Abnormal Invasive Placentation: Ultrasonographic Diagnosis

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PAS disorders (placenta accreta spectrum disorders) include a heterogeneous group of anomalies characterized by an abnormal adhesion or invasion of the trophoblastic tissue into the myometrium. Three forms of placentation anomalies can be identified by histological examination according to depth of trophoblastic invasion into the myometrium [1]:

- Placenta accreta (or adherent), when chorionic villi attach to the myometrium without invading it.
- Placenta increta, when villi invade the myometrium.
- Placenta percreta, when villi invade through the myometrium reaching the uterine serosa.

The placenta of the same patient can be characterized by different degrees of invasion depth.

PAS disorders are further distinguished into focal, partial, or total: such classification depends on the lateral extension of the myometrial invasion and the number of involved cotyledons.

There is not a specific clinical symptomatology of PAS, and in many forms of acretism, there is not bleeding during the gestation. So, we must suspect its presence if there are risks factors. They include placenta previa, advanced maternal age, multiparity, techniques of in vitro fertilization, adenomyosis, previous uterine surgery, and particularly cesarean sections, above all if associated with placenta previa. Their increasing rate has caused a progressive rising incidence of PAS disease in the last decades.

Incidence is highly variable, according to the kind of analyzed population and the pattern of PAS disorder considered. In 2013 a systematic review [2] reported 19% of incidence in women with high risk for this condition that is to say women with anterior placenta previa diagnosed in the third trimester and previous cesarean section.

When the diagnosis of abnormal invasive placentation is made intrapartum, without a previous diagnosis or suspect, it can lead to catastrophic consequences for the patient. This condition exposes to a big risk of intra- and peripartum complications, including severe hemorrhages with possible necessity of hysterectomy and massive blood transfusions. So an accurate prenatal diagnosis (or at least a suspect) is required to reduce the risk of maternal and fetal morbidity and mortality. Prenatal diagnosis allows to plan the timing of delivery, to ensure the presence of a multidisciplinary team with adequate experience, to organize the availability of compatible blood, and to consider the various therapeutic options according to the surgical difficulties and the eventual desire of patient of preserving fertility.

The most recent data of literature indicate that a woman with low-lying or previa anterior placenta and a story of one or more previous cesarean sections should be directed to a reference center for diagnosis and management of PAS disorders [1].

To date ultrasonography is the most employed imaging technique in prenatal diagnosis of such anomalies.

In 2016 a group of experts has published a consensus proposing standardized ultrasound criteria, in the attempt of reducing diagnostic errors linked to the subjective interpretation of the exam [3]:

- *Loss of clear space:* absence or irregularity of the hypoechoic retroplacental area between myometrium and placenta (clear zone). This area coincides with the vessels of the decidua basalis, and its absence or irregularity is related to the insufficient presence of these vessels. Even if it is evident since the 12th week of gestation, sometimes the clear space is not well viewable also in cases of placenta not accreta, especially if it is implanted on the anterior wall of the uterus. Some authors studied the efficacy of clear space as single diagnostic criterion, highlighting

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a high rate of false positives [4]. Comstock suggested that an altered representation of the clear space, above all in case of anterior placenta, could depend on the pressure employed on the probe during the examination [5]. However, the high negative predictive value and sensitivity legitimize the use of this criterion in the ultrasound diagnosis of acretism, in association with other criteria [2, 6] (Fig. 44.1).

- *Placental vascular lacunae:* presence of numerous lacunae (more than three), some of which wide and irregular, in placental parenchyma. They often are characterized by turbulent flow visible with grayscale or color Doppler ultrasound, with high speed and low resistance [7]. The exact histogenetic course is not totally clear: it seems that in case of acretism, the increasing vascularization and the abnormal placental insertion could represent mechanical causes of intraplacental disruption with consequent formation of lacunae [8] (Fig. 44.2).

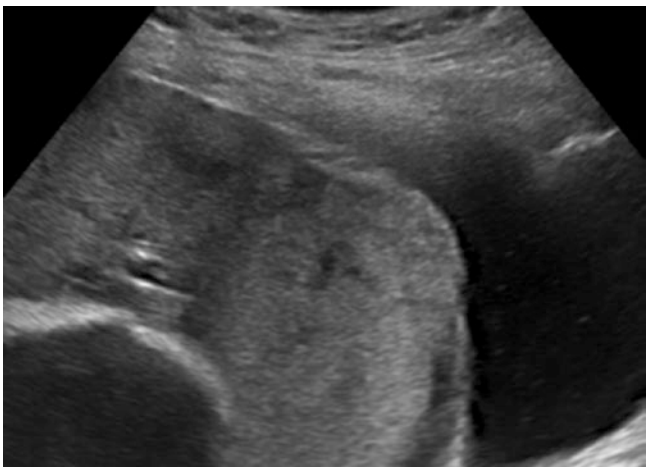

Fig. 44.1 Loss of the clear zone: absence of the clear space between the myometrium and placenta

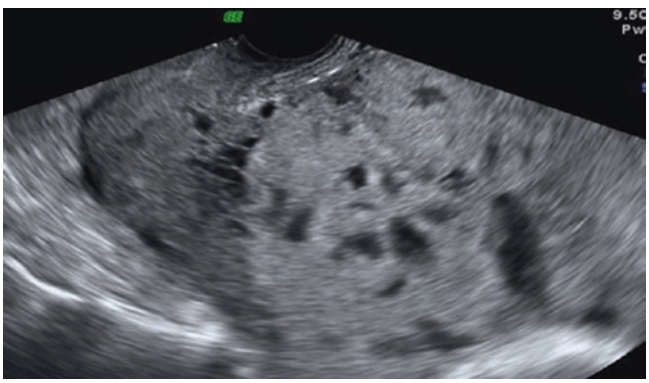

Fig. 44.2 Intraparenchymal placental lacunae in a woman with placenta previa and previous cesarean section, strongly suggestive of PAS disorder

- *Interruption of vesical wall:* loss or interruption of the hyperechoic line between uterine serosa and bladder lumen (bladder line). Uterus-bladder interface is better visible when bladder is partially filled and the probe is positioned at 90° in respect to its wall [8]. Interruption or thinning of the bladder line depends on the neovascularization in the space under the urothelium of the posterior vesical wall. Calì et al. proved that sensitivity of bladder line interruption was 70% with grayscale ultrasound, but it reaches 90% with color Doppler ultrasound [7]. The presence of a chaotic vascularization with confluent and tortuous vessels seems to represent the best single diagnostic criterion, with sensitivity and sensibility of 97% and 92%, respectively [6]. However, to date, there is not a single diagnostic criterion which has high confidence in order to diagnose or exclude placental acretism (Fig. 44.3).
- *Myometrial thinning:* reduction in myometrial thickness, which appears <1 mm or undetectable. Myometrial thickness is measured in correspondence of the inferior uterine segment, between the bladder wall and the retroplacental vessels, visualized with the use of color Doppler (Fig. 44.4).
- *Placental bulge:* deformation of the uterine serosa caused by abnormal protrusion of placental tissue toward adjacent organs, especially the bladder. Uterine serosa appears intact, but outline shape is distorted (Fig. 44.5).
- *Focal exophytic mass:* placental tissue seen breaking through uterine serosa and extending beyond it. It is visible if the bladder is full and is mainly related to the most severe forms of PAS.
- *Uterovesical hypervascularity:* striking amount of color Doppler signal seen between myometrium and posterior bladder wall, showing numerous, closely packed, tortuous vessels with multidirectional flow and aliasing.
- *Subplacental hypervascularity:* striking amount of color Doppler signal in placental bed, showing numerous,

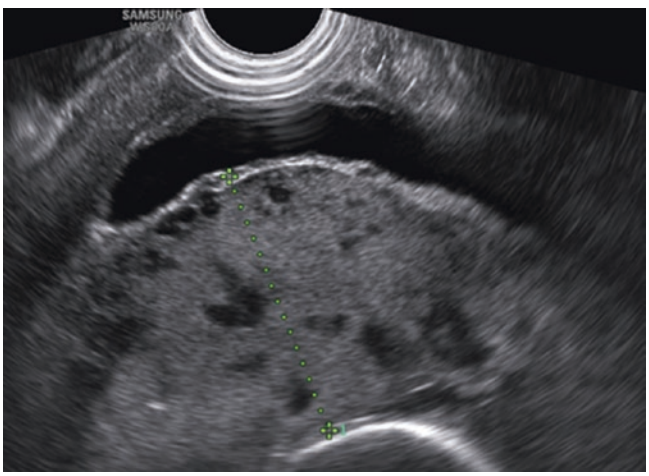

Fig. 44.3 Bladder wall interruption and numerous placental lacunae

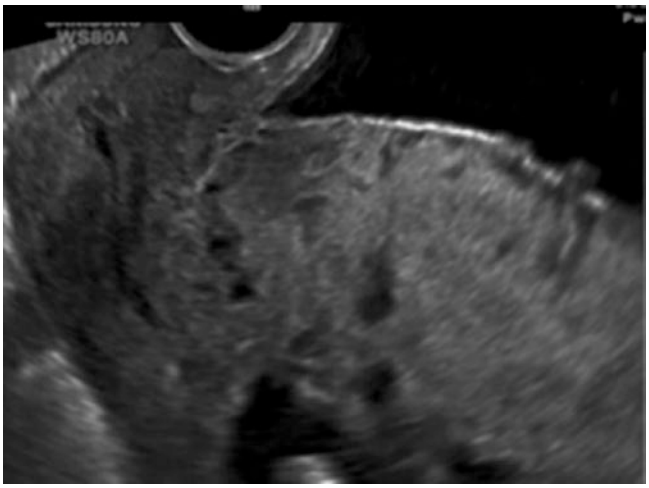

Fig. 44.4 Reduction in myometrial thickness

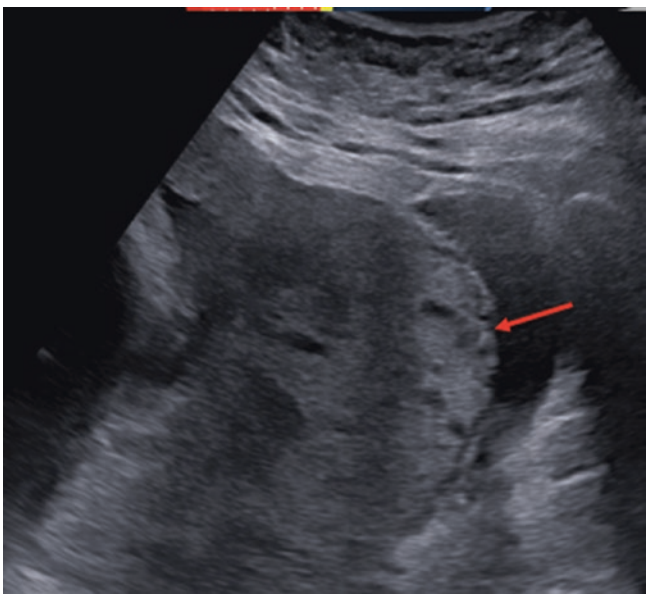

Fig. 44.5 Placental bulge, protrusion of the uterine serosa toward the bladder lumen

closely packed, tortuous vessels with multidirectional flow and aliasing.

- *Bridging vessels:* vessels appearing at color Doppler to extend from the placenta, across the myometrium, and beyond the serosa into the bladder or other organs. They are often perpendicular to the myometrium.
- *Intraplacental hypervascularization:* numerous irregular placental vessels, with tortuous course and variable caliber, showed with 3D color Doppler.

In a meta-analysis of 2013 [2], the loss of clear zone showed sensibility of 66.2% and sensitivity of 77.4%; placental lacunae had sensibility of 77.4% and sensitivity of 95%; anomalies of bladder line had sensibility of 49.6% and sensitivity of 99.7%. Gray-scale and color Doppler ultrasound showed in total sensibility of 90.7% and specificity of 96.9%.

Another meta-analysis of 2017 [9] about cases with placenta previa and previous cesarean sections observed sensibility of 97% and sensitivity of 97% when the exam was made by expert operators, in prospective studies. Instead in retrospective studies, the diagnostic accuracy of ultrasound was inferior, with sensitivity of 88% and specificity of 90%. Moreover, some authors highlighted that in one third of cases, prenatal diagnosis of PAS has not been carried out even in third level centers [10].

A recent prospective longitudinal study of 2018 [11] observed that ultrasound has an excellent diagnostic accuracy if applied to high-risk population, with sensitivity and specificity of 100%. Particularly, the specificity of the exam increases if more diagnostic criteria are used. Probably the increased awareness of the pathophysiology of PAS disorders, the greater attention to the selection of patient at risk, the improvement of ultrasound technology, and the bigger experience of operators led to these important results in the last years.

In consideration of the variability of available data, further efforts will be necessary to achieve a definitive identification of ultrasound and Doppler signs and of their combination to reach a wide diagnostic optimization.

Recently a new imaging sign has been introduced in order to identify women affected with PAS disorders and predict outcomes: *intracervical lakes*, defined as tortuous anechoic spaces within the cervix which appear hypervascularized at color Doppler. A retrospective multicentric study on women with placenta previa observed that intracervical lakes were independently associated with major postpartum hemorrhage, hysterectomy, and placenta percreta, representing a marker of deep villus invasiveness in women with suspected PAS and anticipating the occurrence of severe maternal morbidity [12] (Fig. 44.6).

Although 2D ultrasound is the standard technique in diagnosis of PAS disorders, it is useful to employ all the available diagnostic instruments, such as 3D ultrasound and 3D power Doppler.

3D power Doppler, with its ability to acquire multiplanar images on coronal, axial, and sagittal planes and by rotational technique, permits to visualize more accurately the placenta-bladder interface, thus representing an important exam complementary to 2D ultrasound. It became an instrument of frequent use in the study of placenta development and vascularization, allowing a better study of the degree of bladder invasion. Obviously, this information is very important for counseling and management. Some authors, using 3D color power Doppler, demonstrated that the hypervascularization of the uterine-bladder interface was extended from side to side in all cases of placenta percreta they examined,

Fig. 44.6 Intracervical lakes

with sensitivity, specificity, negative predictive value, and positive predictive value of 90, 100, 100, and 97%, respectively [7].

The sonographic signs described are usually visualized transabdominally, examining the inferior uterine segment from one side to the other keeping the probe perpendicular to it. Transvaginal ultrasound is recommended to identify the internal uterine orifice and its proximity to placental edge. Moreover, it is supportive in the accurate evaluation of the lower uterine segment and the utero-bladder interface.

During the ultrasound examination, the bladder must be filled with about 200–300 cc; otherwise some signs cannot be adequately studied, above all interruption of the bladder line, placental bulge, and utero-bladder hypervascularization.

Excessive pressure on the probe must be avoided, as it could cause the apparent loss of the retroplacental clear zone. Instead, the effective absence of this space is well evaluated with a light pressure on the probe.

Ultrasonography increases its diagnostic power when performed by operators with experience in the evaluation of PAS disorders. Therefore, it is opportune to emphasize again the indication to refer patients at risk to the reference centers for such anomalies.

The histological classification in placenta accreta, increta, and percreta is based on the depth of trophoblastic invasion of the myometrium. Despite its importance, this classification is performed after delivery, and it cannot be used to counsel women prenatally. Moreover, there might be high variability in the surgical outcome even in women presenting with the same depth of placenta invasion. A recent ultrasound staging system for PAS disorders has been proposed to stratify the risk of surgical outcome before birth [13].

Ultrasound criteria used for staging have been:

1. Loss of clear zone.
2. Placental lacunae.
3. Bladder wall interruption.
4. Uterovesical hypervascularity.
5. Increased vascularity in the parametrial region, defined as the presence of hypervascularity extending beyond the lateral uterine walls and involving the region of the parametria [14].

Authors have proposed the following classification of PAS based upon the distribution of the different ultrasound signs in women presenting with placenta previa:

PAS 0: Placenta previa with no US signs of invasion or placenta previa with placental lacunae but no evidence of abnormal uterine-bladder interface (loss of the clear zone and/or bladder wall interruption) (Fig. 44.7)

PAS 1: Presence of at least two ultrasound signs among:

- Placental lacunae
- Loss of the clear zone
- Bladder wall interruption

PAS 2: PAS 1 + uterovesical hypervascularity (Fig. 44.8)

PAS 3: PAS1/PAS2 + evidence of increased vascularity in the inferior part of the lower uterine segment extending in the parametrial region (Fig. 44.9)

Increased severity in staging resulted independently associated with a significant increase in estimated blood loss, units of packed red blood cells, fresh frozen plasma, platelets

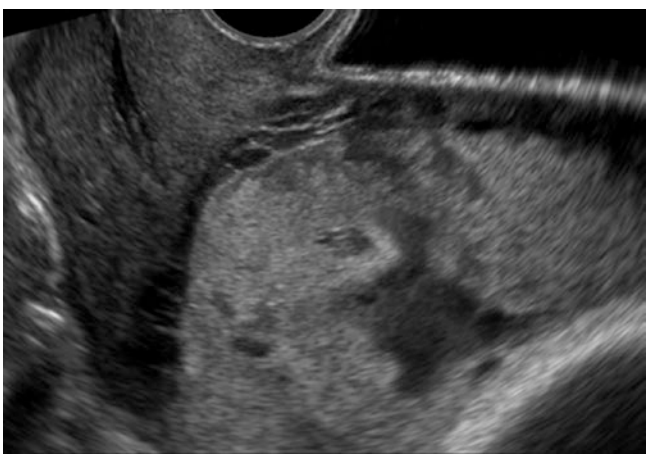

Fig. 44.7 PAS 0: Placenta previa with no ultrasound signs of invasion (normal clear space and normal bladder line)

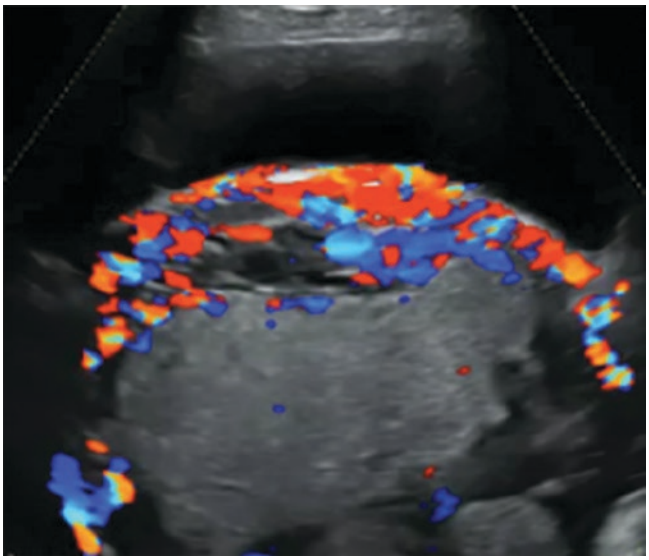

Fig. 44.8 PAS 2: Color Doppler showing uterovesical hypervascularity

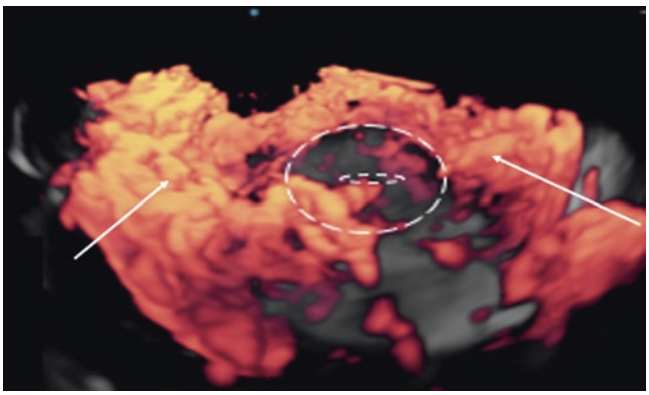

Fig. 44.9 PAS 3: Transvaginal axial scan: parametrial vascular invasion (arrows)

transfused, surgical time, length of in-hospital stay, and surgical complications. All women in PAS 1 had placenta accreta or increta, while those with PAS 2 and PAS 3 had exclusively placenta percreta. Despite presenting with the same depth of placental invasion, women with PAS 3 were at significantly higher risk of hemorrhage and need for transfusion compared with PAS 2.

These results confirm that depth of placental invasion cannot completely stratify the surgical risk of women affected by PAS disorders. Topography of placental invasion is another fundamental aspect which determines surgical morbidity. Invasions in the inferior third of lower uterine segment, posterior bladder wall, and parametria imply a high risk of surgical morbidity, while upper invasions are commonly associated with a more favorable clinical outcome and a relatively easier vascular control during surgery [15]. Therefore, ultrasound evidence of increased vascularization in parametrial regions and in the inferior part of the lower uterine segment identify preoperatively a group of PAS disorders at higher risk, allowing a better planning of surgical management.

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