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RECOMMENDATIONS

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Placenta accreta spectrum (PAS) — prenatal diagnosis and management. The Polish Society of Gynecologists and Obstetricians Guidelines

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These recommendations present current management methods, which can be modified and changed in justified cases following a thorough analysis of specific clinical circumstances. These may form a basis for their modification and update in the future.

INTRODUCTION

Placenta accreta spectrum (PAS) refers to pathological conditions during pregnancy that result from abnormal trophoblast invasion and are characterised by problems with placenta separation after delivery. Such a condition may be associated with life-threatening haemorrhage [1, 2].

The PAS rates are increasing all over the world [1, 3] due to increasing rates of caesarean sections, which is a main risk factor for developing PAS in the subsequent pregnancy. It is one of the most dangerous clinical conditions, significantly linked to high mortality and morbidity rates in mothers [4]. About 50% of women with PAS may require a blood transfusion during labour [5]. The patient must frequently be transferred to an intensive care unit [6]. The need to remove the uterus, which is the most common method of surgical management in PAS, results in a permanent loss of fertility and may be associated with a significant risk of damaging abdominal organs, *e.g.* the ureter(s) or/and the urinary bladder [7, 8]. The delayed consequences of PAS treatment include a need for repeated hospitalisation and additional surgical procedures, as well as the development of persistent psychosocial and emotional problems and deterioration in the quality of life [9–11]. Cases of pregnancy complicated by PAS are accompanied by increased

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morbidity and mortality of neonates, resulting mainly from iatrogenic preterm births [6]. The risk can be reduced, both for a mother and for a foetus, by an early diagnosis and providing patients with specialist care at centres treating patients with pregnancy complicated by placenta accreta spectrum (PAS referral centres) [1, 7, 12–14].

EPIDEMIOLOGY

Placenta accreta pathology is becoming an increasingly common condition. In the 1970s and the 1980s, it affected from one in 2,500 to one in 4,000 pregnancies [4], and its rates rose to one in 533 pregnancies in 2002 [15]. The study from 2016 conducted in the USA showed that PAS frequency reached one in 272 pregnancies [16]. Its statistics for Poland are not known. It is believed that the main factor contributing to this pathology is a continuously rising number of caesarean sections.

CAUSES AND RISK FACTORS

The causes of PAS are still not well understood. In the past, this condition was thought to be caused by an abnormal trophoblast invasion resembling neoplastic infiltration [17]. More recent studies show that the trophoblast may attach to the modified uterine wall and placental villi may later penetrate the restructured and spreading uterine scar [18–20]. Among many PAS risk factors, placenta previa is the most important, diagnosed in women with a history of caesarean section [1, 21]. In this case, placenta accreta develops possibly due to the embryo implantation in the uterine scar or its vicinity (CSP, caesarean scar pregnancy). Then, the developing trophoblast probably implants directly into the myometrium and not into the decidua [20]. The majority, although not all, of caesarean scar pregnancies will develop into clinically significant PAS; therefore, identifying cases that may pose a serious hazard to the mother's health and distinguishing them from cases that will progress as relatively normal pregnancies represents a significant challenge [22]. It was observed that the risk of PAS increases with the number of caesarean sections performed. A large multi-centre study in the United States demonstrated that in the situation when a patient has placenta previa and had caesarean sections in the past, this risk was 3%, 11%, 40%, 61%, and 67% for a history of one, two, three, four, and five and more caesarean sections, respectively [21]. Furthermore, placenta previa is found in about half of all PAS cases [23]. In the last 40 years, caesarean section rates have risen globally from 10% to over 30%, and this was accompanied by a 10-fold increase in PAS rates [24].

Placenta accreta spectrum may also develop after other uterine injuries, for example, frequent uterine curettages, myomectomy, endometrial ablation, manual placenta removal, or a frequently performed hysteroscopy for various reasons, *e.g.* due to infertility [1, 25]. It was also observed that PAS occurred more frequently after in vitro fertilisation, in multiple pregnancies, when PAS occurred in previous pregnancy, and in patients with a history of endometritis [1, 13, 26, 27]. Very rarely, PAS may develop in women without a history of procedures or other risk factors [13, 28].

CLASSIFICATION

The histopathological classification of PAS is based on villi penetration, with this pathology categorised into:

- *placenta accreta*, in which villi are firmly attached to the myometrium but do not penetrate it;
- *placenta increcta*, in which villi penetrate deep to the uterine serosa;
- *placenta percreta*, in which the villi penetrate the entire uterine wall, and in some cases may attach to other organs in the lesser pelvis, such as *e.g.* the urinary bladder [29, 30].

The usefulness of this historical classification was questioned because it focuses solely on the progressing trophoblast invasion, and it is not correlated with the results of prenatal imaging, intraoperative evaluation, and the targeted histopathological evaluation [31, 32]. In 2019, the International Federation of Gynecology and Obstetrics (FIGO) proposed a scheme for clinical classification of PAS [33], and in 2020, an expert team published a document concerning the PAS pathological classification and reporting, which roughly corresponded to the FIGO scheme [34]. These classification schemes are presented in Table 1. Abnormal trophoblast invasion in milder forms of PAS (FIGO 1, Grade 1 PAS) is defined histopathologically, but PAS progress to more advanced forms (FIGO 2–3, Grade 2–3 PAS) is diagnosed based on the visible placenta appearance and location in the modified uterus, and the picture of the surrounding maternal structures [33, 34].

DIAGNOSIS

Methods currently used to diagnose PAS are deficient and their sensitivity is insufficient. Frequently, the diagnosis is made only during labour, or intraoperatively, or ultimately following histopathological examination. Therefore, it may happen that treatment is provided at centres without the necessary infrastructure, and this will result in poorer outcomes, mainly due to an unexpected haemorrhage [35, 36]. It should be noted that the presence of placenta accreta can never be entirely excluded based on an ultrasound scan or magnetic resonance imaging (MRI) correctly performed in a patient before birth. The risk assessment for placenta accreta and a targeted ultrasound scan performed by a gynaecology and obstetrics specialist experienced in PAS diagnostics should form the basis for the diagnosis. In some centres, MRI is used as a primary diagnostic test.

Table 1. Systems for classification of placenta accreta spectrum (PAS) anomalies [13, 33, 34]

Histopathological classification[1] [34]	Description	Clinical classification[2] (FIGO) [33]	Characteristics
Normal condition	A layer of the decidualised endometrium separates the placenta from the myometrium	**Normal condition**	The placenta able to be separated (spontaneously or manually) after delivery
Grade 1	Areas of absent decidua between villi and myometrium; uniform myometrial thickness without thinning	**Grade 1** Abnormally adherent placenta (AAP) (placenta accreta)	The placenta abnormally adherent, where it is not possible to identify by palpation a clean plane separating it from the myometrium; frequently, uterine curettage is required due to increased bleeding during manual or instrumental separation of the placenta
Grade 2	Irregular placenta-myometrium interface, without involvement of outer myometrium (less than 75% of myometrial thickness); intact uterine serosa	**Grade 2** Abnormally invasive placenta (AIP) (placenta increta)	Abnormal macroscopic findings over placental bed: placental bulge; hypervascularity; dimple sign, with uterus pulling in on gentle cord traction
Grade 3		**Grade 3** Abnormally invasive placenta (AIP) (placenta percreta)	
3A	Irregular surface at the interface between the placenta and the myometrium, with involvement of its external part (> 75% of its thickness); the uterine serosa intact	**3a (limited to the uterine serosa)**	Macroscopic findings over placental bed and placental tissue seen through surface of uterus without extension to other organs Appearance of uterine window with base of placenta visible through extremely thin myometrium or single layer of serosa
3D	Deep myometrial invasion with disruption of serosal surface	**3b (with urinary bladder invasion)**	Involvement of urinary bladder; clear surgical plane cannot be identified between uterus and bladder
3E	Extrauterine extension with placental invasion into, or fibroadipose tissue extension to, extrauterine structures	**3c (with invasion of other organs and tissues in the lesser pelvis)**	Involvement or invasion of other pelvic tissues or organs (may also include bladder)

[1]Requires hysterectomy or partial hysterectomy specimen; findings from delivered placentas and curettings are considered separately from PAS and designated basal plate myometrial fibers; [2]Does not require pathologic specimen because grades are assigned based on intraoperative findings; FIGO — International Federation of Gynecology and Obstetrics

However, it is not possible to implement it as a routine test due to its higher costs and limitations in the availability of specialists experienced in MRI image interpretation for PAS anomalies. Therefore, ultrasound scans remain the preferred diagnostic method. Currently, studies are being conducted on PAS biomarkers, but today no clinically useful blood or urine tests are available that would enable foreseeing the development of placenta accreta [37, 38].

RISK ASSESSMENT FOR PAS DEVELOPMENT

A medical interview performed by a doctor providing pregnancy care or specialists performing the ultrasound scan represents a crucial part of screening for PAS. It significantly influences the interpretation of imaging results. On a routine basis, the interview should include questions concerning the history of caesarean sections and other surgical procedures in the uterus, such as myomectomy, uterine curettage, numerous hysteroscopies or manual removal of the placenta. These and other factors presented in Table 2 may increase the risk of PAS

Table 2. Risk factors for placenta accreta spectrum (PAS) [39]

History
1. History of one or more caesarean sections
2. Other uterine procedures — myomectomy — hysteroscopy — uterine curettage — endometrial ablation
3. Manual removal of the placenta during the previous pregnancy
4. PAS in the previous pregnancy
5. CSP in the previous pregnancy
6. PPH in the previous pregnancy
7. History of endometritis
8. Pregnancy resulting from assisted reproductive technologies
9. Anatomical uterine defects
10. Multiple pregnancy
11. The use of an intrauterine device before pregnancy

CSP — caesarean scar pregnancy; PPH — post partum haemorrhage

development [39]. Contrary to diagnostic imaging, the interview does not require advanced specialistic knowledge. In patients with PAS risk factors confirmed, multiple and regular placenta evaluations are necessary, starting already in the first pregnancy trimester. Anomalies on ultrasound or MRI characteristic of PAS should raise greater concern in patients with a positive history compared to those without risk factors. It is important to perform the transvaginal ultrasound scan (TVS) by the eighth gestational week to exclude CSP, which is the most important risk factor for PAS occurrence [40, 41]. If a CSP is found, the patient must be informed about a high risk associated with further continuation of the pregnancy and presented with available management options [41, 42]. In patients with a history of caesarean section, the placenta location in relation to the cervix and the caesarean section scar should be determined in the 2nd pregnancy trimester (optimally, in the 18th–22nd gestational week). If the placenta is located much higher and away from the scar, the risk of PAS is probably small. However, when the placenta is found to cover the entire lower section, including the scar, a more detailed ultrasound evaluation for PAS symptoms is recommended, preferably at a PAS referral centre [41].

ULTRASOUND

An ultrasound scan is the primary method for diagnosing PAS anomalies. Its sensitivity varies and depends on many factors. They include the experience of an ultrasound operator, scan conditions, equipment used and gestational age. The sensitivity of ultrasound markers also varies due to imperfections of previous research studies. These studies were characterised, among others, by a retrospective character, a small number of cases, varying terminology, and a lack of diagnosis confirmation at birth or after a histopathological examination [1]. The presence or absence of a specific symptom mainly depends on the ultrasound operator's interpretation. To reduce the rate of diagnostic errors, the European Working Group on Abnormal Invasive Placenta (EW-AIP) proposed standardised ultrasound scan descriptors in cases of suspected PAS [43]. International Federation of Gynecology and Obstetrics recommendations also considered them to normalise diagnostic criteria [44]. These markers are provided in Table 3.

The most important risk factor implying PAS is placenta previa [45]. This condition increases the risk of development of this anomaly and associated complications to the greatest degree. Particular attention should be paid to placenta previa

Table 3. Standardised ultrasound descriptors for placenta accreta spectrum (PAS) [43, 44]

Ultrasound finding	Definition
2D greyscale	
Loss of "clear zone" (Fig. 1)	Loss, or irregularity, of hypoechoic plane in myometrium underneath placental bed ("clear zone")
Abnormal placental lacunae (Fig. 2)	Presence of numerous lacunae including some that are large and irregular (Grade 3 according to Finberg's criteria [130]), often containing turbulent flow visible on grayscale imaging
Bladder wall interruption (Fig. 3)	Loss or interruption of bright bladder wall (hyperechoic band or 'line' between uterine serosa and bladder lumen)
Myometrium thinning (Fig. 4)	Thinning of myometrium overlying placenta to < 1 mm or undetectable
Placental bulge (Fig. 5)	Deviation of uterine serosa away from expected plane, caused by abnormal placental tissue into neighbouring organ, typically bladder; uterine serosa appears intact but outline shape is distorted
Focal exophytic mass (Fig. 6)	Placental tissue seen breaking through uterine serosa and extending beyond it; most often seen inside filled urinary bladder
Colour 2D Doppler	
Uterovesical hypervascularity (Fig. 7)	Striking amount of colour Doppler signal seen between myometrium and posterior wall of bladder; this sign probably indicates numerous, closely packed, tortuous vessels in that region (demonstrating multidirectional flow and aliasing artifact)
Subplacental hypervascularity (Fig. 8)	Striking amount of colour Doppler signal seen in placental bed; this sign probably indicates numerous, closely packed, tortuous vessels in that region (demonstrating multidirectional flow and aliasing artifact)
Bridging vessels (Fig. 9)	Vessels appearing to extend from placenta, across myometrium and beyond serosa into bladder or other organs; often running perpendicular to myometrium
Placental lacunae feeder vessels (Fig. 10)	Vessels with high-velocity blood flow leading from myometrium into placental lacunae, causing turbulence upon entry
Intraplacental hypervascularity in 3D imaging	Complex, irregular arrangement of numerous placental vessels, exhibiting tortuous courses and varying calibers

2D — two-dimensional imaging; 3D — three-dimensional imaging

in a patient with a history of caesarean sections. The most frequently observed ultrasound PAS signs, which may also occur in physiological pregnancy, include a loss of "clear zone" — a physiological hypoechoic zone between the placenta and the myometrium, the myometrium thinning to less than 1 mm, the presence of abnormal placental lacunae, and a subplacental hypervascularity with a presence of bridging vessels under the urinary bladder. Other signs that may occur include placental bulging, bladder wall interruption, focal exophytic mass, and increased vascularisation in the bladder and uterus area (uterovesical hypervascularity) [43, 44]. To improve the ultrasound scan sensitivity, it is recommended to perform the scan with the urinary bladder filled and additionally using the vaginal probe and the Doppler technique [13, 46]. Studies on other potentially important symptoms visible in the ultrasound scan are being conducted. As no individual symptom has a high diagnostic value for PAS, it is recommended to jointly evaluate the results of an ultrasound scan, MRI (if performed), and the risk established in the interview for a given patient [13]. The scientific reports proposed predictive models for the PAS risk based on an analysis of the number and the characteristics of ultrasound symptoms. However, these models have not yet been appropriately verified and are characterised by unsatisfactory false negative results [47–49]. It should be emphasised that even when no ultrasound symptoms of PAS are found, its diagnosis cannot be excluded in patients with placenta previa, and the clinical risk factors present [13].

MAGNETIC RESONANCE IMAGING

The role of MRI in PAS diagnostics is less established. Limitations in the MRI application result from a lower availability of this method, higher costs, and fewer specialists experienced in interpreting MRI images of the placenta. However, in specific cases, MRI may provide crucial insights, particularly when performed in centres with specialists who have knowledge of interpreting placenta images acquired using this technique [7]. In such conditions,

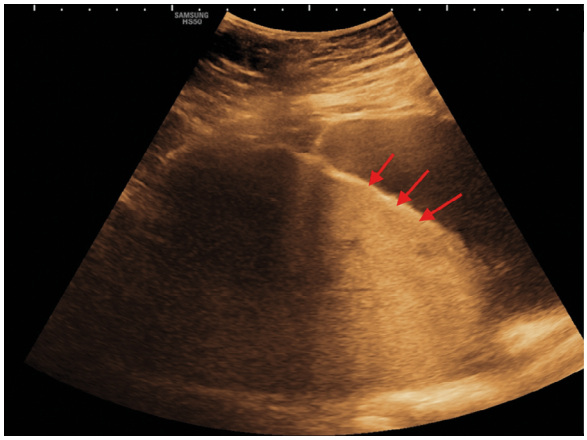

Figure 1. Loss of "clear zone"

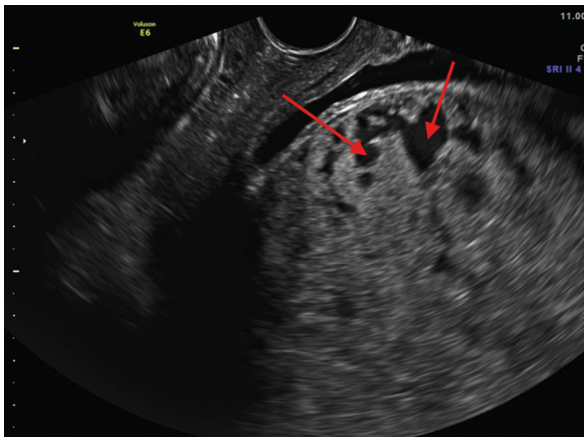

Figure 2. Abnormal placental lacunae

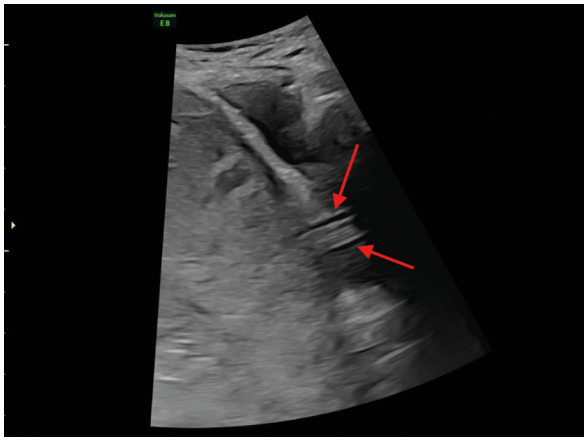

Figure 3. Bladder wall interruption

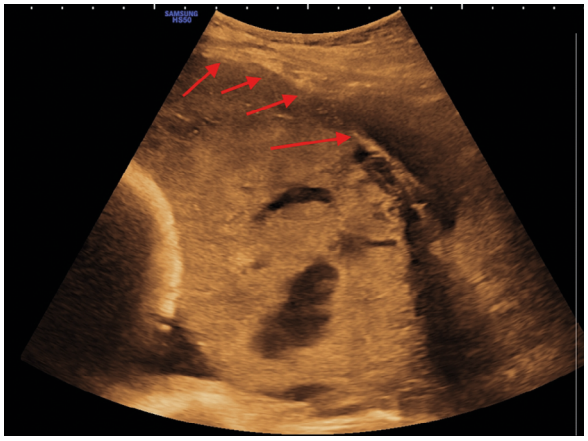

Figure 4. Myometrial thinning

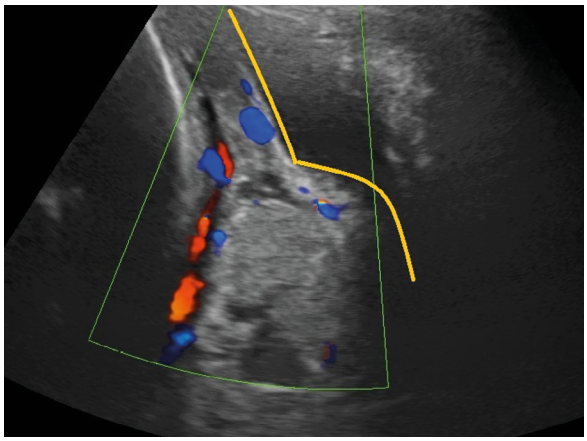

Figure 5. Placental bulge

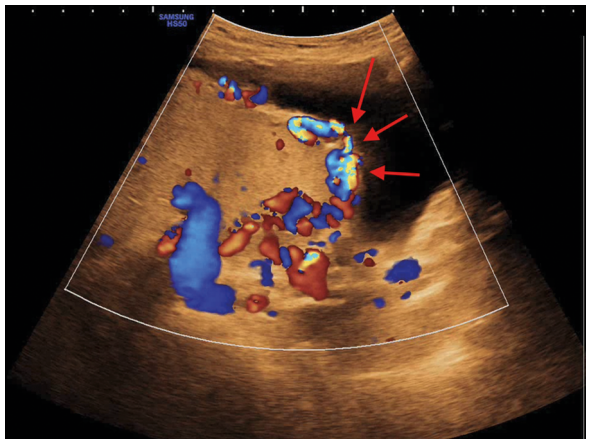

Figure 6. Focal exophytic mass

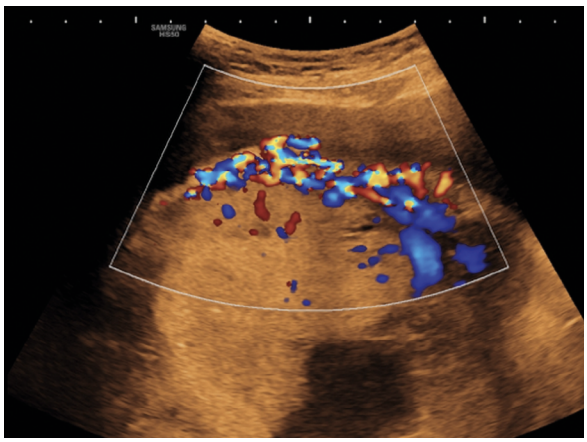

Figure 7. Uterovesical hypervascularity (flow rate of 12.6 cm^3/s)

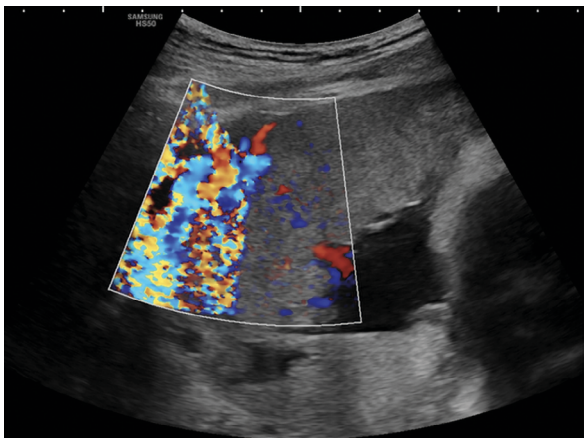

Figure 8. Subplacental hypervascularity (flow rate of 28.3 cm^3/s)

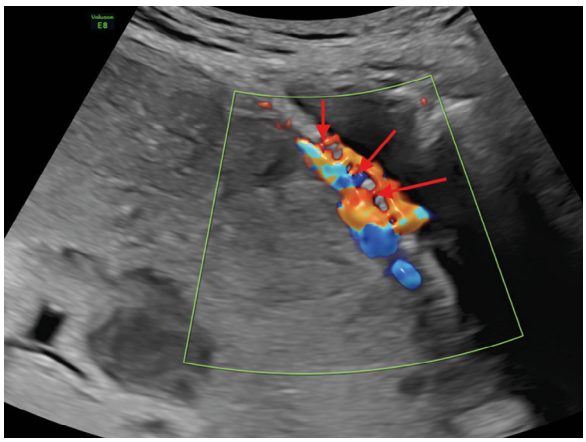

Figure 9. Bridging vessels (flow rate of 29 cm^3/s)

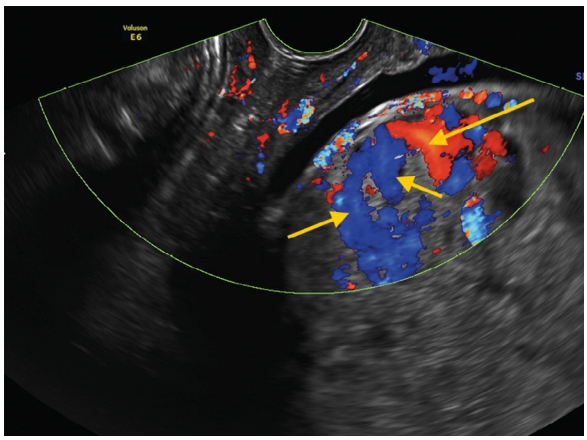

Figure 10. Placental lacunae feeder vessels (flow rate of 12 cm^3/s)

the MRI diagnostic sensitivity may be comparable to the ultrasound scan [50, 51]. Characteristic PAS-related MRI signs include abnormal placental bulging, intraplacental T2-dark bands, myometrial disruption, abnormal vascularisation of the placental bed and a heterogeneously intensified placental signal (placental heterogeneity) [52]. Similarly, as in the case of ultrasound diagnostics, EW-AIP proposed standardised PAS descriptors for MRI [53]. Placenta previa and its bulging are the most consistent symptoms in the MRI scan, although they may also be found

in cases not accompanied by PAS [54]. Considering MRI costs and uncertain usefulness, it is recommended only in cases when it can be expected that this scan will provide important clinical information exceeding ultrasound possibilities, for example, in cases of suspected placental invasion into the posterior uterine wall or the perimetrium, or difficult scan conditions, for example, in obese patients [13, 29].

ARRANGING CARE FOR PATIENTS WITH PAS

In treating patients with suspected PAS, the appropriate preparation of the health care system, medical care centres, or clinical teams is more important than the experience and skills of an individual specialist. It remains a significant challenge due to the low rates of this condition, the required high level of specialist knowledge, and the need to involve extensive hospital resources. Unfortunately, the percentage of PAS cases undiagnosed before birth remains high (up to ca. 50%) [55, 56]. Therefore, all centres providing obstetrics care should have an action plan prepared for unforeseen cases, as well as perform a self-assessment to verify whether they can provide routine care to patients with PAS or whether they will refer such cases to more specialistic centres (PAS referral centres) [57, 58].

Similarly to other scientific associations — American College of Obstetricians and Gynecologists (ACOG), Society for Maternal-Fetal Medicine (SMFM) [7, 58, 59] — The Polish Society of Gynecologists and Obstetricians Guidelines experts recommend ensuring that centres where women with suspected PAS are to be treated are provided with resources appropriate for a level III maternity care centre. Hospitals should be provided with immediate 24/7 access to a blood bank and intensive care units for adults and neonates and have gynaecology and obstetrics, surgery, anesthesiology, neonatology, and possibly also gynaecological oncology, urology and interventional radiology specialists experienced in complex maternal and obstetrics complications such as PAS (Tab. 4). Those centres should have a cross-disciplinary team involved in analyzing cases and regularly improve their skills to optimise the care provided to patients with PAS.

Hospitals and obstetrics care centres with smaller resources or insufficient experience should develop, together with voivodeship consultants, management algorithms. They should cooperate with PAS referral centres to refer patients to them. Patients should be sent as early as possible, optimally at the moment of a diagnosis or a suspected diagnosis, for verification so that the diagnosis can be confirmed and the patient's management at a centre most suitable for a given case can be planned around the 26th–32nd gestational week. If PAS is diagnosed unexpectedly during labour, a patient can be referred to centres of a higher referral level, and this approach is preferred (if the patient's condition allows).

Table 4. Organisational recommendations for a placenta accreta spectrum (PAS) referral centre

No.	Requirements for a PAS referral centre
1	A cross-disciplinary team with an experience in PAS treatment, available 24/7: — an ultrasound/MRI expert (gynaecology and obstetrics specialist/radiology specialist) — an experienced gynaecology and obstetrics specialist (or perinatology specialist) — an anaesthesiology specialist experienced in complex obstetric cases — a surgeon experienced in pelvic surgeries (or a gynaecological oncology specialist) — an urology specialist — a neonatology specialist — an interventional radiology specialist
2	Access to an intensive care unit for adults
3	Access to an intensive care unit for neonates
4	Possibility to perform a quick and massive transfusion of blood products

MRI — magnetic resonance imaging

ANTENATAL CARE

Comprehensive care for a pregnant woman with PAS requires individual risk level assessment to adjust the management, appropriately prepare medical resources, and develop the care plan. As has been mentioned above, risk stratification should be performed after a detailed interview concerning the patient's history and performing necessary imaging scans. Information provided to the patient and her family should include practical and emotional aspects, taking into account the assessed risk, foreseen severity of PAS anomalies, and potential complications, including its negative impact on fertility in the future (a possible hysterectomy during the caesarean section). Furthermore, prognoses for the newborn baby should also be discussed, considering the fact that in the case of PAS anomalies, the majority of births are premature (< the 37th gestational week). Risk stratification can be modified after successive imaging scans during care for a pregnant woman, and this should be considered in the guidance. The patient should be informed where to find reliable information [*e.g.* from the International Society for Placenta Accreta Spectrum (IS-PAS)].

From a practical point of view, the management plan and resource preparation should consider haemorrhage risk control, arranging a place and date of birth, and preparing a cross-disciplinary team (the case discussion). If a given centre does not have appropriate facilities or experience, referring the patient to a more specialised centre is strongly recommended. Due to a risk of haemorrhage, anaemia and/or iron deficiency should be excluded in the patient, and treatment should be initiated sufficiently in advance if haemoglobin levels are below 10.5 g/dL or the ferritin blood

level is lower than 30 ng/dL [60, 61]. If a premature birth is planned, an antenatal course of steroids should be considered [62]. The scheduled admission date should be agreed upon individually, considering the estimated risk and the patient's place of residence. Asymptomatic patients may be provided care in outpatient settings until the planned admission date. In the case of patients presenting with significant clinical symptoms, such as bleeding, uterine contractions, or premature outflow of amniotic fluid, continuous hospitalisation in a PAS referral centre is recommended. There, the periodic evaluation of the risks and benefits assessment of delivering the baby by a caesarean section needs to be conducted based on the current condition of the pregnant woman, including intensified bleeding and laboratory parameters (including a blood count, coagulation, fibrinogen, and gasometry). It is necessary to secure the availability of blood products [packed red blood cells (PRBC) (4–6 units), plasma, platelets, or possibly cryoprecipitate]. Simultaneous monitoring of the foetus condition is also recommended, including an ultrasound scan with the placenta evaluation, a Doppler scan every seven days on average, and a nonstress test (NST) cardiotocography recording at least once daily [41].

The proposed management algorithm for antenatal and postpartum care in placenta previa and PAS cases was published in Ginekologia i Perinatologia Praktyczna (2022, vol. 7, No. 2, pages 92–95) [41].

DELIVERY DATE

Based on available publications, expert opinions, and guidelines of scientific associations, the $34^{th} + 0$–$35^{th} + 6$ gestational week is an optimum date for a caesarean section in the case of suspected or confirmed PAS if there are no bleeding or labour signs [7, 12, 29, 63, 64]. A strategy for planning a caesarean section at the late stage of premature labour results from the observation that an elective caesarean section at that time is associated with a significant reduction in the risk of maternal complications, including a reduction in the risk of life-threatening haemorrhage when compared to cases of urgent and unprepared labour (23% vs 64%) [65]. A caesarean section at an earlier time should be considered in patients with a high risk of severe PAS (Grade 3 according to FIGO, involvement of organs in the vicinity, the perimetrium, PAS involving an extensive uterine area in imaging scans), when episodes of bleeding or premature contractions occurred, or who are hospitalised for premature rupture of membranes [63]. It is recommended to administer a course of steroids preceding an elective caesarean section performed before the 35^{th} gestational week [12, 63, 64]. Birth at a later stage, nearer the 37^{th} gestational week, can be considered in cases without diagnosed placenta previa, when a diagnosis is uncertain, or in patients without listed risk factors for an unexpected haemorrhage. In each case, a balance of benefits and risks of an earlier caesarean section versus the consequences of preterm birth for the baby needs to be considered [63, 66].

PREOPERATIVE PREPARATION

In cases of PAS anomalies, several aspects need to be considered during surgery planning due to their complex nature. Personnel need to be prepared for possible resuscitation and massive blood transfusions. At least one additional venous access must be provided for a transfusion of fluids and blood products using catheters of a large diameter [67]. If a referral centre has devices for recovering blood from a surgical site (cell saver), their use during surgery should be considered [7, 68]. It is also recommended to determine the patient's blood type and ensure the availability of blood products [PRBC, fresh frozen plasma (FFP), platelets, and possibly cryoprecipitates, fibrinogen, activated factor VII or prothrombin complex concentrate] in quantities corresponding to the foreseen difficulty of the surgery, bearing in mind that the maximum blood loss may be at an unforeseen level [7]. If anti-blood cell antibodies are detected, it may be necessary to consult a blood bank to select compatible blood products appropriately.

The consultation with an anesthesiology specialist represents an important part of preoperative preparations, possibly with a specialist experienced in care for women with PAS anomalies or in the treatment of massive obstetric haemorrhages [69]. The best possible method of anaesthesia in PAS cases has not been established, and it may change during the surgery depending on the patient's clinical status. Most referral centres prefer neuraxial anaesthesia during the entire surgery or its part until the infant delivery or a significant haemorrhage occurs [70, 71].

It is recommended to select an operating theatre that guarantees the most accessible access to the equipment needed for the surgery, a quick transfusion of blood products, or intraoperative specialist consultations. Hybrid operating theatres or combined labour and operating rooms are used in many centres [72]. Accordingly, the patient's position on an operating table should ensure easy access for an extensive laparotomy, quick intubation, and placement of many venous accesses for transfusions, as well as provide access to the crotch area for periodic blood loss assessment, transvaginal procedures, or cystoscopy and ureteral catheter placement, if necessary [73].

If urinary bladder involvement or placenta invasion in the perimetrium is suspected, routine preoperative cystoscopy for the urinary bladder evaluation and preventive securing of ureters by inserting ureteral catheters are a controversial approach and not recommended as routine management procedures [1, 7, 12, 74]. However, some studies

show that this management results in a reduced risk of the urogenital system injury during a hysterectomy [75, 76]. The final decision depends on the operator's experience and the agreed individual operating plan.

In PAS, the most common complication associated with the surgery is massive blood loss that may occur even in the case of optimum preoperative planning and providing the patient with care in a referral centre guaranteeing access to an extensive infrastructure and advanced surgical knowledge [63]. This results mainly from an extensive, proliferative vascular system that may develop from internal and external iliac vessels and even from the aorta and ovarian vessels at any location in the pelvis. A characteristic feature of these vessels is their hypertrophy and a very high blood flow [77, 78]. Many PAS referral centres cooperate with interventional radiologists using intravascular procedures such as balloon vascular occlusion or embolisation, which may limit blood loss. There is a significant discrepancy in the obtained study results, limiting the possibility of providing general recommendations and comparing their effectiveness. Many authors advocate the use of these procedures, stating that they reduce blood loss and the need for a transfusion, as well as improve the visibility in a surgical site [79–83]. However, other studies do not show any benefits and their authors criticise the use of these methods [84–86], stating that occlusion balloons cannot prevent catastrophic bleeding because blood flow to the pelvis is maintained by the development of extensive collateral vessels during pregnancy [84, 87]. There are also reports of ruptured vessels and thromboembolic complications associated with the use of catheters, and this questions the risks-to-benefits ratio in the case of these balloons [88–92]. Currently, the available evidence is insufficient to formulate strict recommendations for their use [12, 63]. Further prospective studies are required to confirm and define the benefits of balloon occlusions and embolisation in PAS cases. Therefore, it is recommended that a decision in this respect depends on the experience of a referral centre and an individual operating plan.

LABOUR AND INTRAOPERATIVE CARE

Currently, no clear scientific evidence based on high-quality comparative data is available to determine the best method for the treatment of patients with PAS. There is a significant variation in the clinical practice between centres and treatment outcomes are diversified. In this situation, most teams managing PAS cases draw on local experiences. It is recommended to develop a management plan covering disease characteristic (a risk assessed based on the patient's history and diagnostic imaging results), gestational age at the moment of birth, the experience of a surgery team, and resources available at a given centre. The management plan should consider the preferences of the pregnant woman. Management strategies can be divided into four groups:

1) a hysterectomy during a caesarean section with the placenta left *in situ*;
2) conservative management with the placenta left *in situ*;
3) an elective hysterectomy delayed several days or weeks with the placenta left *in situ;*
4) partial resection of the myometrium with uterine reconstruction; [7, 29, 63, 93, 94]

Suppose placenta accreta is not confirmed intraoperatively, and the placental separation is normal. In that case, the caesarean section procedure can be continued, with particular attention paid to the possibility of increased bleeding from the placental site, requiring pharmacological and surgical treatment [95].

These recommendations do not discuss in detail PAS management at early pregnancy stages or cases of ectopic CSP, which is currently considered a precursor condition for PAS anomalies.

Hysterectomy during a caesarean section

The removal of the uterus during a caesarean section, with the placenta left *in situ*, remains the most common management method in most PAS centres, used in about 90% of the cases [1, 63, 96–98]. Usually, a hysterectomy is the most suitable management method in the case of massive, active bleeding and haemodynamic instability of the operated patient, as well as represents an alternate or rescue procedure when other management strategies fail [7]. In the case of an experienced operating team and less advanced PAS cases, radical management reduces the risk of the most severe complications and poorer outcomes when compared to alternate methods [13].

In the PAS cases, a perinatal hysterectomy is a procedure that is technically complicated and potentially hazardous when compared to a hysterectomy performed in women who are not pregnant, as it is associated with a high rate (40–50%) of severe complications in the mother. The mortality rate may reach 7% (Tab. 5) [93]. This results from a risk of massive bleeding largely associated with the placenta accreta pathology, mainly with the very extensive neovascularisation. In the third pregnancy trimester, the uterus is 30 to 40 times larger than the non-pregnant uterus, and blood flow in uterine arteries is ten times higher, representing even 17% of the cardiac output (700 mL/minute) [13]. Anatomical changes, such as distension and deformation of the lower uterine section, non-physiological location of uterine arteries and ureters, and deformation and frequent placental invasion of the urinary bladder are present. Numerous adhesions between organs resulting from previous surgeries may represent an additional difficulty [13]. Therefore, it is recommended that a hysterectomy be performed by a team of

Table 5. Complications associated with surgery for placenta accreta spectrum (PAS) disorders [63]

Complications	Frequency
Median estimation of blood loss	2–3 L
Median units of packed red blood cells transfused	3.5–5.4
Large-volume blood transfusions (>10 L)	5–40%
Urinary bladder injury	7–48%
Ureter injury	0–18%
Admission to intensive care unit	15–66%
Bowel injury/obstruction	2–4%
Venous thromboembolism	4%
Surgical site infection	18–32%
Reoperation	4–18%
Maternal mortality	1–7%

surgeons who are experienced in this procedure. There are significant differences between centres concerning surgical techniques that may be recommended to reduce the risk of surgical complications. Most experts recommend an incision in the medial line for better visualisation of the abdominal cavity and free access for dissection within the pelvis [12, 13]. However, a transverse incision may heal faster and reduce the risk of postoperative hernia. It is more aesthetic and satisfactory for the woman, too. No studies compared outcomes for the mother or child depending on the skin incision type [12, 99]. Other transverse incisions, such as Pfannenstiel and Maylard incisions, were described and may be used both for aesthetic reasons and for potential reduction in the rate of postoperative complications. An operating team should decide on the type of skin incision used. The placental location, the grade of the suspected invasion, the possibility of intraoperative complications, the mother's build, gestational age, and the operator's preferences should be considered. The uterus should be incised away from the placenta to prevent its transecting. To determine the location of the placental edge more precisely, an intraoperative ultrasound scan can be performed, with a probe secured in a sterile way and placed directly on the uterus [12, 13]. Although preventive administration of oxytocin after birth during a routine caesarean section is recommended to prevent postpartum haemorrhage [95], routine oxytocin administration during a caesarean section in suspected PAS cases has not been studied [12]. The preventive administration of oxytocin immediately after birth increases uterine contraction, and this may be helpful during the assessment of whether the placenta separation proceeds correctly. If the entire placental surface penetrates pathologically into the myometrium, its contraction will not result in placental separation. However, if the placenta is partly adhering or invasive, the uterine contraction may result in its partial separation, resulting in increased blood loss, and this may induce the operator to remove the remaining placenta by force or to perform a more hurried hysterectomy. Taking this risk into account, it is recommended not to administer routinely the uterotonic agents immediately after the infant's birth in cases of suspected PAS. Instead, the complete evaluation should be performed following recommendations on the intraoperative diagnosis described below. If the placenta was removed entirely or partly, or if significant bleeding has already occurred, uterotonic agents should be administered.

Although placenta accreta may be suspected before birth, the final confirmation is made when the placenta does not separate after the child is born. In PAS, attempts at separating the placenta by force may result in a catastrophic haemorrhage. No scientific evidence demonstrates which clinical diagnostic method correlates best with the gold-standard histopathological diagnosis [12]. Considering a high risk of false positive results in all methods of antenatal diagnostics, reliable intrapartum evidence is required, confirming that the significant PAS exists before surgical treatment is initiated, particularly before a hysterectomy [7]. Therefore, based on expert opinions, as the first step after opening the abdominal cavity, it is recommended to evaluate the anterior uterine wall and walls of the lesser pelvis for PAS symptoms, including abnormal distension of the lower part of the uterus with blueish/purple colouration of the wall, the myometrium thinning with the placenta showing through, with a possible invasion of the serosa, and the excessive abnormal vascularisation of the lower segment (especially with vessels running craniocaudally in the peritoneum). If those signs are not visible, then in the second step, the uterine incision should be performed according to the level of suspected PAS. A gentle cord traction should be attempted if the placenta was not transected. If the cord traction results in the uterus being pulled inwards without any separation of the placenta (the so-called "dimple sign") and shrinking of the uterine body is visible, independent of the placenta bed (the snowman sign), then PAS can be diagnosed. If PAS has not been diagnosed in the previous two steps, a gentle palpation may be attempted to evaluate whether the placental separation plane exists. Caution should be observed to avoid causing haemorrhage. If a decision was made to initiate conservative management with the placenta left *in situ* or a strategy of the delayed hysterectomy was chosen, the placenta should not be separated, but the uterus and the abdominal wall should be sutured. Similarly, when the patient is found eligible for removal of the uterus, it is recommended to suture the uterus with the placenta and start the hysterectomy. Only when PAS is not confirmed, and the placenta is separated correctly, the caesarean section procedure can be continued, bearing

in mind a possibility of increased bleeding from the placenta site, requiring pharmacological and/or surgical intervention, as in other obstetric haemorrhages [95]. The proposed algorithm for surgical management is shown in Figure 11.

The removal of the uterus should start with gradual devascularisation, with the uterine and ovarian mesentery cut at the first step, to ensure greater mobility of the uterus, reduce blood supply from the collateral circulation, and provide access to vascular bundles. Then, areas of the greatest vascularisation are resected, including the urinary bladder, and vascular bundles are cut. These stages of the operation are most difficult and associated with possible injuries in structures in the vicinity, mainly the urinary bladder and ureters when the procedure needs to be accelerated due to bleeding.

In some instances, the procedure can be limited to a subtotal hysterectomy (removing the corpus of the uterus). There is no scientific evidence available that a routine

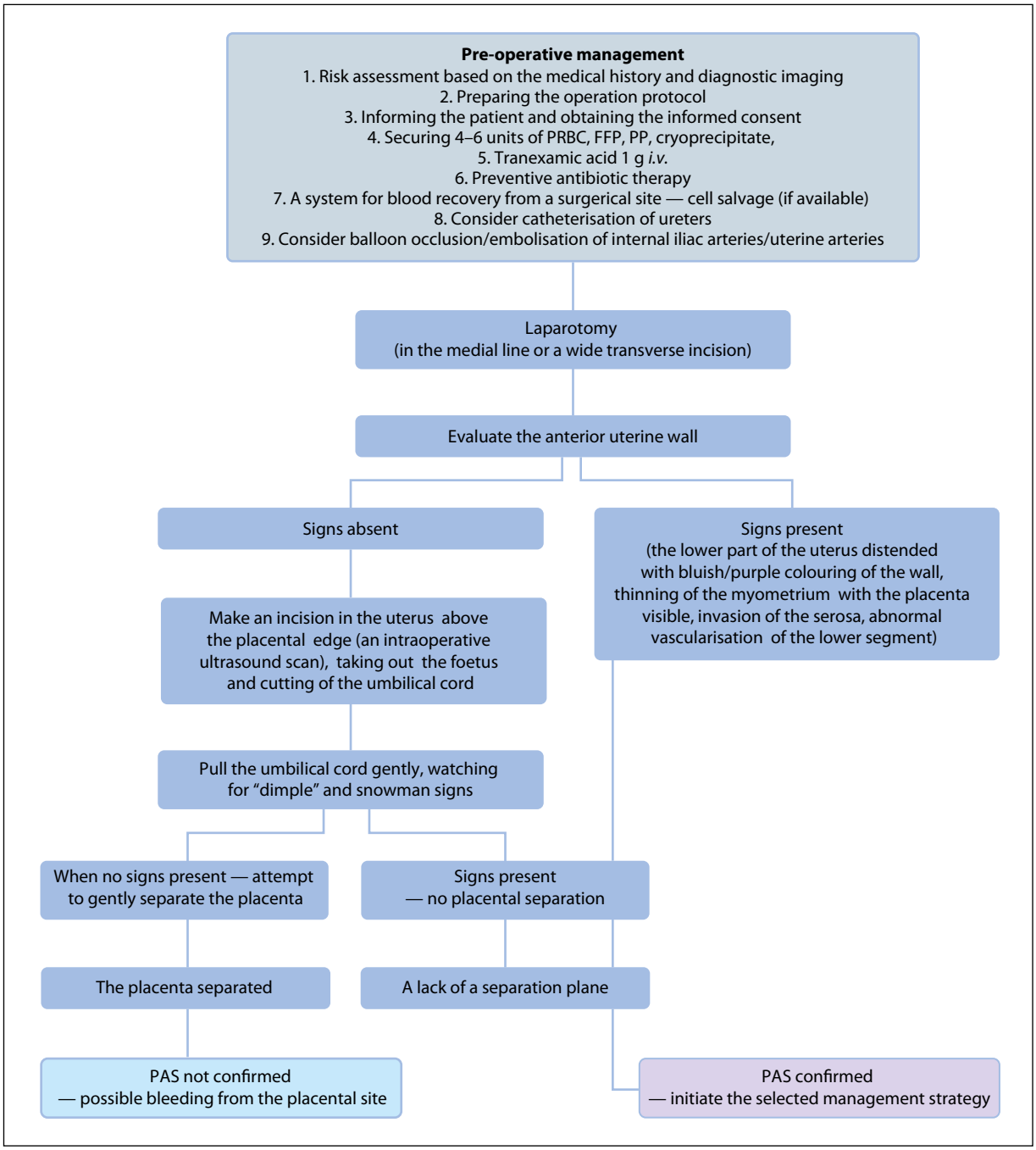

Figure 11. An algorithm for operation in the case of suspected placenta accreta spectrum (PAS); PRBC — packed red blood cells; FFP — fresh frozen plasma; PP — packed platelets; *i.v.* — *intravenosa*

subtotal hysterectomy in all PAS cases reduces the risk of complications or mortality in mothers when compared to a radical hysterectomy. In the largest published study, a radical hysterectomy was associated with a higher number of injuries, mainly to the urinary bladder, a higher frequency of gastrointestinal disorders, and a longer hospital stay. A subtotal hysterectomy was associated with a higher number of reoperations, a higher frequency of transfusions, and a higher rate of perioperative mortality for mothers [100]. The hysterectomy type should be individually considered in each case, considering the location and grade of PAS suspected before birth and found during laparotomy, bleeding intensity, stability of the patient's haemodynamic status, and the operating team's skills, experience, and preferences. In cases of cervical involvement, a radical hysterectomy should be performed.

Conservative management with the placenta left *in situ*

In the case of PAS, the elective leaving of the placenta *in situ* is a preferred management method in many regions of the world, both to preserve the uterus and fertility, and to reduce the rate of postoperative complications [13, 101]. When placenta accreta is left in situ after the child's birth, a gradual reduction in blood flow in the uterus, the perimetrium, and the placenta may be expected. This will result in secondary necrosis of the chorion and, in theory, in a gradual separation of the placenta from the uterus and of the penetrating chorionic tissues from the neighbouring pelvic organs.

After infant delivery and diagnosis of placenta accreta in the way mentioned in the previous chapter, the umbilical cord should be cut close to its attachment to the placenta, and the uterus should be sutured. Postoperative preventive antibiotic therapy is recommended to minimise the risk of infection. The literature review conducted up to 2007 showed that of 26 women with the placenta left *in situ*, the outcome was positive in 22 (85%) cases, and only four (15%) patients required a secondary hysterectomy for a massive obstetric haemorrhage or an infection [102]. A French multicentre retrospective study covering 167 cases of PAS demonstrated a general effectiveness of preservation of the uterus in 78% of patients, and severe maternal complications affected 6% of the cases (Tab. 4) [101]. One case of a mother's death was noted, caused by a multisystem organ failure and septic shock after an additional methotrexate administration into the umbilical cord. The empty uterus was achieved spontaneously in 75% of the cases within 13.5 weeks on average (4–60 weeks) [101]. The results of that large study and other studies suggest that centres with limited experience in conservative treatment of PAS may attempt to preserve the uterus by leaving the placenta *in situ*. Still, ensuring continuous patient care in a referral centre, including emergency access to blood products, interventional radiology, urology and gynaecological surgery, is crucial [102–106]. Additional procedures (such as embolisation or vascular ligation, temporary balloon occlusion of internal iliac arteries, postprocedural methotrexate administration, or hysteroscopic removal of residual chorionic tissues) may be used in the strategy for leaving the placenta *in situ* to reduce morbidity rates or accelerate resorption of the placenta [107]. Currently, no results of randomised clinical studies evaluating those procedures are available. In general, scientific data suggests that leaving the placenta *in situ* is not a recommended choice but may be an option for women who want to preserve their fertility and agree to strict monitoring at centres having the required specialist knowledge.

Elective delayed hysterectomy

A delayed hysterectomy may be an alternate strategy to the immediate removal of the uterus. It is performed several weeks after the caesarean section with the placenta left *in situ*, thus enabling a reduction in the risk of complications associated with complex surgeries in cases of severe PAS, as well as reducing the risk of delayed complications related to leaving the placenta for the complete spontaneous expulsion or resorption. The selection of this strategy should be preceded by a systematic analysis of a given case at a referral centre, with an evaluation of the results of diagnostic imaging scans of the lesser pelvis, the uterus, the urinary bladder, and the perimetrium. In the selected cases in which the delayed hysterectomy is chosen, a repeated intraoperative analysis of the patient's clinical status and the local condition should be performed after the child is taken out. A significant active bleeding is a contraindication to the delayed hysterectomy. The use of additional procedures, such as balloon occlusion, embolisation of uterine arteries, or placement of catheters in ureters, is acceptable. Still, no clear assessment of the significance of those procedures performed during clinical studies is available. Current reports show that delayed hysterectomy is associated with a reduction in the estimated blood loss and the volume of the blood products administered compared to the immediate procedure [108, 109]. The disadvantage of this management is a need for at least two hospitalisations and procedures in the patient, resulting in a longer total surgery time and a longer postoperative stay [109]. The frequency of other surgical and postoperative complications is similar to the case of the immediate hysterectomy [108].

Partial myometrium resection and reconstruction of the uterus

One of the conservative management methods may be a strategy of partial myometrium resection and reconstruction of the uterine wall, used in many referral centres

[110–112]. This strategy involves the placenta resection with the adjoining uterine muscle layer in precisely selected cases, followed by the repair and reconstruction of the remaining uterine wall [113]. This procedure is performed during a caesarean section. The operator's experience is crucial for its success, as they may decide about a partial resection or a hysterectomy following an intraoperative evaluation of the patient's local and clinical status. With carefully performed eligibility assessment, the partial resection procedure is associated with reduced blood loss and surgical complications [12, 114]. Most experts agree that a local resection is possible in cases when the placenta invades less than 50% of the surface of the anterior uterine wall, without the involvement of the cervix, the perimetrium and the posterior uterine wall, and when a margin of at least 2 cm of the healthy myometrium is available above the cervix, enabling uterine wall reconstruction [12, 93, 113]. The ability to correctly decide when to use this approach is a skill that develops only with relevant experience. The uterine wall resection and repair can be combined with processes of pelvic devascularisation, compression suturing, or balloon tamponade to reduce blood loss during the surgery [115, 116].

Before the procedure, the patient in whom this approach is considered needs to be informed that the partial resection may not be possible or may result in significant bleeding, which will require a rescue hysterectomy. Similarly, the patient should be advised against getting pregnant after a reconstruction procedure with preservation of the uterus due to serious doubts concerning the safety of the subsequent pregnancy in the presence of significant deformation of the uterus and extensive scarring. In this case, a subsequent pregnancy may be complicated by PAS recurrence in as many as 29% of the cases, as well as by a uterine rupture and premature birth [12, 93, 117]. Women who wish to maintain their fertility despite all those factors should be advised whether it is possible. If the conservative treatment is effective, the subsequent pregnancy rate is between 86% and 89% [118, 119]. There is no evidence of a relationship between the PAS grade, conservative management methods, and effective fertility preservation.

Intraoperative PAS diagnosis

If previously undiagnosed PAS is found, the management should depend on individual clinical circumstances. If the patient is haemodynamically unstable or an intrauterine fetal compromise is diagnosed, a quick caesarean section may be necessary. However, the final management, involving the removal of the uterus or a conservative strategy, is not absolutely or immediately required if the patient's clinical status stabilises. In practice, diagnosing placenta accreta during a caesarean section in a patient in a stable clinical condition offers an opportunity for reconsidering and evaluating whether the procedure should be continued in each case. The operating team makes this decision based on their experience, specialist knowledge, skills, and other resources available at the medical centre. When the PAS anomalies exceed the abilities of the operating team or the medical centre, suturing the abdomen wall and transferring the pregnant woman to a referral centre may represent one of the possible solutions. However, when the diagnosis is made already after the baby is taken out, the patient is haemodynamically stable, and there is no active bleeding; the uterus and the walls can be sutured with the placenta left *in situ*. This solution may be safer than an attempt to remove the uterus in circumstances of insufficient resources, especially blood products, and when it concerns an inexperienced operating team. The elective removal of the uterus can then be performed after several hours or days when the resources are prepared, and an experienced operating team arrives or after the patient is transferred to a referral centre to be provided further care there. In this situation, recommendations include strict monitoring of the patient's haemodynamic stability, implementation of necessary life-saving care and resuscitation, *e.g.* fluid supplementation, a transfusion of blood and blood-derived products, and administering antifibrinolytic agents.

PROCEDURE IN THE CASE OF EXTENSIVE HAEMORRHAGE ASSOCIATED WITH PAS MANAGEMENT

Currently, no clinical study results are available that support a specific management strategy for an extensive haemorrhage in PAS. In this case, the selection of a particular management method differs depending on the available resources and experiences of a given centre and the preferences of the operating team. Performing the simplest techniques with the lowest rate of complication as the first approach is a reasonable strategy [1, 12]. In the case of a massive haemorrhage occurring after the placenta removal, intrauterine tamponade should be the procedure of the first choice (*e.g.* using balloon tamponade). If this method proves ineffective or the placenta remains in place, uterine devascularisation with or without compression sutures represents an additional supportive approach. The last procedure that may be tried is ligation of internal iliac arteries, depending on the experience and skills of the operator, as this procedure is associated with the highest risk of postoperative complications. When the undertaken actions are ineffective, the patient is haemodynamically unstable, or bleeding is life-threatening, the rapid hysterectomy must be performed as soon as possible. Compression of common iliac arteries or the aorta may be used as a method to gain time for temporarily stopping

the bleeding, stabilising the patient's clinical status by fast filling of the vascular bed, and a transfusion of blood products, followed by immediate performance of the final procedure [12]. "Packing" of the lesser pelvis can also be performed to stabilise the patient's status before further treatment or transport to a referral centre.

A transfusion of PRBC or FFP must follow the transfusion protocols without undue delay. Fluid resuscitation should be adjusted to changes in haemodynamic parameters, the volume of urine excreted, and lactate levels or base deficit in the blood. The initial treatment involves intravenous administration of the heated crystalloid solution at a ratio of 3:1 concerning the estimated volume of blood lost. If the therapy using balanced crystalloids is ineffective, administering colloids at the smallest possible dose must be considered. In the case of a massive haemorrhage, a universal blood (0 RhD negative) transfusion needs to be initiated without waiting for a result of the cross-match test before a product compatible with the patient's blood type is received. In the case of a severe haemorrhage, apart from PRBC, an FFP transfusion is necessary, and a transfusion of packed platelets (PP) and cryoprecipitate needs to be considered [120–123]. In the case of transfusions of ≥ 5 units of PRBC, 1 unit of FFP per every two units of PRBC and one unit of PP per every five units of PRBC need to be administered. In cases of heavy bleeding (requiring a PRBC transfusion), PP needs to be administered if the platelet count is below < 50 000/μL and 1 unit of cryoprecipitate per 10 kg body weight needs to be administered when the fibrinogen level is < 1.5 g/L. In cases of massive bleeding, the administration of fibrinogen products, cryoprecipitate or FFP with PRBC must be considered from the treatment initiation (the target fibrinogen level > 1.5–2.0 g/L). In cases of massive haemorrhages, one unit of FFP and one unit of PP must be administered per every PRBC unit. Hypothermia prevention is also important, as well as adjustment of acidosis and hypocalcaemia (maintaining Ca 2+ levels at > 0.9 mmol/L), as these disorders impair blood coagulation [124, 125]. Tranexamic acid (TA) should be administered in each case of massive bleeding, preferably as soon as possible after the onset of significant bleeding, at a dose of 1–2 g, *i.e.* 15–30 mg/kg of body weight, before fibrinogen substitution (factor concentrate or FFP) is considered [126]. The advantages of early tranexamic acid administration in the reduction of maternal mortality rates were proven in the WOMAN study — a large multicentre, double-blind study comparing tranexamic acid with placebo in the prevention of deaths resulting from all causes of bleeding, including PAS and other complications [127]. In cases of heavy bleeding, in clinical settings of an uncontrolled haemorrhage that is not stopped by surgical intervention and a transfusion of blood components, TA, and fibrinogen, the administration of recombinant activated factor VII (rFVIIa; 40–90–120 ug/kg body weight) needs to be considered. [128, 129]. A detailed protocol for surgical and pharmacological intervention is provided in recommendations of the Polish Society of Gynecologists and Obstetricians "Postępowania w przypadku wystąpienia krwotoków okołoporodowych" [95].

POSTPARTUM CARE AFTER PAS MANAGEMENT

Patients post PAS-related surgery require not only standard postpartum care but also additional attention to their special needs, mainly related to intensive management procedures. Cooperation between the obstetrics and the postoperative and/or intensive care unit teams is important. Apart from the specialist treatment, for which an anaesthesiology and intensive care specialist is responsible, the patients require daily cross-disciplinary care, particularly provided by a gynaecology or perinatology specialist experienced in PAS management. At every ward, patients can be provided with some elements of postpartum care, like lactation support or ensuring the mother's contact with the newborn baby. The team managing PAS complications needs to inform other people involved in the care of those patients, i.e. nurses, personnel, and consultants at a given facility, about the specific needs of these puerperaes. Elements of their care that need to be considered first include monitoring of bleeding (drainage) and the risk of reoperation, pain management, and restoring the function of the urinary and gastrointestinal tracts. Understanding the course of operative events enables the introduction of modifications in the management versus the standard postoperative care after labour. In the postpartum period, patients with PAS complications require emotional support due to the highly stressful and unexpected character of their experience, especially in contrast to their motherhood-related expectations. Circumstances associated with birth and PAS-related surgeries expose the patients and their families to great suffering, fear, a sense of loss, and trauma of varying intensity. Stress related to the stay at the intensive care unit may represent an additional burden. Thus, the disorders may persist for weeks or even months after discharge from the hospital. It may be helpful for patients with PAS and their families if they are provided with educational materials, recovery planning protocols, easy access to specialist evaluation of PAS complications by a psychologist, and support at every stage, from the diagnosis through postpartum recovery up to so-called "post-PAS life".

CONCLUSIONS

Placenta accreta spectrum is a condition which may be threatening to the patient's life to a degree higher than it is

the case in other obstetric situations. Its incidence will probably increase with time due to an increase in the number of caesarean sections worldwide. Physicians should be aware of the difficulties and challenges associated with diagnostics and treatment of this condition. Patients should be provided care in specialist referral centres with resources to meet an extensive range of needs resulting from the PAS diagnosis.

In the management of this condition, the most crucial step is a clinical risk assessment for the occurrence of PAS related to a history of uterine surgeries, as well as a specialist ultrasound scan. In cases diagnosed before birth, a hysterectomy during a caesarean section remains a gold standard and an ultimate solution; however, the use of conservative methods should be considered, depending on skills, specialist knowledge and resources of the referral centre, the severity of this disorder and individual preferences of the patient. Every medical institution that provides obstetric care should be prepared for the possibility of PAS occurrence and have a management protocol ready for such cases, as well as an option to refer patients to a referral centre. Among childbirth complications, the diagnosis of placenta accreta is associated with a higher risk of bleeding, and the management protocols should focus on this aspect, considering that in some instances, the best solution is to transfer the patient to a referral centre specialising in PAS management, after stabilising her condition.

Although the knowledge about PAS is continuously expanding, increasingly better diagnostic and management methods are available, and the surgical skills of individual referral centres are improving, many areas related to this disorder remain unexplored. Future studies should focus on collecting data for prospective studies on PAS diagnosing and management, considering PAS biomarkers and a correlation between prenatal imaging, clinical PAS evaluation at birth, and a histopathological examination. We need to focus on the patient and her psychosocial experiences and on reducing her trauma. Those issues are crucial for ensuring the best possible solutions for screening, diagnosing, and treating women affected by PAS.

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REFERENCES

1. Morlando M, Collins S. Placenta Accreta Spectrum Disorders: Challenges, Risks, and Management Strategies. Int J Womens Health. 2020; 12: 1033–1045, doi: 10.2147/IJWH.S224191, indexed in Pubmed: 33204176.
2. Bartels HC, Postle JD, Downey P, et al. Placenta Accreta Spectrum: A Review of Pathology, Molecular Biology, and Biomarkers. Dis Markers. 2018; 2018: 1507674, doi: 10.1155/2018/1507674, indexed in Pubmed: 30057649.
3. Jauniaux E, Chantraine F, Silver RM, et al. FIGO Placenta Accreta Diagnosis and Management Expert Consensus Panel. FIGO consensus guidelines on placenta accreta spectrum disorders: Epidemiology. Int J Gynaecol Obstet. 2018; 140(3): 265–273, doi: 10.1002/ijgo.12407, indexed in Pubmed: 29405321.
4. Jauniaux E, Bunce C, Grønbeck L, et al. Prevalence and main outcomes of placenta accreta spectrum: a systematic review and meta-analysis. Am J Obstet Gynecol. 2019; 221(3): 208–218, doi: 10.1016/j.ajog.2019.01.233, indexed in Pubmed: 30716286.
5. Beigi R, Phillips Heine ; R, Silver RM, Wax JR (2012) Number 7 (Replaces Committee Opinion No. 529 2012.
6. Morlando M, Schwickert A, Stefanovic V, et al. International Society for Placenta Accreta Spectrum (IS-PAS). Maternal and neonatal outcomes in planned versus emergency cesarean delivery for placenta accreta spectrum: A multinational database study. Acta Obstet Gynecol Scand. 2021; 100 Suppl 1: 41–49, doi: 10.1111/aogs.14120, indexed in Pubmed: 33713033.
7. American College of Obstetricians and Gynecologists, Society for Maternal-Fetal Medicine. Obstetric Care Consensus No. 7: Placenta Accreta Spectrum. Obstet Gynecol. 2018; 132(6): e259–e275, doi: 10.1097/AOG.0000000000002983, indexed in Pubmed: 30461695.
8. Eller AG, Porter TF, Soisson P, et al. Optimal management strategies for placenta accreta. BJOG. 2009; 116(5): 648–654, doi: 10.1111/j.1471-0528.2008.02037.x, indexed in Pubmed: 19191778.
9. Bartels HC, Terlizzi K, Cooney N, et al. Quality of life and sexual function after a pregnancy complicated by placenta accreta spectrum. Aust N Z J Obstet Gynaecol. 2021; 61(5): 708–714, doi: 10.1111/ajo.13338, indexed in Pubmed: 33763885.
10. Grover B, Einerson BD, Keenan KD, et al. Patient-Reported Health Outcomes and Quality of Life after Peripartum Hysterectomy for Placenta Accreta Spectrum. Am J Perinatol. 2022; 39(3): 281–287, doi: 10.1055/s-0040-1715465, indexed in Pubmed: 32819016.
11. Tol ID, Yousif M, Collins SL. Post traumatic stress disorder (PTSD): The psychological sequelae of abnormally invasive placenta (AIP). Placenta. 2019; 81: 42–45, doi: 10.1016/j.placenta.2019.04.004, indexed in Pubmed: 31138430.
12. Collins SL, Alemdar B, van Beekhuizen HJ, et al. International Society for Abnormally Invasive Placenta (IS-AIP). Evidence-based guidelines for the management of abnormally invasive placenta: recommendations from the International Society for Abnormally Invasive Placenta. Am J Obstet Gynecol. 2019; 220(6): 511–526, doi: 10.1016/j.ajog.2019.02.054, indexed in Pubmed: 30849356.
13. Einerson BD, Gilner JB, Zuckerwise LC. Placenta Accreta Spectrum. Obstet Gynecol. 2023; 142(1): 31–50, doi: 10.1097/AOG.0000000000005229, indexed in Pubmed: 37290094.
14. Cnota W, Banas E, Dziechcinska-Poletek D, et al. "The Killer Placenta" — a threat to the lives of young women giving birth by cesarean section. Ginekol Pol. 2022; 93(4): 314–320, doi: 10.5603/GP.a2021.0235, indexed in Pubmed: 35156697.
15. Wu S, Kocherginsky M, Hibbard JU. Abnormal placentation: twenty-year analysis. Am J Obstet Gynecol. 2005; 192(5): 1458–1461, doi: 10.1016/j.ajog.2004.12.074, indexed in Pubmed: 15902137.
16. Mogos MF, Salemi JL, Ashley M, et al. Recent trends in placenta accreta in the United States and its impact on maternal-fetal morbidity and healthcare-associated costs, 1998-2011. J Matern Fetal Neonatal Med. 2016; 29(7): 1077–1082, doi: 10.3109/14767058.2015.1034103, indexed in Pubmed: 25897639.
17. Luke RK, Sharpe JW, Greene RR. Placenta accreta: the adherent or invasive placenta. Am J Obstet Gynecol. 1966; 95(5): 660–668, doi: 10.1016/s0002-9378(16)34741-x, indexed in Pubmed: 5942637.
18. Tantbirojn P, Crum CP, Parast MM. Pathophysiology of placenta creta: the role of decidua and extravillous trophoblast. Placenta. 2008; 29(7): 639–645, doi: 10.1016/j.placenta.2008.04.008, indexed in Pubmed: 18514815.

19. Jauniaux E, Hussein AM, Elbarmelgy RM, et al. Failure of placental detachment in accreta placentation is associated with excessive fibrinoid deposition at the utero-placental interface. Am J Obstet Gynecol. 2022; 226(2): 243.e1–243.e10, doi: 10.1016/j.ajog.2021.08.026, indexed in Pubmed: 34461077.
20. Jauniaux E, Jurkovic D. Placenta accreta: pathogenesis of a 20th century iatrogenic uterine disease. Placenta. 2012; 33(4): 244–251, doi: 10.1016/j.placenta.2011.11.010, indexed in Pubmed: 22284667.
21. Silver RM, Landon MB, Rouse DJ, et al. National Institute of Child Health and Human Development Maternal-Fetal Medicine Units Network. Maternal morbidity associated with multiple repeat cesarean deliveries. Obstet Gynecol. 2006; 107(6): 1226–1232, doi: 10.1097/01.AOG.0000219750.79480.84, indexed in Pubmed: 16738145.
22. Timor-Tritsch IE, Monteagudo A, Cali G, et al. Cesarean scar pregnancy and early placenta accreta share common histology. Ultrasound Obstet Gynecol. 2014; 43(4): 383–395, doi: 10.1002/uog.13282, indexed in Pubmed: 24357257.
23. Thurn L, Lindqvist PG, Jakobsson M, et al. Abnormally invasive placenta-prevalence, risk factors and antenatal suspicion: results from a large population-based pregnancy cohort study in the Nordic countries. BJOG. 2016; 123(8): 1348–1355, doi: 10.1111/1471-0528.13547, indexed in Pubmed: 26227006.
24. Jauniaux E, Ayres-de-Campos D. FIGO Placenta Accreta Diagnosis and Management Expert Consensus Panel. FIGO consensus guidelines on placenta accreta spectrum disorders: Introduction. Int J Gynaecol Obstet. 2018; 140(3): 261–264, doi: 10.1002/ijgo.12406, indexed in Pubmed: 29405322.
25. Badr DA, Al Hassan J, Salem Wehbe G, et al. Uterine body placenta accreta spectrum: A detailed literature review. Placenta. 2020; 95: 44–52, doi: 10.1016/j.placenta.2020.04.005, indexed in Pubmed: 32452401.
26. Miller HE, Leonard SA, Fox KA, et al. Placenta Accreta Spectrum Among Women With Twin Gestations. Obstet Gynecol. 2021; 137(1): 132–138, doi: 10.1097/AOG.0000000000004204, indexed in Pubmed: 33278284.
27. Modest AM, Toth TL, Johnson KM, et al. Placenta Accreta Spectrum: In Vitro Fertilization and Non-In Vitro Fertilization and Placenta Accreta Spectrum in a Massachusetts Cohort. Am J Perinatol. 2021; 38(14): 1533–1539, doi: 10.1055/s-0040-1713887, indexed in Pubmed: 32623707.
28. Türker Aras ÜA, Korkmazer E, Üstünyurt E. The nightmare of obstetricians - the placenta accreta spectrum in primiparous pregnant women. Ginekol Pol. 2023; 94(2): 135–140, doi: 10.5603/GP.a2022.0141, indexed in Pubmed: 36597751.
29. Jauniaux E, Alfirevic Z, Bhide AG, et al. Royal College of Obstetricians and Gynaecologists. Placenta Praevia and Placenta Accreta: Diagnosis and Management: Green-top Guideline No. 27a. BJOG. 2019; 126(1): e1–e48, doi: 10.1111/1471-0528.15306, indexed in Pubmed: 30260097.
30. Jauniaux E, Collins S, Burton GJ. Placenta accreta spectrum: pathophysiology and evidence-based anatomy for prenatal ultrasound imaging. Am J Obstet Gynecol. 2018; 218(1): 75–87, doi: 10.1016/j.ajog.2017.05.067, indexed in Pubmed: 28599899.
31. Jauniaux E, Hecht JL, Elbarmelgy RA, et al. Searching for placenta percreta: a prospective cohort and systematic review of case reports. Am J Obstet Gynecol. 2022; 226(6): 837.e1–837.e13, doi: 10.1016/j.ajog.2021.12.030, indexed in Pubmed: 34973177.
32. Einerson B, Comstock J, Silver R, et al. Placenta Accreta Spectrum Disorder. Obstetrics & Gynecology. 2020; 135(5): 1104–1111, doi: 10.1097/aog.0000000000003793.
33. Jauniaux E, Ayres-de-Campos D, Langhoff-Roos J, et al. 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; 146(1): 20–24, doi: 10.1002/ijgo.12761, indexed in Pubmed: 31173360.
34. Hecht JL, Baergen R, Ernst LM, et al. Classification and reporting guidelines for the pathology diagnosis of placenta accreta spectrum (PAS) disorders: recommendations from an expert panel. Mod Pathol. 2020; 33(12): 2382–2396, doi: 10.1038/s41379-020-0569-1, indexed in Pubmed: 32415266.
35. Silver RM, Fox KA, Barton JR, et al. Center of excellence for placenta accreta. Am J Obstet Gynecol. 2015; 212(5): 561–568, doi: 10.1016/j.ajog.2014.11.018, indexed in Pubmed: 25460838.
36. Eller AG, Bennett MA, Sharshiner M, et al. Maternal morbidity in cases of placenta accreta managed by a multidisciplinary care team compared with standard obstetric care. Obstet Gynecol. 2011; 117(2 Pt 1): 331–337, doi: 10.1097/AOG.0b013e3182051db2, indexed in Pubmed: 21309195.
37. Afshar Y, Dong J, Zhao P, et al. Circulating trophoblast cell clusters for early detection of placenta accreta spectrum disorders. Nat Commun. 2021; 12(1): 4408, doi: 10.1038/s41467-021-24627-2, indexed in Pubmed: 34344888.
38. Shainker SA, Silver RM, Modest AM, et al. Placenta accreta spectrum: biomarker discovery using plasma proteomics. Am J Obstet Gynecol. 2020; 223(3): 433.e1–433.e14, doi: 10.1016/j.ajog.2020.03.019, indexed in Pubmed: 32199927.
39. Conturie CL, Lyell DJ. Prenatal diagnosis of placenta accreta spectrum. Curr Opin Obstet Gynecol. 2022; 34(2): 90–99, doi: 10.1097/GCO.0000000000000773, indexed in Pubmed: 35230992.
40. Timor-Tritsch IE, Monteagudo A. Unforeseen consequences of the increasing rate of cesarean deliveries: early placenta accreta and cesarean scar pregnancy. A review. Am J Obstet Gynecol. 2012; 207(1): 14–29, doi: 10.1016/j.ajog.2012.03.007, indexed in Pubmed: 22516620.
41. Zimmer M, Sieroszewski P, Wielgoś M, et al. Algorytm postępowania w przypadkach łożyska przodującego i/lub łożyska z nieprawidłową implantacją (PAS). Polskie Towarzystwo Ginekologów i Położników — 2022, cz. I i II. Ginekologia i Perinatologia Praktyczna. 2022; 7: 92–95.
42. Miller R, Gyamfi-Bannerman C. Society for Maternal-Fetal Medicine (SMFM), Publications Committee. Electronic address: pubs@smfm.org. Society for Maternal-Fetal Medicine Consult Series #63: Cesarean scar ectopic pregnancy. Am J Obstet Gynecol. 2022; 227(3): B9–BB20, doi: 10.1016/j.ajog.2022.06.024, indexed in Pubmed: 35850938.
43. Collins SL, Ashcroft A, Braun T, et al. European Working Group on Abnormally Invasive Placenta (EW-AIP). Proposal for standardized ultrasound descriptors of abnormally invasive placenta (AIP). Ultrasound Obstet Gynecol. 2016; 47(3): 271–275, doi: 10.1002/uog.14952, indexed in Pubmed: 26205041.
44. Jauniaux E, Bhide A, Kennedy A, et al. FIGO Placenta Accreta Diagnosis and Management Expert Consensus Panel. FIGO consensus guidelines on placenta accreta spectrum disorders: Prenatal diagnosis and screening. Int J Gynaecol Obstet. 2018; 140(3): 274–280, doi: 10.1002/ijgo.12408, indexed in Pubmed: 29405319.
45. Hessami K, Salmanian B, Einerson BD, et al. Clinical Correlates of Placenta Accreta Spectrum Disorder Depending on the Presence or Absence of Placenta Previa: A Systematic Review and Meta-analysis. Obstet Gynecol. 2022; 140(4): 599–606, doi: 10.1097/AOG.0000000000004923, indexed in Pubmed: 36075058.
46. Jauniaux E, D'Antonio F, Bhide A, et al. Delphi consensus expert panel. Modified Delphi study of ultrasound signs associated with placenta accreta spectrum. Ultrasound Obstet Gynecol. 2023; 61(4): 518–525, doi: 10.1002/uog.26155, indexed in Pubmed: 36609827.
47. Sargent W, Gerry S, Collins SL. A Risk-Prediction Model for Placenta Accreta Spectrum Severity From Standardized Ultrasound Markers. Ultrasound Med Biol. 2023; 49(2): 512–519, doi: 10.1016/j.ultrasmedbio.2022.09.021, indexed in Pubmed: 36347659.
48. Happe SK, Yule CS, Spong CY, et al. Predicting Placenta Accreta Spectrum: Validation of the Placenta Accreta Index. J Ultrasound Med. 2021; 40(8): 1523–1532, doi: 10.1002/jum.15530, indexed in Pubmed: 33058255.
49. Kolak M, Gerry S, Huras H, et al. External validation of and improvement upon a model for the prediction of placenta accreta spectrum severity using prospectively collected multicenter ultrasound data. Acta Obstet Gynecol Scand. 2024 Aug 20. doi: 10.1111/aogs.14941. Epub ahead of print. Indexed in Pubmed: 39164972.
50. De Oliveira Carniello M, Oliveira Brito LG, Sarian LO, et al. Diagnosis of placenta accreta spectrum in high-risk women using ultrasonography or magnetic resonance imaging: systematic review and meta-analysis. Ultrasound Obstet Gynecol. 2022; 59(4): 428–436, doi: 10.1002/uog.24861, indexed in Pubmed: 35041250.
51. Familiari A, Liberati M, Lim P, et al. Diagnostic accuracy of magnetic resonance imaging in detecting the severity of abnormal invasive placenta: a systematic review and meta-analysis. Acta Obstet Gynecol Scand. 2018; 97(5): 507–520, doi: 10.1111/aogs.13258, indexed in Pubmed: 29136274.
52. Jha P, Põder L, Bourgioti C, et al. 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; 30(5): 2604–2615, doi: 10.1007/s00330-019-06617-7, indexed in Pubmed: 32040730.
53. Morel O, Collins SL, Uzan-Augui J, et al. International Society for Abnormally Invasive Placenta (IS-AIP). A proposal for standardized magnetic

resonance imaging (MRI) descriptors of abnormally invasive placenta (AIP) - From the International Society for AIP. Diagn Interv Imaging. 2019; 100(6): 319–325, doi: 10.1016/j.diii.2019.02.004, indexed in Pubmed: 30853416.
54. Einerson BD, Rodriguez CE, Silver RM, et al. Accuracy and Interobserver Reliability of Magnetic Resonance Imaging for Placenta Accreta Spectrum Disorders. Am J Perinatol. 2021; 38(9): 960–967, doi: 10.1055/s-0040-1701196, indexed in Pubmed: 31986538.
55. Bailit JL, Grobman WA, Rice MM, et al. Eunice Kennedy Shriver National Institute of Child Health and Human Development (NICHD) Maternal-Fetal Medicine Units (MFMU) Network. Morbidly adherent placenta treatments and outcomes. Obstet Gynecol. 2015; 125(3): 683–689, doi: 10.1097/AOG.0000000000000680, indexed in Pubmed: 25730233.
56. Fitzpatrick KE, Sellers S, Spark P, et al. Incidence and risk factors for placenta accreta/increta/percreta in the UK: a national case-control study. PLoS One. 2012; 7(12): e52893, doi: 10.1371/journal.pone.0052893, indexed in Pubmed: 23300807.
57. Silver RM, Fox KA, Barton JR, et al. Center of excellence for placenta accreta. Am J Obstet Gynecol. 2015; 212(5): 561–568, doi: 10.1016/j.ajog.2014.11.018, indexed in Pubmed: 25460838.
58. Levels of Maternal Care: Obstetric Care Consensus No, 9. Obstet Gynecol. 2019; 134(2): e41–e55, doi: 10.1097/AOG.0000000000003383, indexed in Pubmed: 31348224.
59. Einerson BD, Healy AJ, Lee A, et al. Society for Maternal-Fetal Medicine (SMFM), SMFM Patient Safety and Quality Committee. Electronic address: smfm@smfm.org. Society for Maternal-Fetal Medicine Special Statement: Emergency checklist, planning worksheet, and system preparedness bundle for placenta accreta spectrum. Am J Obstet Gynecol. 2024; 230(1): B2–BB11, doi: 10.1016/j.ajog.2023.09.001, indexed in Pubmed: 37678646.
60. Sieroszewski P, Bomba-Opon D, Cnota W, et al. Guidelines of the Polish Society of Gynecologists and Obstetricians on the diagnosis and treatment of iron deficiency and iron deficiency with anemia. Ginekol Pol. 2023; 94(5): 415–422, doi: 10.5603/GP.a2022.0153, indexed in Pubmed: 37042329.
61. James AH. Iron Deficiency Anemia in Pregnancy. Obstet Gynecol. 2021; 138(4): 663–674, doi: 10.1097/AOG.0000000000004559, indexed in Pubmed: 34623079.
62. Robinson BK, Grobman WA. Effectiveness of timing strategies for delivery of individuals with placenta previa and accreta. Obstet Gynecol. 2010; 116(4): 835–842, doi: 10.1097/AOG.0b013e3181f3588d, indexed in Pubmed: 20859146.
63. Allen L, Jauniaux E, Hobson S, et al. FIGO Placenta Accreta Diagnosis and Management Expert Consensus Panel. FIGO consensus guidelines on placenta accreta spectrum disorders: Nonconservative surgical management. Int J Gynaecol Obstet. 2018; 140(3): 281–290, doi: 10.1002/ijgo.12409, indexed in Pubmed: 29405317.
64. Mhuircheartaigh NR, C DJ (2022) The National Women and Infants Health Programme (NWIHP) and the Institute of Obstetricians and Gynaecologists (IOG) Clinical Advisory Group (CAG) 2022.
65. Shamshirsaz AA, Fox KA, Salmanian B, et al. Maternal morbidity in patients with morbidly adherent placenta treated with and without a standardized multidisciplinary approach. Am J Obstet Gynecol. 2015; 212(2): 218.e1–218.e9, doi: 10.1016/j.ajog.2014.08.019, indexed in Pubmed: 25173187.
66. Butwick A, Lyell D, Goodnough L. How do I manage severe postpartum hemorrhage? Transfusion. 2020; 60(5): 897–907, doi: 10.1111/trf.15794, indexed in Pubmed: 32319687.
67. Warrick CM, Rollins MD. Peripartum Anesthesia Considerations for Placenta Accreta. Clin Obstet Gynecol. 2018; 61(4): 808–827, doi: 10.1097/GRF.0000000000000403, indexed in Pubmed: 30312187.
68. Warrick CM, Sutton CD, Farber MM, et al. Anesthesia Considerations for Placenta Accreta Spectrum. Am J Perinatol. 2023; 40(9): 980–987, doi: 10.1055/s-0043-1761637, indexed in Pubmed: 37336215.
69. Viana Pinto P, Kawka-Paciorkowska K, Morlando M, et al. Prevalence of fetal anomalies, stillbirth, neonatal morbidity, or mortality in pregnancies complicated by placenta accreta spectrum disorders. Acta Obstet Gynecol Scand. 2024 Jul 14. doi: 10.1111/aogs.14919, Epub ahead of print. Indexed in Pubmed: 39004930.
70. Bartels HC, Walsh D, Nieto-Calvache AJ, et al. Anesthesia and postpartum pain management for placenta accreta spectrum: The healthcare provider perspective. Int J Gynaecol Obstet. 2024; 164(3): 964–970, doi: 10.1002/ijgo.15096, indexed in Pubmed: 37724823.
71. Markley JC, Farber MK, Perlman NC, et al. Neuraxial Anesthesia During Cesarean Delivery for Placenta Previa With Suspected Morbidly Adherent Placenta: A Retrospective Analysis. Anesth Analg. 2018; 127(4): 930–938, doi: 10.1213/ANE.0000000000003314, indexed in Pubmed: 29481427.
72. Clark A, Farber M, Sviggum H, et al. Cesarean Delivery in the Hybrid Operating Suite. Anesthesia & Analgesia. 2013; 117(5): 1187–1189, doi: 10.1213/ane.0b013e3182a00aff.
73. Einerson BD, Weiniger CF. Placenta accreta spectrum disorder: updates on anesthetic and surgical management strategies. Int J Obstet Anesth. 2021; 46: 102975, doi: 10.1016/j.ijoa.2021.102975, indexed in Pubmed: 33784573.
74. Çetin F, Sucu S, Özcan HÇ, et al. The potential role of preoperative cystoscopy for determining the depth of invasion in the placenta accreta spectrum. Ginekol Pol. 2023 [Epub ahead of print], doi: 10.5603/GP.a2023.0012, indexed in Pubmed: 36929798.
75. Scaglione M, Allshouse A, Canfield D, et al. Prophylactic Ureteral Stent Placement and Urinary Injury During Hysterectomy for Placenta Accreta Spectrum. Obstetrics & Gynecology. 2022; 140(5): 806–811, doi: 10.1097/aog.0000000000004957.
76. Tam Tam KB, Dozier J, Martin JN. Approaches to reduce urinary tract injury during management of placenta accreta, increta, and percreta: a systematic review. J Matern Fetal Neonatal Med. 2012; 25(4): 329–334, doi: 10.3109/14767058.2011.576720, indexed in Pubmed: 23003574.
77. Miller HE, Leonard SA, Fox KA, et al. Placenta Accreta Spectrum Among Women With Twin Gestations. Obstet Gynecol. 2021; 137(1): 132–138, doi: 10.1097/AOG.0000000000004204, indexed in Pubmed: 33278284.
78. Khong TY, Robertson WB. Placenta creta and placenta praevia creta. Placenta. 1987; 8(4): 399–409, doi: 10.1016/0143-4004(87)90067-1, indexed in Pubmed: 3684969.
79. Teixidor Viñas M, Chandraharan E, Moneta MV, et al. The role of interventional radiology in reducing haemorrhage and hysterectomy following caesarean section for morbidly adherent placenta. Clin Radiol. 2014; 69(8): e345–e351, doi: 10.1016/j.crad.2014.04.005, indexed in Pubmed: 24880757.
80. Takahashi H, Ohkuchi A, Usui R, et al. Factors Contributing to Massive Blood Loss on Peripartum Hysterectomy for Abnormally Invasive Placenta: Who Bleeds More? Obstet Gynecol Int. 2016; 2016: 5349063, doi: 10.1155/2016/5349063, indexed in Pubmed: 27630716.
81. Luo F, Xie L, Xie P, et al. Intraoperative aortic balloon occlusion in patients with placenta previa and/or placenta accreta: a retrospective study. Taiwan J Obstet Gynecol. 2017; 56(2): 147–152, doi: 10.1016/j.tjog.2016.11.004, indexed in Pubmed: 28420498.
82. Chou MM, Kung HF, Hwang JI, et al. Temporary prophylactic intravascular balloon occlusion of the common iliac arteries before cesarean hysterectomy for controlling operative blood loss in abnormal placentation. Taiwan J Obstet Gynecol. 2015; 54(5): 493–498, doi: 10.1016/j.tjog.2014.03.013, indexed in Pubmed: 26522098.
83. Pyra K, Szmygin M, Dymara-Konopka W, et al. Maternal and perinatal outcomes in placenta accreta spectrum disorders with prophylactic internal iliac artery balloon catheterization and embolization. Ginekol Pol. 2022; 93(12): 980–986, doi: 10.5603/GP.a2021.0221, indexed in Pubmed: 35315022.
84. Clausen C, Stensballe J, Albrechtsen CK, et al. Balloon occlusion of the internal iliac arteries in the multidisciplinary management of placenta percreta. Acta Obstet Gynecol Scand. 2013; 92(4): 386–391, doi: 10.1111/j.1600-0412.2012.01451.x, indexed in Pubmed: 22574880.
85. Bodner LJ, Nosher JL, Gribbin C, et al. Balloon-assisted occlusion of the internal iliac arteries in patients with placenta accreta/percreta. Cardiovasc Intervent Radiol. 2006; 29(3): 354–361, doi: 10.1007/s00270-005-0023-2, indexed in Pubmed: 16502171.
86. Salim R, Chulski A, Romano S, et al. Precesarean Prophylactic Balloon Catheters for Suspected Placenta Accreta: A Randomized Controlled Trial. Obstet Gynecol. 2015; 126(5): 1022–1028, doi: 10.1097/AOG.0000000000001113, indexed in Pubmed: 26444128.
87. Sentilhes L, Goffinet F, Kayem G. Management of placenta accreta. Acta Obstet Gynecol Scand. 2013; 92(10): 1125–1134, doi: 10.1111/aogs.12222, indexed in Pubmed: 23869630.
88. Matsueda S, Hidaka N, Kondo Y, et al. External iliac artery thrombosis after common iliac artery balloon occlusion during cesarean hysterectomy for placenta accreta in cervico-isthmic pregnancy. J Obstet Gynaecol Res. 2015; 41(11): 1826–1830, doi: 10.1111/jog.12777, indexed in Pubmed: 26223441.

89. Bishop S, Butler K, Monaghan S, et al. Multiple complications following the use of prophylactic internal iliac artery balloon catheterisation in a patient with placenta percreta. Int J Obstet Anesth. 2011; 20(1): 70–73, doi: 10.1016/j.ijoa.2010.09.012, indexed in Pubmed: 21168325.
90. Gagnon J, Boucher L, Kaufman I, et al. Iliac artery rupture related to balloon insertion for placenta accreta causing maternal hemorrhage and neonatal compromise. Can J Anaesth. 2013; 60(12): 1212–1217, doi: 10.1007/s12630-013-0038-0, indexed in Pubmed: 24092477.
91. Teare J, Evans E, Belli A, et al. Sciatic nerve ischaemia after iliac artery occlusion balloon catheter placement for placenta percreta. Int J Obstet Anesth. 2014; 23(2): 178–181, doi: 10.1016/j.ijoa.2013.11.002, indexed in Pubmed: 24572724.
92. Greenberg JI, Suliman A, Iranpour P, et al. Prophylactic balloon occlusion of the internal iliac arteries to treat abnormal placentation: a cautionary case. Am J Obstet Gynecol. 2007; 197(5): 470.e1–470.e4, doi: 10.1016/j.ajog.2007.05.017, indexed in Pubmed: 17980178.
93. Sentilhes L, Kayem G, Chandraharan E, et al. FIGO Placenta Accreta Diagnosis and Management Expert Consensus Panel. FIGO consensus guidelines on placenta accreta spectrum disorders: Conservative management. Int J Gynaecol Obstet. 2018; 140(3): 291–298, doi: 10.1002/ijgo.12410, indexed in Pubmed: 29405320.
94. Paping A, Bluth A, Al Naimi A, et al. Opportunities for, and barriers to, uterus-preserving surgical techniques for placenta accreta spectrum. Acta Obstet Gynecol Scand. 2024 May 2. doi: 10.1111/aogs.14855. Epub ahead of print, indexed in Pubmed: 38695676.
95. Kwiatkowski S, Huras H, Fuchs T, et al. Rekomendacje Polskiego Towarzystwa Ginekologów i Położników. Postępowania w przypadku wystąpienia krwotoków okołoporodowych. Ginekologia i Perinatologia Praktyczna. 2022; 7: 34–45.
96. Jolley JA, Nageotte MP, Wing DA, et al. Management of placenta accreta: a survey of Maternal-Fetal Medicine practitioners. J Matern Fetal Neonatal Med. 2012; 25(6): 756–760, doi: 10.3109/14767058.2011.594467, indexed in Pubmed: 21827352.
97. Esakoff TF, Handler SJ, Granados JM, et al. PAMUS: placenta accreta management across the United States. J Matern Fetal Neonatal Med. 2012; 25(6): 761–765, doi: 10.3109/14767058.2011.598585, indexed in Pubmed: 21843108.
98. Jauniaux E, Bhide A. Prenatal ultrasound diagnosis and outcome of placenta previa accreta after cesarean delivery: a systematic review and meta-analysis. Am J Obstet Gynecol. 2017; 217(1): 27–36, doi: 10.1016/j.ajog.2017.02.050, indexed in Pubmed: 28268196.
99. Buyukkurt S, Sucu M, Hatipoglu I, et al. Placenta accreta spectrum surgery with the Joel Cohen incision for abdominal access: a single-center experience. Ginekol Pol. 2023 [Epub ahead of print], doi: 10.5603/GP.a2023.0050, indexed in Pubmed: 37249265.
100. Wright JD, Herzog TJ, Shah M, et al. Regionalization of care for obstetric hemorrhage and its effect on maternal mortality. Obstet Gynecol. 2010; 115(6): 1194–1200, doi: 10.1097/AOG.0b013e3181df94e8, indexed in Pubmed: 20502290.
101. Sentilhes L, Ambroselli C, Kayem G, et al. Maternal outcome after conservative treatment of placenta accreta. Obstet Gynecol. 2010; 115(3): 526–534, doi: 10.1097/AOG.0b013e3181d066d4, indexed in Pubmed: 20177283.
102. Timmermans S, van Hof AC, Duvekot JJ. Conservative management of abnormally invasive placentation. Obstet Gynecol Surv. 2007; 62(8): 529–539, doi: 10.1097/01.ogx.0000271133.27011.05, indexed in Pubmed: 17634154.
103. Bręborowicz GH, Markwitz W, Gaca M, et al. Conservative management of placenta previa complicated by abnormal placentation. J Matern Fetal Neonatal Med. 2013; 26(10): 1012–1015, doi: 10.3109/14767058.2013.766708, indexed in Pubmed: 23350544.
104. Pather S, Strockyj S, Richards A, et al. Maternal outcome after conservative management of placenta percreta at caesarean section: a report of three cases and a review of the literature. Aust N Z J Obstet Gynaecol. 2014; 54(1): 84–87, doi: 10.1111/ajo.12149, indexed in Pubmed: 24471850.
105. Clausen C, Lönn L, Langhoff-Roos J. Management of placenta percreta: a review of published cases. Acta Obstet Gynecol Scand. 2014; 93(2): 138–143, doi: 10.1111/aogs.12295, indexed in Pubmed: 24266548.
106. Miyakoshi K, Otani T, Kondoh E, et al. Perinatal Research Network Group in Japan. Retrospective multicenter study of leaving the placenta in situ for patients with placenta previa on a cesarean scar. Int J Gynaecol Obstet. 2018; 140(3): 345–351, doi: 10.1002/ijgo.12397, indexed in Pubmed: 29159943.
107. Sentilhes L, Goffinet F, Kayem G. Management of placenta accreta. Acta Obstet Gynecol Scand. 2013; 92(10): 1125–1134, doi: 10.1111/aogs.12222, indexed in Pubmed: 23869630.
108. Zuckerwise LC, Craig AM, Newton JM, et al. Outcomes following a clinical algorithm allowing for delayed hysterectomy in the management of severe placenta accreta spectrum. Am J Obstet Gynecol. 2020; 222(2): 179.e1–179.e9, doi: 10.1016/j.ajog.2019.08.035, indexed in Pubmed: 31469990.
109. Gatta LA, Weber JM, Gilner JB, et al. Transfusion Requirements with Hybrid Management of Placenta Accreta Spectrum Incorporating Targeted Embolization and a Selective Use of Delayed Hysterectomy. Am J Perinatol. 2022; 29(14): 1503–1513, doi: 10.1055/s-0042-1754321, indexed in Pubmed: 35973741.
110. Chandraharan E, Rao S, Belli AM, et al. The Triple-P procedure as a conservative surgical alternative to peripartum hysterectomy for placenta percreta. Int J Gynaecol Obstet. 2012; 117(2): 191–194, doi: 10.1016/j.ijgo.2011.12.005, indexed in Pubmed: 22326782.
111. Aryananda RA, Aditiawarman A, Gumilar KE, et al. Uterine conservative-resective surgery for selected placenta accreta spectrum cases: Surgical-vascular control methods. Acta Obstet Gynecol Scand. 2022; 101(6): 639–648, doi: 10.1111/aogs.14348, indexed in Pubmed: 35301710.
112. Palacios-Jaraquemada JM, Fiorillo A, Hamer J, et al. 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): 275–282, doi: 10.1080/14767058.2020.1716715, indexed in Pubmed: 31984808.
113. Nieto-Calvache AJ, Palacios-Jaraquemada JM, Aryananda R, et al. How to perform the one-step conservative surgery for placenta accreta spectrum move by move. Am J Obstet Gynecol MFM. 2023; 5(2): 100802, doi: 10.1016/j.ajogmf.2022.100802, indexed in Pubmed: 36372188.
114. Clausen C, Lönn L, Langhoff-Roos J. Management of placenta percreta: a review of published cases. Acta Obstet Gynecol Scand. 2014; 93(2): 138–143, doi: 10.1111/aogs.12295, indexed in Pubmed: 24266548.
115. Abo-Elroose AAE, Ahmed MR, Shaaban MM, et al. Triple P with T-shaped lower segment suture; an effective novel alternative to hysterectomy in morbidly adherent anterior placenta previa. J Matern Fetal Neonatal Med. 2021; 34(19): 3187–3191, doi: 10.1080/14767058.2019.1678145, indexed in Pubmed: 31615304.
116. Dawood AS, Elgergawy AE, Elhalwagy AE. Evaluation of three-step procedure (Shehata's technique) as a conservative management for placenta accreta at a tertiary care hospital in Egypt. J Gynecol Obstet Hum Reprod. 2019; 48(3): 201–205, doi: 10.1016/j.jogoh.2018.10.007, indexed in Pubmed: 30316906.
117. Palacios-Jaraquemada JM, Basanta N, Labrousse C, et al. Pregnancy outcome in women with prior placenta accreta spectrum disorders treated with conservative-reconstructive surgery: analysis of 202 cases. J Matern Fetal Neonatal Med. 2022; 35(25): 6297–6301, doi: 10.1080/14767058.2021.1910671, indexed in Pubmed: 33843411.
118. Provansal M, Courbiere B, Agostini A, et al. Fertility and obstetric outcome after conservative management of placenta accreta. Int J Gynaecol Obstet. 2010; 109(2): 147–150, doi: 10.1016/j.ijgo.2009.12.011, indexed in Pubmed: 20152971.
119. Sentilhes L, Kayem G, Ambroselli C, et al. Fertility and pregnancy outcomes following conservative treatment for placenta accreta. Hum Reprod. 2010; 25(11): 2803–2810, doi: 10.1093/humrep/deq239, indexed in Pubmed: 20833739.
120. Spahn DR, Bouillon B, Cerny V, et al. Management of bleeding and coagulopathy following major trauma: an updated European guideline. Crit Care. 2013; 17(2): R76, doi: 10.1186/cc12685, indexed in Pubmed: 23601765.
121. Pacagnella RC, Borovac-Pinheiro A. Assessing and managing hypovolemic shock in puerperal women. Best Pract Res Clin Obstet Gynaecol. 2019; 61: 89–105, doi: 10.1016/j.bpobgyn.2019.05.012, indexed in Pubmed: 31345740.
122. Nolan JP, Pullinger R. Hypovolaemic shock. BMJ. 2014; 348: g1139, doi: 10.1136/bmj.g1139, indexed in Pubmed: 24609389.
123. Silva J, Gonçalves L, Sousa PP. Fluid therapy and shock: an integrative literature review. Br J Nurs. 2018; 27(8): 449–454, doi: 10.12968/bjon.2018.27.8.449, indexed in Pubmed: 29683753.
124. McNamara H, Mallaiah S, Barclay P, et al. Coagulopathy and placental abruption: changing management with ROTEM-guided fibrinogen concentrate therapy. Int J Obstet Anesth. 2015; 24(2): 174–179, doi: 10.1016/j.ijoa.2014.12.005, indexed in Pubmed: 25659517.

125. Grottke O, Frietsch T, Maas M, et al. German Society of Anaesthesiology and Intensive Care Medicine. [Dealing with massive bleeding and associated perioperative coagulopathy: recommendations for action of the German Society of Anaesthesiology and Intensive Care Medicine]. Anaesthesist. 2013; 62(3): 213–16, 218, doi: 10.1007/s00101-012-2136-8, indexed in Pubmed: 23407716.
126. James AH, Kouides PA, Abdul-Kadir R, et al. Von Willebrand disease and other bleeding disorders in women: consensus on diagnosis and management from an international expert panel. Am J Obstet Gynecol. 2009; 201(1): 12.e1–12.e8, doi: 10.1016/j.ajog.2009.04.024, indexed in Pubmed: 19481722.
127. WOMAN Trial Collaborators. Effect of early tranexamic acid administration on mortality, hysterectomy, and other morbidities in women with post-partum haemorrhage (WOMAN): an international, randomised, double-blind, placebo-controlled trial. Lancet. 2017; 389(10084): 2105–2116, doi: 10.1016/S0140-6736(17)30638-4, indexed in Pubmed: 28456509.
128. Lavigne-Lissalde G, Aya AG, Mercier FJ, et al. Recombinant human FVIIa for reducing the need for invasive second-line therapies in severe refractory postpartum hemorrhage: a multicenter, randomized, open controlled trial. J Thromb Haemost. 2015; 13(4): 520–529, doi: 10.1111/jth.12844, indexed in Pubmed: 25594352.
129. Segal S, Shemesh IY, Blumental R, et al. The use of recombinant factor VIIa in severe postpartum hemorrhage. Acta Obstet Gynecol Scand. 2004; 83(8): 771–772, doi: 10.1111/j.0001-6349.2004.00501.x, indexed in Pubmed: 15255852.
130. Yang JI, Lim YK, Kim HS, et al. Sonographic findings of placental lacunae and the prediction of adherent placenta in women with placenta previa totalis and prior Cesarean section. Ultrasound Obstet Gynecol. 2006; 28(2): 178–182, doi: 10.1002/uog.2797, indexed in Pubmed: 16858740.