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Prophylactic occlusion balloons of both internal iliac arteries in caesarean hysterectomy for placenta accreta spectrum disorder reduces blood loss: A retrospective comparative study

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ABSTRACT

Background: The placenta accreta spectrum is a complex disorder characterized by abnormal invasion of the placenta into the uterine wall, posing a significant risk of life-threatening haemorrhage for patients. Its incidence is on the rise, largely attributed to the increasing rates of caesarean sections. Management of this spectrum involves a multidisciplinary approach, although standardized protocols are not yet established. While caesarean hysterectomy remains the standard Gold, several adjunctive treatments have emerged in recent years to mitigate bleeding risk and associated morbidity. Among these, prophylactic occlusion balloons placed in the internal iliac arteries have shown promise. The aim of our study is to demonstrate the effect of prophylactic occlusion balloons in both uterine iliac arteries in the management of placental accreta spectrum disorders.

Methods: A retrospective monocentric cohort study was conducted in the Department "C" of Gynaecology and Obstetrics at the Maternity Center of Tunis. The study spanned three years, from January 2nd, 2020, to December 31st, 2022. The study population consisted of two groups: Control Group (CG) comprised patients who underwent caesarean hysterectomy without internal-iliac prophylactic occlusion balloons, and Occlusion balloons of both internal iliac arteries Group (OBIIAG) included patients who underwent caesarean hysterectomy with internal-iliac prophylactic occlusion balloons.

Results: A total of 38 patients were included in the study, all of whom exhibited similar epidemiological characteristics and comparable personal and obstetric histories. The most prevalent risk factor among the patients was a history of caesarean section (92%). On average, patients were diagnosed at 30 weeks of gestation, with third-trimester bleeding being the most common presentation (71% of cases). The median gestational age at delivery was between 36 and 37 weeks. We observed a significant difference in blood loss between the two groups (2888 ml in the control group and 1828 ml in the group with internal-iliac prophylactic occlusion balloons, $p < 0.05$). Implementation of this technique resulted in a reduced need for massive transfusions ($p < 0.01$) and shorter operating times (126 min for the control group and 92 min for the group with internal-iliac prophylactic occlusion balloons; $p = 0.04$). There were no significant differences in morbidity between the two groups.

Conclusion: The intra-iliac prophylactic occlusion balloons can help reduce the risk of hemorrhage and the morbidities that come with the placenta accreta spectrum disorder.

Introduction

Placenta accreta spectrum disorders (PASD) encompass abnormal placental attachment, with distinct variations involving villi adherence to the myometrium (accreta), invasion into it (increta), or penetration through it into the serosa (percreta) [1]. A 2019 meta-analysis found that among PAS patients, 63% had placenta accreta, 15% had placenta increta, and 22% had placenta percreta. The surge in caesarean deliveries globally has paralleled an increase in PASD cases [2]. PAS presents significant risks during pregnancy, particularly life-threatening

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haemorrhage, resulting in substantial maternal morbidity and mortality. Caesarean hysterectomy is the primary intervention in 70% of PAS cases [3]. The etiology of PAS remains elusive, but the prevailing hypothesis proposes that following uterine surgery, abnormal vascularization during the scarring process induces localized hypoxia, leading to defective decidualization. This, in turn, allows for excessive trophoblastic invasion during placentogenesis [4]. It's noteworthy that even in patients with no history of caesarean delivery, the presence of placenta previa carries a 3% risk of PAS [5].

The International Federation of Gynecology and Obstetrics (FIGO) expert panel introduced a new classification for PAS disorders in 2018 to streamline diagnosis and management [6]. While caesarean hysterectomy remains the gold standard [7], conservative approaches like placental preservation or segmental resection have emerged [8]. However, placental conservation carries risks such as infection and haemorrhage, necessitating careful monitoring [9]. Adjunctive techniques, including selective embolization and intraoperative ligation, are being studied, but currently, there's no clear consensus on the most effective

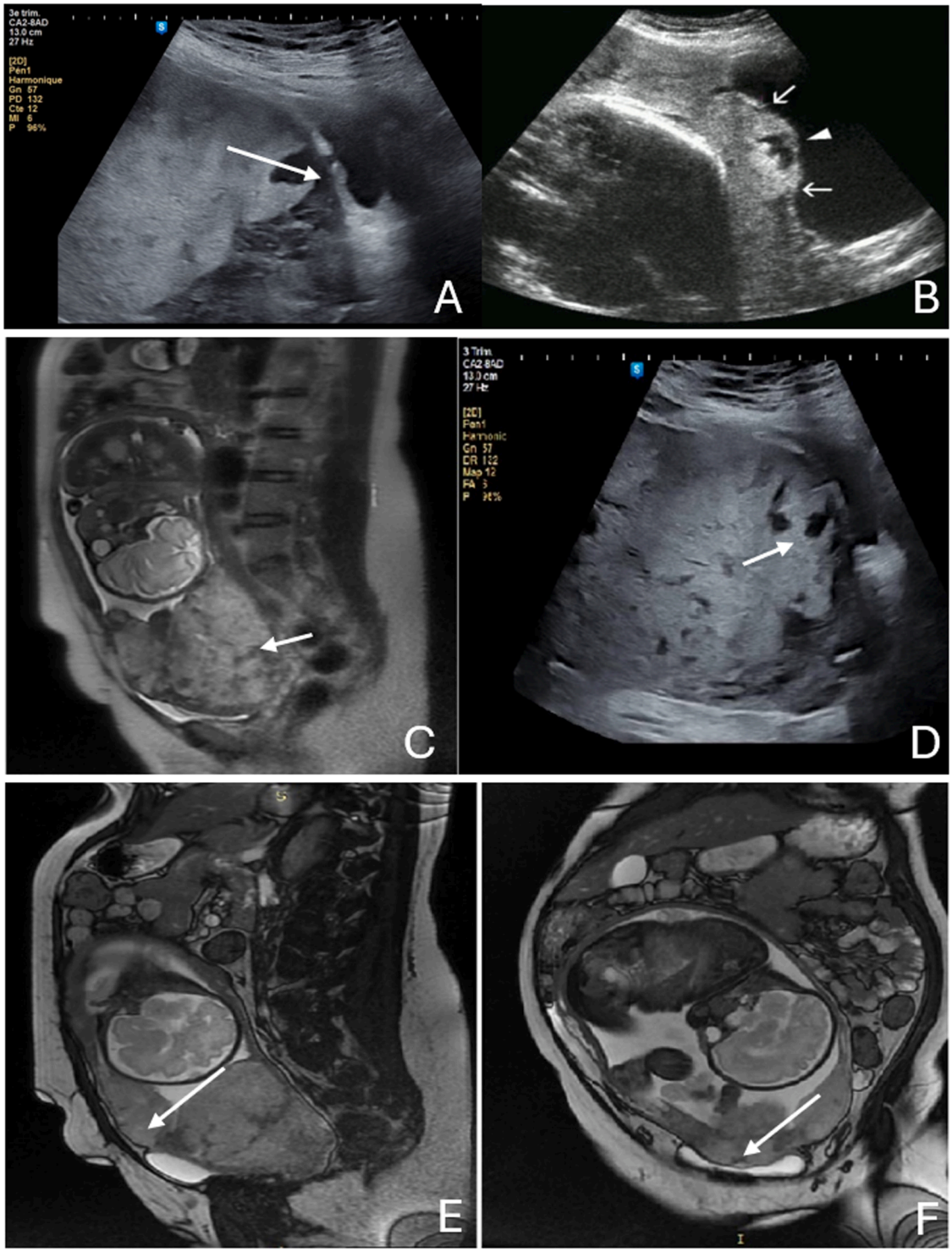

Fig. 1. : MRI and US findings of PASD. **A:** Abnormalities of uterus–bladder interface (white arrow). **B:** Exophytic aspect of the posterior wall of the bladder (white arrows). **C:** Dark intraplacental bands on T2 (white arrow). **D:** Placental lacunae (white arrow). **E, F:** uterine bulging (white arrow).

approach [10].

Since 1997, prophylactic placement of internal iliac artery balloons has been reported to decrease blood loss during caesarean hysterectomy for PASD [11]. This minimally invasive approach aims to reduce blood flow before caesarean hysterectomy, requiring a sophisticated technical platform and well-trained personnel. The preoperative technique targets minimizing blood loss by decreasing uterine perfusion rates, thereby enhancing control during hysterectomy, and reducing surgical complications. However, consensus on its safety and effectiveness remains elusive [11].

Objective

The study aims to investigate the effectiveness and safety of prophylactic occlusion balloons of both internal iliac arteries in the caesarean hysterectomy for PASD to reduce blood loss.

Study design

This study is a descriptive and comparative retrospective monocentric cohort investigation carried out at the Department of Gynaecology and Obstetrics 'C' within the Maternity and Neonatology Center of Tunis (CMNT), covering a period of 3 years from January 2, 2020, to December 31, 2022.

The study protocol underwent review and approval by the Ethics Committee of CMNT, Tunis, Tunisia (Approval number: 042020). Informed consent was obtained from all participating patients. The study was registered in ClinicalTrials also (NCT06356493).

We affirm that no financial support was received for this study, and there are no conflicts of interest to disclose.

Study population

All patients undergoing scheduled caesarean hysterectomy for confirmed placenta accreta spectrum disorder (PASD), confirmed by histopathological examination, were included. Patients with suspected placenta accreta based on magnetic resonance imaging (MRI) and ultrasound (US) findings (Fig. 1), but whose diagnosis was disproved according to histopathological criteria, as well as cases of PASD managed conservatively, were excluded.

In the study, the population was divided into two groups:

- Control Group (CG): Patients treated by caesarean hysterectomy without prior placement of prophylactic occlusion balloons of both internal iliac arteries.
- Occlusion balloons of both internal iliac arteries Group (OBIIAG): Patients treated by caesarean hysterectomy with prior placement of prophylactic occlusion balloons of both internal iliac arteries.

Service protocol

The delivery was scheduled between 36 and 37 weeks of gestation [12]. Dexamethasone was administered to all patients to promote foetal lung maturation, following consultation with the paediatric and neonatology team. This decision was influenced by previous cases of neonatal death attributed to hyaline membrane disease occurring after 36 weeks of gestation [13].

Preoperative placement of prophylactic occlusion balloons of both internal iliac arteries (OBIIA) was performed at radiology department. Access to the internal iliac arteries was achieved by retrograde transcutaneous introduction of hydrophilic sheath kits of 8.5 mm under fluoroscopic guidance from both femoral arteries (Fig. 2). Once in the lumens of the two internal iliac arteries, the radiologist inflated the balloons until blood flow ceased (Fig. 3). The pressure at which occlusion of both internal iliac arteries was achieved was recorded for subsequent replication in the operating room. The patient was then directly transferred to the operating room.

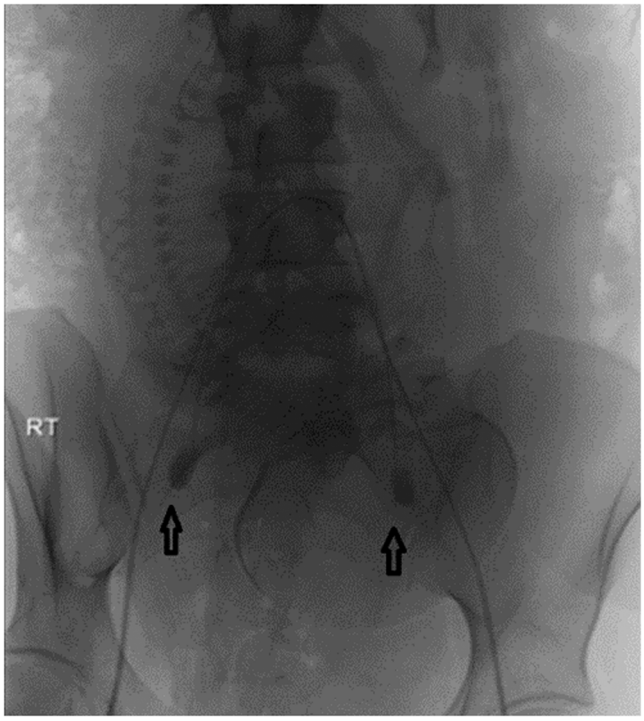

Fig. 2. : Fluoroscopic image showing both occlusion balloons of both internal iliac arteries (black arrows).

General anaesthesia was preferred. Initially, a JJ stent was inserted for both groups to limit urinary tract injuries [14]. Caesarean hysterectomy was performed through a midline infraumbilical incision. The bladder-uterine peritoneum was dissected, followed by a vertical fundal hysterotomy away from the placenta, and the foetus was delivered. Inflation of the occlusion balloons of both internal iliac arteries was performed simultaneously with extraction by the radiologist. This was followed by clamping the umbilical cord and closure of the hysterotomy while leaving the placenta in situ without any attempt at traction or delivery and without oxytocin administration (Fig. 4).

After completing the remaining steps of hysterectomy [15], the radiologist deflated the balloons at the end of the hysterectomy. The inflation of the OBIIA did not exceed 60 min. Haemostasis was verified, and the surgeon places a drain in the Douglas pouch following intraperitoneal irrigation [15]. Blood loss was quantified by weighing surgical pads (sponges and swabs) both before and after the procedure. The difference between the two weights reflected the amount of blood absorbed by the pads, in addition to measuring aspirated bleeding. We have developed a video summarizing the procedure in OBIIAG (video 1).

Results

Thirty-eight patients were collected and divided into two groups: CG ($n = 22$) and OBIIAG ($n = 16$). The average age was 35 ± 3 years. A history of myomectomy was observed in only two patients (5%), while fourteen patients (36%) had experienced at least one previous miscarriage. Thirty-five patients (92%) had a history of at least one previous caesarean section.

The screening term in the population was 30 weeks of gestation. This diagnosis was prompted in 71% ($n = 27$) of cases following an episode of third-trimester bleeding. There was no significant difference observed between the two groups, as all patients exhibited similar epidemiological characteristics, as well as comparable personal and obstetric histories (Table 1). The preoperative haemoglobin level was 11 ± 1 g/dl.

The prophylactic intra-iliac occlusion balloon limited blood loss from

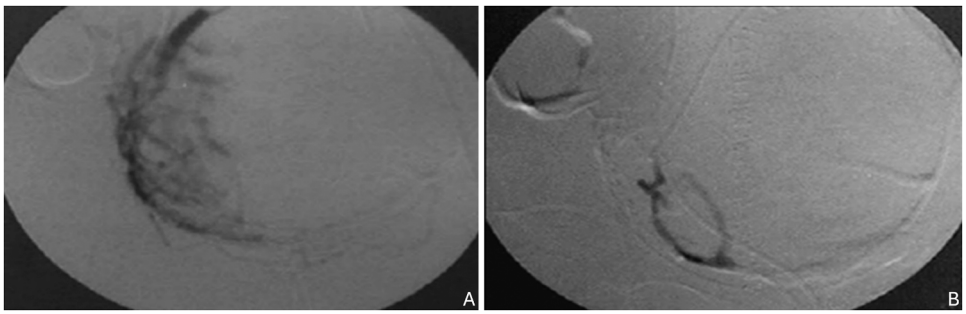

Fig. 3. : Arteriography showing cessation of blood flow in the right internal iliac artery. **A:** before inflation of the balloons. **B:** after inflation of the balloons.

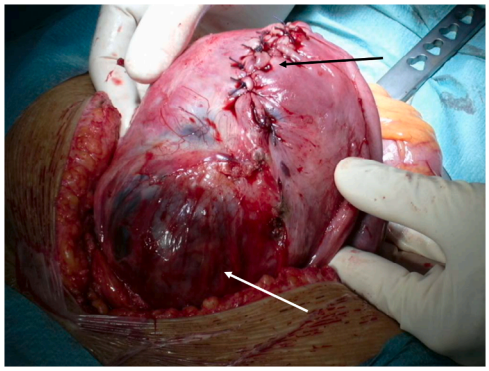

Fig. 4. : Closure of the hysterorrhaphy (black arrow), with the placenta still in place. Bulging of the placenta through the lower uterine segment (white arrow).

Table 1
Comparison of Epidemiological and Obstetric Characteristics between Two Groups.

	CG* (n = 22)	OBIIAG† (n = 16)	*p*
Age means (SD)	35 ± 4	34 ± 3	NS§
Personal history, No.	7	6	NS
• Type 2 diabetes	3	1	
• Chronic arterial hypertension	1	1	
• Hypothyroidism	1	1	
• Chronic anemia	0	1	
• Asthma	0	1	
• Appendicitis	1	0	
Obstetric history:			
Gestity median	3	3	-
Parity median	2	3	NS
Dilation and curettage, No.	7	7	-
Myomectomy, No.	1	1	-
History of Cesarean sections, No.	20	15	NS
Cesarean section scar, No:			NS
• 1 Scar	10	7	
• 2 Scars	6	6	
• 3 Scars	2	2	
• 4 Scars	1	0	
• 5 Scars	1	0	
Gestational diabetes, No.	8	4	NS
Pre-eclampsia, No.	4	2	NS

†Occlusion balloons of both internal iliac arteries Group
§non-significant
* Control group

2888 ± 863 ml in CG to 1828 ± 324 ml in OBIIAG ($p < 0.01$). It reduced the need for massive transfusion (10 ± 5 Red Blood Cell Unit in CG vs 4 ± 3 Red Blood Cell Unit in OBIIAG, $p < 0.01$). The average duration of surgery was 112 min. The operative time was estimated at 126 ± 36 min for CG and 92 ± 17 min for OBIIAG ($p = 0.04$). Placement of prophylactic intra-iliac occlusion balloons shortened the length of postoperative hospital stay (6 ± 1 days for CG vs 3 ± 2 for OBIIAG; $p < 0.05$). Thirty-five patients (92%) required postoperative transfer to the intensive care unit. All CG patients were transferred, while three OBIIAG patients were not. On average, patients spent 2 days in the intensive care unit, ranging from 0 to 6 days (2.73 days in CG vs 1.38 days in OBIIAG, $p = 0018$). There were no significant differences in morbidity between the two groups, which encompassed surgical site infection, bladder injury, need for surgical revision, and pulmonary embolism. Additionally, no instances of complications such as vascular injury or thrombus formation were reported in this study.

Discussion

In the context of placenta previa absence, an extensive literature review reveals an escalating incidence of placenta accreta spectrum (PAS), ranging from 0.3% in women with a single prior caesarean delivery to 6.74% among those with five or more caesarean deliveries [16]. Moreover, there is a clear association between the number of prior caesarean deliveries and PAS risk, with rates peaking at 67% among patients with four previous caesarean deliveries and placenta previa [17]. Our study underscores this relationship, with most participants, specifically thirty-five patients (92%), having undergone at least one prior caesarean section.

Preoperative maternal haemoglobin levels exhibited an inverse correlation with the risk of massive intraoperative haemorrhage in PAS disorders. A non-linear relationship was observed, with a critical point identified at 11.5 g/dL [18]. In our study, the preoperative haemoglobin level was 11 ± 1 g/dl.

In a previous study, we demonstrated that placing a tourniquet on the lower segment of the uterus reduces blood loss during caesarean hysterectomy for PASD [19]. To find the optimal conditions for performing caesarean hysterectomy in cases of PASD. Could employing prophylactic occlusion balloons in both internal iliac arteries during caesarean hysterectomy for PASD result in decreased blood loss?

Blood loss in patients from the Sucu et al. series was estimated at 595 ± 172 ml compared to 1450 ± 662 ml in the control group ($p < 0.001$). Twelve patients underwent temporary clamping of bilateral common iliac arteries just before and during hysterectomy (study group), while 20 patients underwent caesarean total hysterectomy without any arterial ligation or clamping (control group) [20].

In another study, twenty-three cases of PASD underwent caesarean hysterectomy alone, while 30 cases underwent caesarean hysterectomy combined with pre-operative balloon catheters. Significant differences in estimated blood loss and units of transfused blood products were observed between the caesarean hysterectomy alone group and the balloon catheter group for the entire sample [21].

A 2021 systematic review and meta-analysis examined the efficacy of internal iliac artery balloon occlusion for PASD across fifteen studies involving 1098 women. Results showed no significant differences in estimated blood loss volume, red blood cell transfusion rates (both in observational studies and randomized controlled trials), admission to

the intensive care unit, or urinary system injury between the occlusion and control groups [11]. This can be attributed to the emergence of extensive collateral arterial blood supply, stemming from significant circulation among pelvic arteries, including branches of the external iliac arteries or the aorta. [22,23].

In our study, the prophylactic intra-iliac occlusion balloon significantly reduced blood loss from 2888 ± 863 ml in CG to 1828 ± 324 ml in OBIIAG ($p < 0.01$). Moreover, it decreased the requirement for massive transfusion (10 ± 5 Red Blood Cell Units in CG vs 4 ± 3 Red Blood Cell Units in OBIIAG, $p < 0.01$).

The prophylactic use of internal iliac artery balloon occlusion poses risks such as vascular injury, including perforation, dissection, pseudoaneurysm formation, hematoma at the femoral insertion site, and thrombus formation [24,25]. Remarkably, our study observed no complications.

The utilization of internal iliac artery balloons significantly extends the total surgical procedure duration and is associated with higher costs compared to intraoperative internal iliac artery ligation [26]. These factors contribute to the limited adoption of this strategy, and the absence of a consensus on its widespread use among obstetricians remains evident.

Strength of the study lies in our utilization of calculated blood loss rather than estimation through a mathematical formula [27].

One of the main limitations of our study is the small sample size of our population limited the comparative analytical study of the two groups based on the type of spectrum disorders of placenta accreta, which may be explained by the rare prevalence of this spectrum. This analysis would allow for the selection of the ideal situation for the use of both prophylactic occlusion balloons for both internal iliac arteries.

Conclusion

Prophylactic occlusion balloons of both internal iliac arteries have improved patient management and prognosis of PASD. Optimal management planning relies on accurate antenatal diagnosis to determine the ideal timing for the placement of prophylactic occlusion balloons of both internal iliac arteries, pending the widespread adoption of this technique.

Ethics

Our work was submitted to the ethics committee of the maternity and neonatology center of Tunis and was approved.

we obtained informed and voluntary written consent from patients for publication.

CRediT authorship contribution statement

Hatem FRIKHA: Investigation. **Rami Hammami:** Formal analysis. **Sofiene B MARZOUK:** Supervision. **Saber Hassine Abouda:** Methodology. **Haithem Aloui:** Writing – original draft. **Hadhami JAOUAD:** Conceptualization. **Mohamed Badis Channoufi:** Validation. **Hayen MAGHREBI:** Project administration.

Declaration of Competing Interest

The authors declare they have nothing to disclose.

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Appendix A. Supporting information

Supplementary data associated with this article can be found in the online version at doi:10.1016/j.eurox.2024.100310.

References

1 Jha P, Poder L, Bourgioti C, Bharwani N, Lewis S, Kamath A, Nougaret S, Soyer P, Weston M, Castillo RP, Kido A, Forstner R, Masselli G. Society of abdominal radiology (SAR) and European society of urogenital radiology (ESUR) joint consensus statement for MR imaging of placenta accreta spectrum disorders. Eur Radiol 2020.
2 Jauniaux E, Bunce C, Gronbeck L, et al. Prevalence and main outcomes of placenta accreta spectrum: a systematic review and meta-analysis. Am J Obstet Gynecol 2019; 221(3):208–18.
3 Shellhaas CS, Gilbert S, Landon MB, et al. The frequency and complication rates of hysterectomy accompanying cesarean delivery. Obstet Gynecol 2009;114(2 Pt 1): 224–9.
4 Wehrum MJ, Buhimschi IA, Salafia C, et al. Accreta complicating complete placenta previa is characterized by reduced systemic levels of vascular endothelial growth factor and by epithelial-to-mesenchymal transition of the invasive trophoblast. Am J Obstet Gynecol 2011;204(5). 411 e411.
5 Horgan R, et al. Placenta accreta spectrum: prenatal diagnosis and management. Obstet Gynecol Clin N Am 2013;49(3):423–38.
6 Jauniaux E, Ayres-de-Campos D, Langhoff-Roos J, Fox KA, Collins S. FIGO placenta accreta diagnosis and management expert consensus panel. FIGO classification for the clinical diagnosis of placenta accreta spectrum disorders. Int J Gynaecol Obstet 2019 Jul;146(1):20–4.
7 Cahill AG, Beigi R, Heine RP, Silver RM, Wax JR. Placenta accreta spectrum. Am J Obstet Gynecol 2018;219(6):2–16.
8 Piñas Carrillo A, Chandraharan E. Conservative surgical approach: the triple P procedure. Best Pr Res Clin Obstet Gynaecol 2021;72:67–74.
9 Palacios Jaraquemada JM, Fiorillo A, Hamer J, Martínez M, Bruno C. Placenta accreta spectrum: a hysterectomy can be prevented in almost 80% of cases using a resective reconstructive technique. J Matern Fetal Neonatal Med 2022;35(2):275–82.
10 Hobson SR, Kingdom JC, Murji A, Windrim RC, Carvalho JCA, Singh SS, et al. No 383 dépistage, diagnostic et prise en charge des troubles du spectre du placenta accreta. J Obstet Gynaecol Can 2019;41(7):1050–66.
11 Liang D, Zhao H, Liu D, Lin Y. Internal iliac artery balloon occlusion in the management of placenta accreta: a systematic review and meta-analysis. Eur J Radio 2021 Jun;139:109711.
12 Salmanian B, Einerson BD, Carusi DA, Shainker SA, Nieto-Calvache AJ, Shrivastava VK, Subramaniam A, Zuckerwise LC, Lyell DJ, Khandelwal M, Fitzgerald GD, Hessami K, Fox KA, Silver RM, Shamshirsaz AA. Timing of delivery for placenta accreta spectrum: the pan-american society for the placenta accreta spectrum experience. Am J Obstet Gynecol MFM 2022 Nov;4(6):100718.
13 Ayachi A, Rigourd V, Kieffer F, Dommergues MA, Voyer M, Magny JF. Maladie des membranes hyalines chez le nouveau-né à terme [Hyaline membrane disease in full-term neonates]. Arch Pedia 2005 Feb;12(2):156–9 (French).
14 Scaglione MA, Allshouse AA, Canfield DR, Mclaughlin HD, Bruno AM, Hammad IA, Branch DW, Maurer KA, Dood RL, Debbink MP, Silver RM, Einerson BD. Prophylactic ureteral stent placement and urinary injury during hysterectomy for placenta accreta spectrum. Obstet Gynecol 2022 Nov 1;140(5):806–11.
15 Takeda S, Takeda J, Murayama Y. Placenta previa accreta spectrum: cesarean hysterectomy. Surg J (N Y) 2021 May 25;7(Suppl 1):S28–37.
16 Marshall NE, Fu R, Guise JM. Impact of multiple cesarean deliveries on maternal morbidity: a systematic review. Am J Obstet Gynecol 2011;205(3). 262 e261–268.
17 Silver RM, Landon MB, Rouse DJ, et al. Maternal morbidity associated with multiple repeat cesarean deliveries. Obstet Gynecol 2006;107(6):1226–32.
18 Zhang B, Liu H, Wang W, Wang J, Jiang Y, Jia W, Li H, Zhu H, Du X, Huang X. Impact of maternal preoperative hemoglobin levels on intraoperative hemorrhage risk in placenta accrete spectrum disorders: a retrospective cross-sectional study. Med Sci Monit 2023 Aug 10;29:e940443.
19 Abouda HS, Marzouk SB, Boussarsar Y, Aloui H, Frikha H, Hammami R, Chennoufi B, Maghrebi H. Tourniquet on the low segment of the uterus reduces blood loss in postpartum hemorrhage during hysterectomy for placenta accreta: old but gold. Eur J Obstet Gynecol Reprod Biol X 2024 Feb 2;21:100285.
20 Sucu S, Ozcan HÇ, Misirlioglu M, Guralp O, Kaya B. Temporary clamping of bilateral common iliac artery during cesarean hysterectomy for the management of placenta percreta. Eur J Obstet Gynecol Reprod Biol 2020;250:188–94.
21 Cali G, Forlani F, Giambanco L, Amico ML, Vallone M, Puccio G, Alio L. Prophylactic use of intravascular balloon catheters in women with placenta accreta, increta and percreta. Eur J Obstet Gynecol Reprod Biol 2014 Aug;179:36–41.
22 Palacios Jaraquemada JM, García Mónaco R, Barbosa NE, Ferle L, Iriarte H, Conesa HA. Lower uterine blood supply: extrauterine anastomotic system and its application in surgical devascularization techniques. Acta Obstet Gynecol Scand 2007;86:228–34.
23 Hobson SR, Kingdom JC, Murji A, Windrim RC, Carvalho JCA, Singh SS, Ziegler C, Birch C, Frecker E, Lim K, Cargill Y, Allen LM. No. 383-screening, diagnosis, and management of placenta accreta spectrum disorders. J Obstet Gynaecol Can 2019 Jul;41(7):1035–49.
24 Peng Y, Jiang L, Peng C, Wu D, Chen L. The application of prophylactic balloon occlusion of the internal iliac artery for the treatment of placenta accreta spectrum with placenta previa: a retrospective case-control study. BMC Pregnancy Childbirth 2020 Jun 8;20(1):349.

25 Petrov DA, Karlberg B, Singh K, et al. Perioperative internal iliac artery balloon occlusion, in the setting of placenta accreta and its variants: the role of the interventional radiologist. Curr Probl Diagn Radio 2018;47:445–51.
26 Hobson SR, Kingdom JC, Murji A, Windrim RC, Carvalho JCA, Singh SS, Ziegler C, Birch C, Frecker E, Lim K, Cargill Y, Allen LM. No. 383-screening, diagnosis, and management of placenta accreta spectrum disorders. J Obstet Gynaecol Can 2019 Jul;41(7):1035–49.
27 Gari A, Hussein K, Daghestani M, Aljuhani S, Bukhari M, Alqahtani A, Almarwani M. Estimating blood loss during cesarean delivery: a comparison of methods. J Taibah Univ Med Sci 2022 Apr 11;17(5):732–6.