartum bleeding or contractions that may either a) prevent transfer of the patient from home to the designated regional centre or b) result in the provision of emergency surgery with suboptimal assembly of team components. Multiple studies have demonstrated reduced complications related to blood loss with non-emergent versus emergent delivery.[1,46,47] The risk of unscheduled delivery increases if the patient experiences episodes of antepartum hemorrhage.[48] Extensive analysis of these factors suggests that elective surgery around 34–36 weeks is optimal, with the administration of antenatal betamethasone within 1 week of planned delivery if at or before 34 +6 weeks gestation.[49–52]

Recommendations

4. Antenatal admission to a designated regional management centre may be indicated, especially following an antepartum hemorrhage, or based on considerations of geography or transport conditions (III-B).
5. For otherwise healthy women with no history of vaginal bleeding, the optimal timing of elective Caesarean section delivery is around 34–36 weeks gestation (II-3B). Surgery should be considered earlier for repeated episodes of antepartum hemorrhage or contractions to reduce the risks of emergent unplanned surgery and should ideally be preceded by a course of corticosteroids to enhance fetal lung maturation if prior to 35+0 weeks gestation (II-2A).
6. Regional anaesthesia may be safer than general anaesthesia as it is associated with reduced blood loss and is preferred by patients and their partners (II-2A). A massive transfusion protocol should be in place to respond to significant blood loss (III-B).

INTRAOPERATIVE CONSIDERATIONS

Formal use of a surgical safety checklist should take place when all members of the health care team, and their resources, are assembled in the operating room.[53] Surgery in the modified lithotomy position is ideal as this facilitates additional surgical assistance, monitoring of vaginal blood loss, and cystoscopy. Pneumatic compression stockings may be considered.[54] Antibiotics and tranexamic acid should be given intravenously at skin incision.[55,56] Ultrasound mapping should be used to locate the upper anterior edge of the placenta, to guide the upper margin of the skin incision needed for adequate exposure of the uterus.[57] Cystoscopy may be of value to inspect the posterior bladder wall for placental invasion, followed by selective bilateral placement of ureteric stents.[58] Upon opening the abdomen, the lower anterior uterine wall should be inspected to define the extent of neoangiogenesis indicating areas of disease; partial reflection of the bladder may be required for adequate visualization and assessment of placental invasion. Ultrasound performed in a sterile manner directly on the uterine surface may be used to map the upper anterior placental edge prior to delivery by classical CS. The uterus should be handled gently at this stage so as to minimize the risk of vascular disruption and hemorrhage. Once consensus is achieved to proceed with hysterectomy for PAS disorder, the uterine incision should be closed in one layer to limit blood loss. Cell saver equipment may be used to conserve blood loss[59]; if equipment is used, all amniotic fluid should first be removed from the operative field to avoid contamination. Posterior dissection of the broad ligament, following division of the round ligaments, facilitates ureteric identification and ureterolysis while permitting IIA ligation if deemed necessary. Partial intermittent filling of the bladder with a 3-way methylene blue dye channel facilitates accurate

identification of the correct vesicouterine plane during dissection of the bladder. Prior to excision of the uterus, vaginal placement of an instrument in the fornices, such as the Breisky retractor or colpotomizer, aids accurate identification of the anterior or posterior cervicovaginal margins. Currently, there is insufficient evidence to recommend giving or withholding uterotonic drugs after delivery of the baby. Following vault closure, repeat cystoscopy may be indicated to inspect the ureteric orifices prior to closure of the abdomen.

Recommendations

7. Intravenous tranexamic should be administered at the commencement of surgery because it reduces intraoperative blood loss (I-A).
8. Surgery should be performed in the modified lithotomy position, using midline access, sufficiently high so as to deliver the fetus without incising through the placenta; preoperative or intraoperative ultrasound can be used to guide the optimal uterine incision (III-B). No attempt should be made to remove the placenta if it shows no signs of separation as this may cause substantial hemorrhage (III-B).
9. Presently there is insufficient evidence to recommend giving or withholding uterotonic drugs after delivery of the fetus (III-C).

INTERNAL ILIAC ARTERY OCCLUSION

Surgical ligation of the anterior division of the IIAs is practised by many specialist centres managing women with PAS disorders. The effectiveness of this intervention in the context of a PAS disorder is, however, limited by the development of extensive collateral arterial blood supply either from branches of the external iliac arteries or the aorta. To date, no large definitive randomized controlled trial has been conducted to determine the effectiveness of this approach. Proponents state that exposure of the IIAs in the retroperitoneal spaces aids identification of the course of the ureters. One recent small parallel randomized controlled trial, involving 57 women allocated to Caesarean hysterectomy with or without surgical IIA ligation with PAS disorders,[60] demonstrated no significant difference in intraoperative estimated blood loss (1632 ± 804 mL vs. 1698 ± 1251 mL, respectively; P value 0.8). The authors did report an intuitive increase in total operative procedure duration for those receiving IIA ligation compared to Caesarean hysterectomy alone (223 ± 66 minutes vs. 171 ± 41.4 minutes, respectively; $P = 0.001$). An alternative to intraoperative IIA ligation is the transfemoral bilateral preoperative placement of flow balloons into the same location, followed by intraoperative inflation after delivery. In a small pilot randomized controlled trial, placement of bilateral IIA balloons did not reduce blood loss, though mean blood loss was high (>4 L) in both arms of the study.[61] The strategy of placing IIA balloons significantly extends the total surgical procedure duration and is more expensive than intraoperative IIA ligation. Moreover, IIA ligation may be performed selectively, depending on blood loss during surgery. One potential advantage of IIA balloons is to perform immediate postoperative angiography,[31] though with careful surgical hemostasis techniques the likelihood of identifying bleeding arterial vessels should be very low. IIA balloon placement has been associated with significant maternal morbidity, including perforation, dissection, or pseudo-aneurysm formation of the IIAs; hematoma formation at the femoral insertion site; and distal embolic phenomena in the feet.[62] Opponents of any type of IIA intervention report relatively rapid restoration of arterial pulse pressure during ongoing surgery, limited benefit due to aberrant IIA-independent arterial blood supply, and the inherent potential risk of vascular complications.[63,64]

Another recently proposed alternative is temporary infrarenal aortic balloon occlusion with or without uterine artery embolization.[65–69] With appropriate training, this device may be rapidly inserted to its correct infrarenal location, without the need for angiography.[70] This selective approach can be used to control bleeding from all arterial sources within the pelvis during difficult surgery for PAS disorders without the risk of ischemic complications of the lower limbs.

Recommendation

10. Presently there is insufficient evidence to recommend either approach (preoperative balloon placement or intraoperative ligation) designed to arrest blood flow from the internal iliac arteries prior to hysterectomy (II-1C).

CONSERVATION OF THE UTERUS

Where the invasive placental disease is found to be focal so that a large portion of the placenta gradually separates, consideration may be given to extension of the classical uterine incision, thereby resecting the placenta and

implantation site. The combination of midline access classical CS, optional ligation of the IIAs, excision of adherent placenta with any overlying myometrium, and repair of the uterus was originally described in 2004[71] and more recently popularized as the "triple-P procedure".[45] Preoperative MRI findings may be used to select patients to counsel for this option.[72] Successful pregnancies without further PAS disorders have been reported following this procedure.[73]

Recommendation

11. Focal central disease may be amenable to wedge resection, with complete removal of the placenta and repair of the uterus (the triple-P procedure) (II-3B).

Classical CS with closure of the uterus is an alternative choice to initially manage PAS disorders, especially if the diagnosis is made intraoperatively or delivery occurs in a remote or community setting. Gradual expulsion of placental fragments may occur, leading to complete resolution over a protracted period of time.[74] This approach will lead to an initial period of devascularization of the uterus, though over time there is a risk of forming large-bore arteriovenous malformations in the uterine wall in contact with the necrotic placenta.[75] Therefore, vaginal bleeding, coagulopathy, sepsis, and the need for repeat laparotomy and emergency hysterectomy are significant risks from an initial conservative treatment approach. Published experience, both locally from Canada and abroad, have consistently demonstrated a 40% risk of subsequent emergent hysterectomy with a 42% chance of major maternal morbidity with this conservative approach.[75,76] Pro-active surgical measures, following an initial 4–6-week period of recovery and devascularization, include a) hysteroscopic resection of placenta tissues under ultrasound or laparoscopic guidance[77] and b) total hysterectomy by laparoscopy or laparotomy.[78,79]

Recommendation

12. Classical CS and non-removal of the invasive placenta is an acceptable method of delivery but is associated with a protracted course of recovery and a persistent risk of hysterectomy (II-3B).

POSTOPERATIVE CONSIDERATIONS

Team-based care involving clinical nursing specialists aligned to the multidisciplinary program facilitates delivery of protocol-based care in a setting that is familiar to the woman and her family. Admission rates to intensive care following elective surgery vary, but where not deemed necessary, an initial period of intensive 1-to-1 nursing care for 24 hours is advised, ideally in labour and delivery or a high-dependency area. Retention of an epidural affords effective pain relief and avoidance of excessive narcotic use. In line with local protocols, prophylactic daily low-molecular-weight heparin (LMWH) is advised for a variable length of time, depending upon clinical risk factors and the intraoperative course. Planned transfer of medical and nursing care into the community setting is advised, with specialist team backup. Ongoing social work and mental health support is an important consideration. Return for a 6–8 week postoperative review, to include review of the pathology, is advised, to discuss ongoing gynaecologic care. Breastfeeding is encouraged and is often successful but may be difficult with elective non-removal of the placenta, due to ongoing estrogen production by the decaying placental tissues.

MULTIDISCIPLINARY PLACENTA ACCRETA SPECTRUM DISORDER CARE CHECKLIST

As discussed, there are many approaches to the diagnosis and management of patients with PAS disorders; however, several specific checklists have been developed to guide care in the Canadian context (Table 6).[41,80]

RETAINED PLACENTA FOLLOWING VAGINAL DELIVERY

PAS disorders may occur with a normally sited placenta and present with non-separation of the placenta following delivery of the fetus. Most women in this situation have no prior risk factors for PAS disorders, though increasingly women are becoming pregnant following risk factors that do not mandate CS delivery, including surgery for intrauterine adhesions (Asherman syndrome), fibroid embolization, and multiple prior dilation and curettage procedures. PAS disorders should be suspected following delivery if no revealed vaginal bleeding occurs and no easy plane of placental separation is identified via bimanual examination of the uterus. The following are recommended in this context: umbilical cord should be cut and ligated short with an absorbable suture, with administration of prophylactic antibiotics, continued intravenous

Table 6. Multidisciplinary checklist for suspected placenta accreta spectrum disorder

Patient demographics
Date
Name
Medical record number
Most responsible physician/contacts
Age
GTPAL
Estimated due date
BMI
Number of previous CS
Other prior uterine surgery
Desire for future fertility
Number of APH episodes to date
Antenatal assessment
Placental position
Ultrasound features
MRI features
CBC ± ferritin ± Hb electrophoresis
Iron supplementation as indicated
Blood type and antibody screen
Dates of Rh immunoglobulin administration
Blood borne virus screen (Hep B, Hep C, HIV)
MFM/high-risk obstetrics consult
Surgical gynaecology consult
Surgical consent form completed
Blood product consent form completed
Obstetric anaesthesia consult
NICU consult
Additional team consults as indicated (hematology, IR, urology etc)
Antenatal corticosteroids as indicated
Care plan documented
Patient letter in case of emergency
Surgical planning
Delivery site designated
Book operating room
Surgical nursing team available
Cell saver and perfusionist arranged
Labour and delivery nurse arranged
Newborn resuscitation equipment available
Book IR suite for day of surgery if required
Antenatal admission
Confirm history and physical examination
Routine admission care orders
CBC
Cross-match 4 units pRBC
Confirm Rh immunoglobulin requirements
Standard preoperative fasting orders
Discuss plan with care team
Day of surgery
Anaesthesia pre-medication, peripheral/central lines, and care as indicated
Items in OR: Doppler fetal heart monitor, ultrasound machine, uterine tamponade balloon, tranexamic acid, uterotonics, newborn medications
Hysterectomy instrument set
Cell saver and perfusionist
NICU team present
Ability to perform cystoscopy if indicated
3-way Foley urinary catheter
Preoperative IR procedure if required
Transfer to OR, position low lithotomy
Surgical team briefing
Confirm adequate regional anaesthesia
Set up two suction devices (including cell saver) and cautery
Time-out prior to skin incision
Administer IV tranexamic acid
Delivery of infant by CS with delayed cord clamping where possible
Immediate postpartum infant care directed as appropriate
Surgical ligation of pelvic arteries if required
Intraoperative management as directed by surgical team
Postoperative transfer back to IR for removal of devices if indicated
Postpartum care
Lead by surgical team with daily inpatient reviews
Care principally guided by local ERAS procedures
If cell saver used: postpartum labs including CBC, hemolytic screen, antibody screen
Venous thromboembolism prophylaxis
Bladder care as required
Breastfeeding support as required
Wound care as indicated
Discharge when standard criteria met
Postpartum appointments

APH: antepartum hemorrhage; BMI: body mass index; CBC: complete blood count; CS: Caesarean section; ERAS: enhanced recovery after surgery; GTPAL: gravida/term/preterm/aborta/living; Hb: hemoglobin; Hep: hepatitis: HIV: human immunodeficiency virus; IR: interventional radiology; MFM: maternal fetal medicine; MRI: magnetic resonance imaging; NICU: neonatal intensive care unit; OR: operating room; pRBC: packed red blood cells.

Modified from El-Messidi et al.[80] and Walker et al.[41]

access with an oxytocin infusion, and no oral intake for an initial observation period of 12–24 hours, in case there is a need for general anaesthesia. Team discussion should include consideration of patient transfer to a regional centre designated to manage PAS disorders, which will include specialized expertise in ultrasound and MRI interpretation. Administration of methotrexate and elective embolization of the uterine arteries are of no value in the stable patient.[74] Discharge home with elective weekly follow-up for a period of 4–6 weeks will permit pelvic devascularisation. Timed interval removal of retained placental tissue should be considered by experienced surgeons in institutions with the ability to convert to hysterectomy as needed and to provide massive blood transfusion support.

Options to managed delayed placental extraction include:

- removal of placental tissue using ultrasound guidance
- hysteroscopic-guided tissue removal
- laparoscopic monitoring, including ligation of the anterior divisions of the IIAs within the posterior broad ligaments
- preparation to convert to laparotomy in case of excessive bleeding or complications, such as uterine perforation
- availability of an intrauterine tamponade balloon device
- administration of intravenous antibiotics and tranexamic acid

Several reports of successful outcomes using this approach have been published.[77] Where ultrasound or MRI is suggestive of placenta increta or percreta, general anaesthesia with initial laparoscopic-guided surgical management is advised.[78,79]

RECURRENCE RISKS FOLLOWING PREGNANCY WITH PLACENTA ACCRETA SPECTRUM DISORDERS

High rates of recurrence of PAS disorders have been reported (17%–29%), though the rates vary widely by series and underlying diagnosis.[81–83] Successful near-term pregnancies have been reported, although within the Canadian context subsequent pregnancies are rare.[75,81] For women becoming pregnant following a conserving triple-P type procedure, the risk of recurrence depends largely upon location of a future pregnancy.[84] Recurrence rates may be higher for women with more widespread uterine disease (e.g., following fibroid embolization or surgery for intrauterine adhesions).

Recommendation

13. Women who retain their fertility following a diagnosis of placenta accreta spectrum disorder should be instructed to access specialist ultrasound early in any future pregnancy so that all management options are available should a Caesarean section scar pregnancy be found (III-B).

MANAGEMENT OPTIONS IN EARLY PREGNANCY

Where a CS scar pregnancy is diagnosed in the first trimester, a number of options exist for safe termination of pregnancy with conservation of the uterus if required. In the early first trimester, up to 8–9 weeks, ultrasound-guided potassium chloride injection into the embryo, followed by intramuscular methotrexate may be followed by a latent period of 2–3 days for devascularization, then hysteroscopic resection of the pregnancy from within the lower anterior wall of the uterus.[85,86] In larger CS scar pregnancies (e.g., discovered at the 11–13-week nuchal translucency examination), the aforementioned medical interventions may need to be directly followed by surgical intervention in centres with this experience. A recent case series from a group in Toronto recommends approaching such cases with laparoscopic assessment, ligation of the anterior divisions of the IIAs, then either vaginal tissue extraction or laparoscopic wedge resection of the pregnancy and suture repair of the uterus.[85] The latter approach resects the CS scar niche and should be followed up postoperatively with a sonohysterogram prior to consideration of any further pregnancy. Some women receiving the diagnosis of a CS scar pregnancy will elect to continue in pregnancy and be delivered by CS with or without hysterectomy, based on favorable contemporary maternal and perinatal outcome data in large regional centres.[87]

Recommendation

14. Prenatal diagnosis of the more severe forms of placenta accreta spectrum disorder, expressed as a Caesarean section scar pregnancy, may permit management using minimally invasive surgical techniques (II-3B).

RESEARCH

Though substantial improvements have been made to delivery safer care for women with PAS disorders over the past 20 years, the level of evidence behind many recommendations remains weak due to lack of appropriately designed and powered studies. Increased effective knowledge translation is needed, in particular to strengthen ultrasound expertise in the community setting to increase the detection rate in the antenatal period.[20] Identification of appropriate and effective screening strategies is urgently needed, given the high current incidence of PAS disorders. Collaboration of regional centres via secure research links will provide accurate data to inform patients and foster the development of research questions that can be answered with current resources.

Recommendation

15. Though many women with placenta accreta spectrum disorder in well-resourced countries receive safe care, more research and knowledge translation are needed to effectively deliver all management options at the population-based level (III-B).

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