

Diagnosis of Placenta Accreta Spectrum: Review Article

Mohamed Ahmed Abdellah*¹, Yasser Ahmed Helmy¹,

Hazem Mohamed Mohamed¹, Doaa S. M. Bardis², Mohamed Hasan Alameldin³

Departments of ¹Obstetrics and Gynecology, ²Clinical and Chemical Pathology and ³Radiology,
Faculty of Medicine, Sohag University, Egypt

*Corresponding author: Mohamed Ahmed Abdellah, Mobile: (+20) 01098437456,

E-Mail: mohamedabdelaah@med.sohag.edu.eg

ABSTRACT

Background: Placenta accreta is defined as abnormal trophoblast invasion of part or all of the placenta into the myometrium of the uterine wall. Placenta accreta spectrum, formerly known as morbidly adherent placenta, refers to the range of pathologic adherence of the placenta, including placenta increta, placenta percreta, and placenta accreta. Maternal morbidity and mortality can occur because of severe and sometimes life-threatening hemorrhage, which often requires blood transfusion. Rates of maternal death are increased for women with placenta accreta spectrum.

Objective: The purpose of this review was to highlight diagnosis by magnetic resonance imaging (MRI) and ultrasonographic of the presence of placenta accreta spectrum (PAS).

Methods: These databases were searched for articles published in English in 3 data bases [PubMed – Google scholar-science direct] and Boolean operators (AND, OR, NOT) had been used such as [Diagnosis of Placenta Accreta and Placenta Accreta Spectrum OR PAS] and in peer-reviewed articles between June 2005 and February 2021. Documents in a language apart from English have been excluded as sources for interpretation was not found. Papers apart from main scientific studies had been excluded: documents unavailable as total written text, conversation, conference abstract papers and dissertations.

Conclusion: The timely diagnosis of abnormal placentation is of great importance since, the earliest diagnosis implies less risky, less costly and successful management. Ultrasonography may successfully achieve this goal. Furthermore, MRI imaging, in cases of diagnostic dilemmas may be particularly useful and lead to safer and more precise diagnosis.

Keywords: Diagnosis of Placenta Accreta, MRI, Ultrasonography.

INTRODUCTION

The recent rapid increase in caesarean delivery (CD) rates has changed the epidemiology of placenta accreta spectrum (PAS) worldwide from a rare, serious, pathological condition to an increasingly common major obstetric complication. The risk of placenta previa increases following CD, and women presenting with a low lying/placenta previa and history of CD are at the highest risk of PAS (previa PAS) ⁽¹⁾.

Historical background:

Placenta accreta was first described nearly 80 years ago as a clinicopathological condition in which the placenta fails to separate partially or totally from the uterine wall. It was first described in 1937 by obstetrician Frederick C. Irving and pathologist Arthur T. Hertig at the Boston Lying-In Hospital ⁽²⁾.

Definition:

Placenta accreta is defined as abnormal trophoblast invasion of part or all of the placenta into the myometrium of the uterine wall ⁽³⁾. Abnormal placentation includes both abnormally adherent

placenta (placenta accreta) and abnormally invasive placenta (AIP – including placenta increta and placenta percreta); the term PAS encompasses the whole spectrum of the disorder (Figure 1).

In abnormally adherent placenta the implantation of the villi is in direct contact with the myometrium in the absence of an obvious plane of cleavage. In abnormally invasive placentation, the villi invade deeply the myometrium, and cannot be easily removed either manually or by curettage.

The result of different, sometimes incorrect, diagnostic criteria is a wide variability in the reported predictive value of antenatal imaging strategies, and the outcomes associated with different management strategies. Maternal morbidity and mortality can occur because of severe and sometimes life-threatening hemorrhage, which often requires blood transfusion and the rates of maternal death are increased for women with placenta accreta spectrum. Additionally, patients with placenta accreta spectrum are more likely to require hysterectomy at the time of delivery or during the postpartum period and have longer hospital stays ⁽⁴⁾.

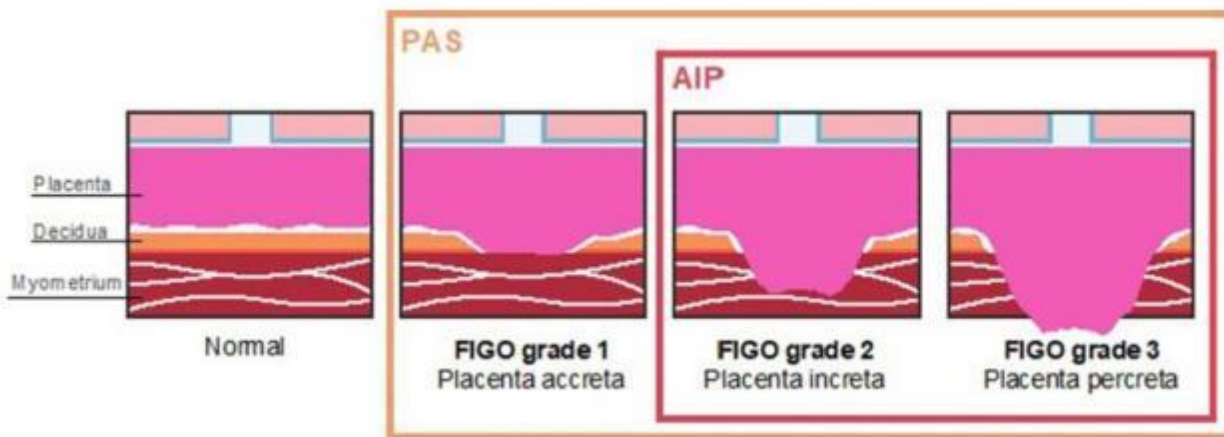


Figure (1): Illustration demonstrates the pathophysiology and subtypes of the placenta accreta spectrum. PAS includes both abnormally adherent placenta (placenta accreta) and abnormally invasive placenta (AIP – including placenta increta and placenta percreta). In the abnormally adherent placenta the implantation of the villi is in direct contact with the myometrium in the absence of an obvious plane of cleavage, while in the AIP the villi invade deeply into the myometrium and surrounding organs. Federation of Gynecology and Obstetrics (FIGO) defines these as grades 1, 2, and 3 ⁽⁵⁾.

Incidence:

Rates of placenta accreta spectrum are increasing. Observational studies from the 1970s and 1980s described the prevalence of placenta accreta as between 1 in 2,510 and 1 in 4,017 compared with a rate of 1 in 533 from 1982 to 2002 ⁽⁶⁾. A 2016 study conducted using the National Inpatient Sample found that the overall rate of placenta accrete in the United States was 1 in 272 for women who had a birth related hospital discharge diagnosis, which is higher than any other published study. The increasing rate of placenta accreta over the past four decades is likely due to a change in risk factors, most notably the increased rate of cesarean delivery ⁽⁷⁾.

Risk Factors:

There are several risk factors for placenta accreta spectrum. The most common is a previous cesarean delivery, with the incidence of placenta accreta spectrum increasing with the number of prior cesarean deliveries ⁽⁸⁾. In a systematic review, the rate of placenta accreta spectrum increased from 0.3% in women with one previous cesarean delivery to 6.74% for women with five or more cesarean deliveries ⁽⁹⁾. Additional risk factors include advanced maternal age, multiparity, prior uterine surgeries or curettage, and Asherman syndrome. Placenta previa is another significant risk factor. Placenta accreta spectrum occurs in 3% of women diagnosed with placenta previa and no prior cesarean deliveries. In the setting of a placenta previa and one or more previous cesarean deliveries, the risk of placenta accreta spectrum is dramatically increased. For women with placenta previa, the risk of placenta accreta is 3%, 11%, 40%, 61%, and 67%, for the first, second, third, fourth, and fifth or more cesarean, respectively ⁽¹⁰⁾.

Moreover, abnormal results of placental biomarkers increase the risk of placenta accreta

spectrum. For example, unexplained elevation in maternal serum alpha fetoprotein is associated with an increased risk of placenta accrete spectrum. However, maternal serum alpha fetoprotein is a poor predictor of placenta accreta spectrum and is not accurate enough to be clinically useful ⁽¹¹⁾. Other placental analytes linked to placenta accreta spectrum include pregnancy-associated plasma protein A, pro B-type natriuretic peptide, troponin, free b-hCG (mRNA), and human placental lactogen (cell-free mRNA) ⁽¹²⁾. In addition, other proposed markers of aberrant trophoblast invasion, such as total placental cell-free mRNA, may be associated with placenta accreta spectrum. As with alpha fetoprotein, they are too nonspecific for clinical use ⁽¹³⁾.

Etiology and Pathophysiology:

The most favored hypothesis regarding the etiology of placenta accreta spectrum is that a defect of the endometrial-myometrial interface leads to a failure of normal decidualization in the area of a uterine scar, which allows abnormally deep placental anchoring villi and trophoblast infiltration. Several studies suggest that disruptions within the uterine cavity cause damage to the endometrial-myometrial interface, thereby affecting the development of scar tissue and increasing the likelihood of placenta accreta. However, this explanation fails to explain the rare occurrence of placenta accreta spectrum in nulliparous women without any previous uterine surgery or instrumentation ⁽¹⁴⁾.

Diagnosis of Placenta Accreta Spectrum:

1-Ultrasonographic assessment:

The prenatal detection and risk stratification for PAS are primarily made by ultrasound. However, ultrasound is an operator-dependent imaging modality with substantial variability in image quality among

providers. Furthermore, placental location and challenging imaging conditions, including elevated body mass index (BMI) or posterior placentation, may impede the sonographic detection of PAS markers. There has been limited consensus on the optimal approach to the ultrasound evaluation of patients at risk of PAS, such as the appropriate timing of screening, need for transvaginal ultrasound (TVUS) imaging, use of color and pulsed Doppler, angle of placental insonation, and equipment settings. Despite a large body of literature on various PAS ultrasound markers and their screening performance, important inconsistencies in screening results persist. This is primarily because of the retrospective design of most studies, lack of standardized definitions of PAS markers, lack of agreement on the optimal gestational age for assessment, and inconsistencies in the approach to the ultrasound evaluation of the placenta (15).

Furthermore, patients' a priori risks have a significant influence on the positive predictive value (PPV) of PAS markers. Recent data have shown that

these markers are frequently present in women at low risk for PAS (16).

In response to the need for standardizing the definitions of PAS markers and the approach to the ultrasound examination, the Society for Maternal-Fetal Medicine (SMFM) convened a task force with the goals of assessing PAS sonographic markers on the basis of available data and expert consensus, providing a standardized approach to the prenatal ultrasound evaluation of the uterus and placenta in pregnancies at risk of PAS, and identifying research gaps in the field (17).

As outlined in a recent Obstetrics Care Consensus, ultrasound is the primary screening modality for PAS. Ultrasound markers of PAS can be seen early in the first trimester, although historically screening is predominantly performed in the second and third trimesters of pregnancy (17). The ultrasound marker with the strongest association with PAS is a persistent placenta previa at the time of delivery, in the setting of a previous cesarean delivery (18) (Figure 2).

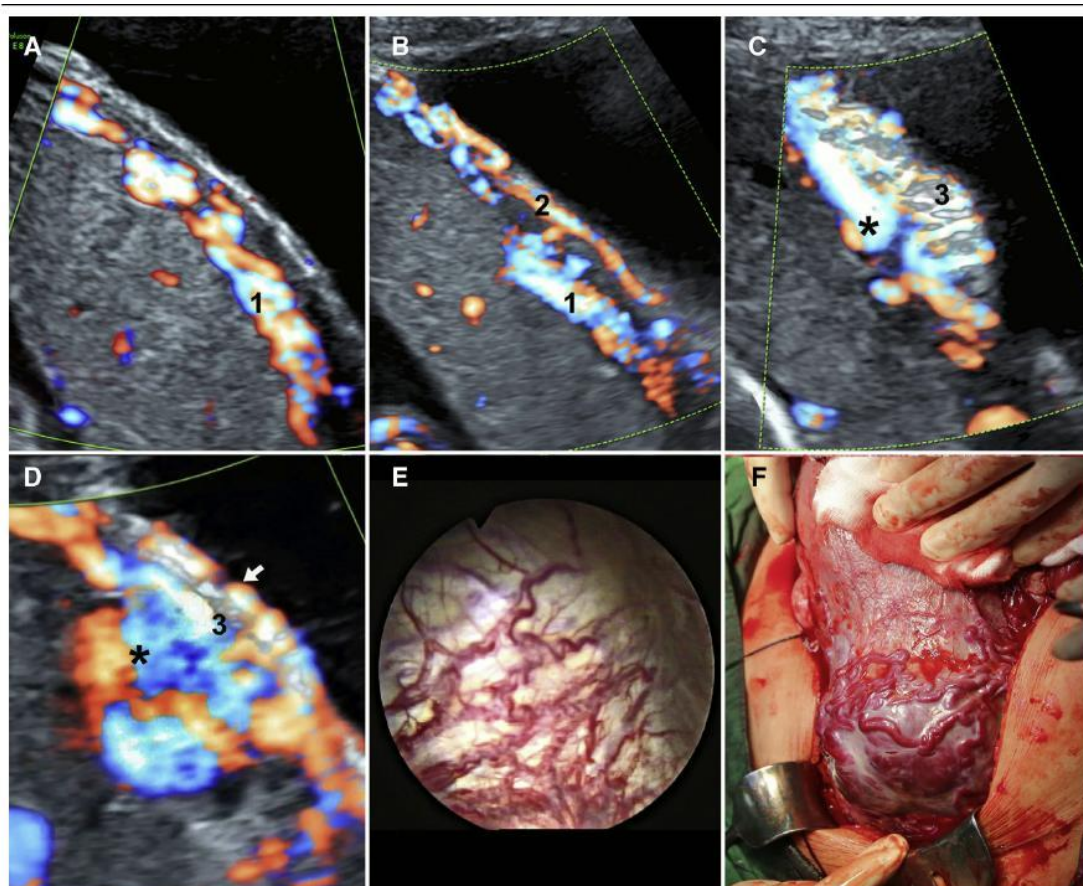


Figure (2): Sonographic assessment of placenta accreta. A, B, Color Doppler ultrasound examination for a patient with placenta previa creta. A, In this patient, only subplacental hypervascularity (indicated by “1”) existed at 30 weeks’ gestation. B, The uterovesical hypervascularity (indicated by “2”) appeared only after 33 weeks’ gestation; C, E, D, Color Doppler interrogation for a patient with placenta previa percreta and bladder invasion at 34 weeks’ gestation. C, Numerous newly formed, coral-shaped vessels (indicated by “3”) extended perpendicularly from the placenta to the bladder mucosa (so-called bridging vessels). D, The subplacental and uterovesical hypervascularity merged (indicated by an asterisk) and even progressed into an aneurysm. The parallel subplacental or uterovesical hypervascularity and neovascularization of the bladder mucosa (indicated by a short arrow), together with interconnected bridging vessels indicated by “3”, constitute the “rail sign” in (D). (E) and (F) were the corresponding images from cystoscopy and surgical findings of the patients in (C) and (D) (19).

2- MRI assessment:

Typically, PAS is clinically suspected based on well-known risk factors and is screened for during the second trimester with ultrasound (US). Diagnosing PAS involves recognizing multiple imaging signs that reflect the underlying pathophysiology⁽²⁰⁾. Magnetic Resonance Imaging (MRI) is being increasingly used both as a diagnostic adjunct and for pre-procedural planning. However, the MRI literature on PAS is fraught with disparate but conceptually overlapping MRI signs. Recently released SAR-ESUR (Society of Abdominal Radiology and European Society of Urogenital Radiology) consensus statement is a major step in harmonizing MRI research on PAS. The statement proposes a common lexicon to allow for uniformity in MRI acquisition, interpretation, and reporting of PAS disorders and endorses the additive value of MRI over ultrasound, especially in fully characterizing the topography and depth of placental invasion⁽²¹⁾.

MRI and US are both non-invasive and non-ionizing imaging modalities and have unique technical and practical advantages with respect to imaging the placenta. Importantly, the advantages of one modality befittingly complement the drawbacks of the other⁽¹⁴⁾.

Major advantages of US over MRI, are (i) higher spatial and temporal resolution, (ii) dynamic vascular interrogation with Doppler, and (iii) feasibility of intraoperative use. The drawbacks of US including operator dependence and limited penetration/field of view are overcome by reproducible large field of view imaging with MRI⁽²²⁾. The most appealing advantage of MRI is its higher contrast resolution and tissue specific characterization allowing visualization of the entire placental-myometrial interface in fine detail. MRI is also superior for presurgical assessment of extra-uterine invasion of adjacent organs and delineating critical iliac vasculature. Limited availability and high cost are well-known challenges with MRI⁽¹⁴⁾.

Planning the imaging plane, field of view, and degree of urinary bladder distension are key for achieving diagnostic grade images. Irrespective of the imaging modality being used, it is critical to orient the imaging plane perpendicular to the focal point of the disease process: the placental myometrial interface (PMI). However, this is not always possible with every sequence and therefore careful planning is needed to prioritize key sequences to be obtained perpendicular to the PMI. Moderate urinary bladder distention is recommended. While an under distended bladder can cause loss of proper visualization of the interface, and overdistension leads to stretching and compaction of the posterior bladder wall against the placenta making it prone to overdiagnosis of PAS. Key MRI sequences and their specific utility in PAS diagnosis are provided below to help understand the subsequent section on MRI signs. Although no published literature compares the role of 3 Tesla (T) to conventional 1.5 T MRI, 1.5 T magnets are sufficient for clinical diagnosis and have longstanding evidence for safety in pregnancy⁽¹⁴⁾.

A typical MRI PAS-protocol involves three essential sequences: T2 weighted Single Shot Fast Spin Echo (SSFSE; black blood), predominantly T2 weighted Steady State Free Precession (SSFP; bright blood) and T1 weighted Fast Saturated (T1FS). T2 weighted imaging is key to identifying and evaluating the PMI. SSFSE is the workhorse for interrogating the intrinsic signal of the placenta, the SSFP sequence often helps reduce overall motion artifacts and provides better delineation of the placental myometrial interface and the bladder myometrial interface. T1FS sequence is essential for the purposes of identifying subchorionic hemorrhage. The average time for a placenta protocol MRI is about 20–30 min. Although not routinely recommended “feet-first” approach and lateral decubitus positioning can often help allay patient apprehension related to claustrophobia and improving patient comfort. Although MRI contrast agents have been shown to improve PMI conspicuity, their use is neither required or recommended for PAS diagnoses. Gadolinium-based MRI contrast agents cross the placental-fetal barrier and belong to Food and Drug Administration (FDA) Category C. However, if the patient makes the decision to discontinue the pregnancy, contrast enhanced MRI can be considered⁽²³⁾.

A mature decidual reaction occurs at the site of implantation and provides an effective uteroplacental vascular communication by way of controlled chorionic villous invasion. A definitive placenta is formed by the end of the first trimester (12–16 weeks). During the late second trimester the placenta develops regularly spaced thin septations dividing the placenta into individual cotyledons (24–31 weeks)⁽²⁴⁾.

On ultrasound, the placenta may display variable echogenicity based on technical factors but is typically more echogenic in comparison to the hypoechoic subplacental myometrial layers, together termed as the subplacental clear space/zone (SCZ). A continuous and smooth SCZ is the hallmark of normal placentation and its absence is the principal finding in PAS. Placental echotexture progressively becomes heterogeneous with increasing gestational age. Placental vascularity is readily amenable to color and spectral Doppler interrogation⁽²⁴⁾.

On MRI, the normal first to second trimester placenta is typically homogeneously intermediate T2 intensity in contrast to the homogenous low T2 intensity of the myometrial layer. T1 weighted does not allow differentiation of these two structures. The optimal gestational age for diagnosing PAS using MRI is 24–30 weeks⁽²⁵⁾. Beyond 30 weeks, the placenta becomes increasingly bulky and heterogenous as the internal cotyledonous architecture starts to manifest on imaging. The mass effect of the growing fetus and bulky placenta causes thinning of the overlying myometrium with poor perceptibility of the PMI. Although developing placental vasculature (seen as flow voids) also parallels increasing gestational age, the vessels are largely located around the cord insertion in normal placentation⁽²⁵⁾ (Figure 3).

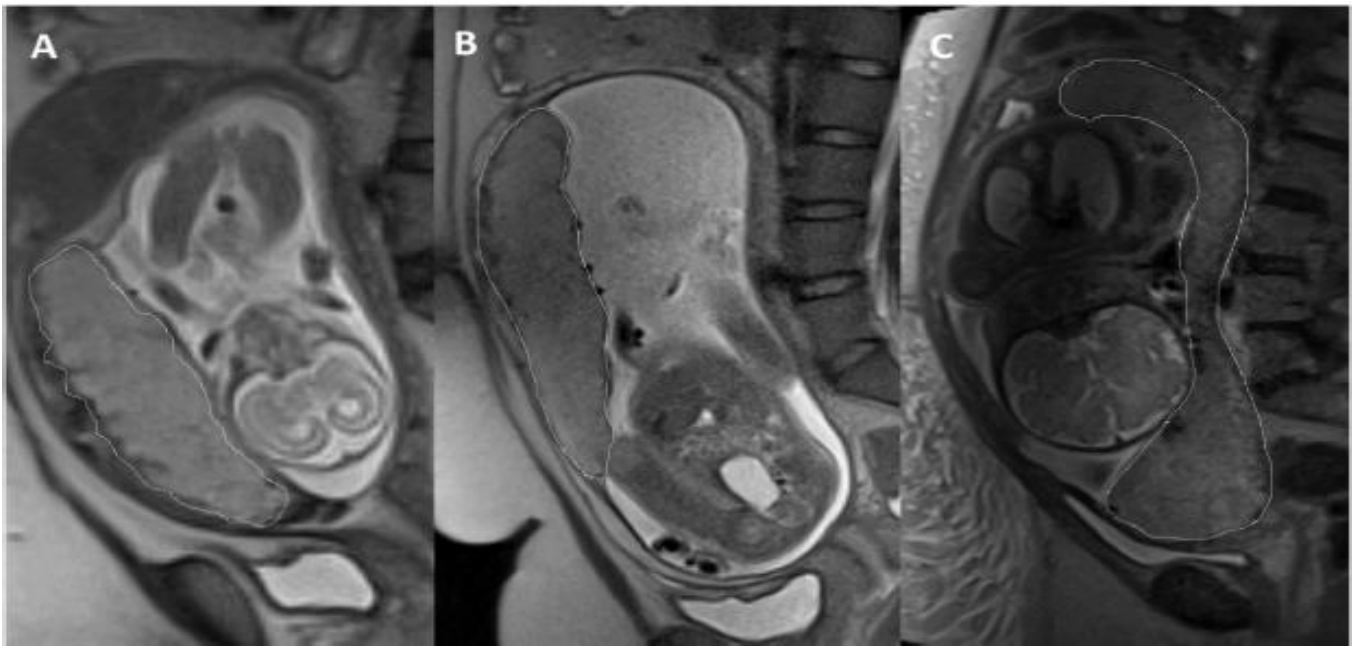


Figure (3): Normal placenta on MR. Sagittal view MRI of the placenta (dashed white line) in the first (A), second (B) and third (C) trimester demonstrating progressively increased heterogeneity ⁽²⁶⁾.

Typically, PAS is often suspected when a low-lying placenta is seen in a patient with pertinent clinical risk factors at routine second trimester (18-20 weeks) antenatal ultrasound screening. Ultrasound has a high negative predictive value for PAS in experienced hands, which perfectly suits its role as a screening modality ⁽¹⁴⁾. If US findings are equivocal, especially in cases of posterior/lateral placenta, and large patient body habitus, diagnostic MRI between 24 and 30 weeks is used as an adjunctive tool for confirmation. Even though US and MRI have shown comparable overall diagnostic accuracy and most recent FIGO recommendations state MRI to be “not essential, a trend towards increased utilization of and greater reliance on MRI for diagnostic confirmation is noticeable in tertiary care centers of excellence ⁽¹⁴⁾.

The recent release of the International Federation of Gynecology and Obstetrics (FIGO) guidelines in 2018 coupled with the joint consensus statement from the Society of Abdominal Radiology (SAR) and European Society of Urogenital Radiology (ESUR) in 2020 reflect decades worth of diagnostic and therapeutic advances in this field ⁽²¹⁾. Although the increasing role of MRI in PAS diagnosis is evident, the literature on PAS reveals several disparate but conceptually overlapping MRI signs. Identifying and differentiating between placenta increta and percreta on imaging may be quite challenging even with MRI and sometimes even on final pathology. Below, in a comprehensive review **Kapoor et al.** ⁽²⁶⁾ subcategorize the whole range of known MRI signs based on underlying pathophysiologic alterations into (i) Gross morphologic signs; (ii) Interface signs; and (iii) Tissue architecture signs. Seven of these signs achieved strong consensus recommendation (80%) in the recent SAR-ESUR publication whereas four others were assigned an

uncertain“ category where the data was considered subthreshold for recommendation” ⁽²¹⁾.

Management:

The antenatal diagnosis of placenta accreta spectrum is critical because it provides an opportunity to optimize management and outcomes. Optimal management involves a standardized approach with a comprehensive multidisciplinary care team accustomed to management of placenta accreta spectrum ⁽²⁷⁾. Such an approach most frequently includes having an identified team available for early collaboration. This team will likely include, but is not limited to, experienced obstetricians and maternal-fetal medicine subspecialists, pelvic surgeons with advanced expertise (often, but not exclusively, gynecologic oncologists or female pelvic medicine and reconstructive surgeons), urologists, interventional radiologists, obstetric anesthesiologists, critical care experts, general surgeons, trauma surgeons, and neonatologists. In addition, established infrastructure and strong nursing leadership accustomed to managing high-level postpartum hemorrhage should be in place, and access to a blood bank capable of employing massive transfusion protocols should help guide decisions about delivery location. Delivery in highly experienced maternity centers that have this type of coordinated care team and the ability to garner additional expertise and resources in cases of severe hemorrhage appears to improve outcomes ^(27,28). Perhaps no condition fits this conceptual framework more than antenatally diagnosed placenta accreta spectrum ⁽²⁷⁾.

CONCLUSION

Pathological placentation is a serious problem, unfortunately, in the last years, there has been an

increasing incidence of this condition, which could be mainly attributed to the increase of cesarean sections. The timely diagnosis of abnormal placentation is of great importance since, the earliest diagnosis implies less risky, less costly and successful management. Ultrasonography may successfully achieve this goal. Furthermore, MRI imaging, in cases of diagnostic dilemmas may be particularly useful and lead to safer and more precise diagnosis. Early prenatal diagnosis is the most important strategy to prevent the adverse outcome of pregnancy with abnormally invasive placenta as it offers the attending physician available time to optimize the preoperative planning, have a birth plan that could properly assess the expected blood loss and other complications of childbirth, thus, minimize maternal morbidity and mortality.

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