Chapter 5
Classification of Placenta Accreta Spectrum

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Introduction

Placenta accreta spectrum (PAS) is the term that describes the pathologic adherent of the placenta into the uterine wall without intervening decidua or basalis layer. The main mechanical risk factor of PAS is the cesarean section, curettage, or in vitro fertilization (IVF), and this is consistent with the possible cause of endometrial defect which leads to PAS in the next pregnancy [1, 2].

PAS is a heterogeneous condition associated with a high maternal morbidity and mortality rate, presenting unique challenges in diagnosis and management. It is caused by the lack of a standardized approach in reporting PAS cases for the ultrasound, clinical, and pathologic diagnosis [3]. PAS has many controversies and one of them is about the pre-, intra-, and postsurgical classification [4].

In the past, the diagnosis of placental implantation was only based on histopathology findings of cesarean hysterectomy, but several considerations related to uterine conservative surgery and the risk of bleeding during cesarean hysterectomy have made uterine conservative surgery an option in the management of PAS.

The traditional category only uses the terminologies placenta accreta, increta, and percreta based on histopathology and does not describe clinical criteria at the time of surgery. This traditional classification describes accreta invasion as placental villi adhering to the underlying myometrium, without an intervening layer of decidua, increta invasion as placental villi invading into the myometrial wall, and percreta invasion as placental villi invading through the full thickness of the

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myometrial wall to involve the uterine serosa [5, 6]. This traditional classification does not reflect the complexity of the surgery, and one placenta can have a different type of invasion and is highly dependent on sampling technique, so this classification has many weaknesses.

Clinicopathology Classification

There are two approaches used to describe the degree of PAS severity, clinical criteria during surgery and histopathological criteria. These two criteria have different approaches and important information, so they often cause controversy.

The clinical criteria for PAS used when placental tissue is present on the uterine surface can also lead to overdiagnosis because uterine dehiscence can have the same appearance as the PAS. Therefore, the clinical definition has to be the most important criterion for the definition of PAS [7].

The main histopathological criteria used to confirm the diagnosis of PAS were the absence of a decidual invasion and presence of placental invasion that penetrate the endometrial-myometrial layer, but this is a dilemmatic problem because the histopathological results are strongly influenced by surgical techniques and macroscopic sampling methods [8]. Different degrees of villous invasion have been described throughout the same placenta, with areas of accreta and percreta coexisting on the same specimen, further limiting the accuracy of microscopic diagnosis as it becomes dependent on the site of sampling.

One of the management of PAS is uterine resective-reconstructive surgery where the focal myometrial resection is applied in the abnormality of placental invasion [9]. The pathologist only obtained a focal myometrial resection with a placental attachment which was presumed to be the area of implantation of the placenta into the myometrium based on clinical findings during surgery. This conservative surgical technique presents a new challenge for the pathologist in the macroscopic examination of placental implantation, where it will be difficult to distinguish placental and uterine, especially on fresh tissue. Unfixation tissue is very soft and the myometrial sample is thin that it is sometimes difficult to find and distinguish, and for that a multidisciplinary team is needed. The existence of communication between the operator and the pathologist has an important role, where agreement on the provision of markers of the location of the placenta-uterine attachment during tissue delivery can help histopathological analysis. Histopathological diagnosis of PAS was confirmed by hysterectomy and uterine resective-reconstructive surgery, but histopathology diagnosis of PAS could not be confirmed if the sample received was only part of placental tissue which is taken during surgery or placental bed biopsy [3, 10].

Histopathological and clinical criteria controversies in PAS cause overdiagnosis of placental invasion disorders and bias to explain the epidemiology of PAS in the world. The International Federation of Gynaecology and Obstetrics (FIGO) made a consensus to bridge the clinical appearance and histopathological grading of PAS (Table 5.1) [1].

Table 5.1 The International Federation of Gynaecology and Obstetrics (FIGO) classification of placenta accreta spectrum

Grade	Clinical criteria	Histologic criteria
1 Abnormally adherent placenta (accreta) (Fig. 5.1)	At vaginal delivery: – No separation with synthetic oxytocin and gentle controlled cord traction. – Attempts at manual removal of the placenta results in heavy bleeding from the placenta implantation site requiring mechanical or surgical procedures. If laparotomy is required (including for cesarean delivery): – Same as above. – Macroscopically, the uterus shows no obvious distension over the placental bed (placental "bulge"), no placental tissue is seen invading through the surface of the uterus, and there is no or minimal neovascularity.	Microscopic examination of the placental bed samples from hysterectomy specimen shows extended areas of absent decidua between villous tissue and myometrium with placental villi attached directly to the superficial myometrium – The diagnosis cannot be made on just delivered placental tissue nor on random biopsies of the placental bed
2 Abnormally invasive placenta (increta) (Fig. 5.2)	At laparotomy: – Abnormal macroscopic findings over the placental bed: Bluish/purple coloring, distension (placental "bulge"). – Significant amounts of hypervascularity (dense tangled bed of vessels or multiple vessels running parallel craniocaudially in the uterine serosa). – No placental tissue seen to be invading through the uterine serosa. – Gentle cord traction results in the uterus being pulled inward without separation of the placenta (so-called the dimple sign).	Hysterectomy specimen or partial myometrial resection of the increta area shows placental villi within the muscular fibers and sometimes in the lumen of the deep uterine vasculature (radial or arcuate arteries)
3 Abnormally invasive placenta (percreta)		

(continued)

Table 5.1 (continued)

Grade	Clinical criteria	Histologic criteria
3a Limited to the uterine serosa (Fig. 5.3)	At laparotomy: – Abnormal macroscopic findings on uterine serosal surface (as above) and placental tissue seen to be invading through the surface of the uterus. – No invasion into any other organ, including the posterior wall of the bladder (a clear surgical plane can be identified between the bladder and uterus).	Hysterectomy specimen showing villous tissue within or breaching the uterine serosa
3b with urinary bladder invasion (Fig. 5.4)	At laparotomy: – Placental villi are seen to be invading into the bladder but no other organs. – Clear surgical plane cannot be identified between the bladder and uterus.	Hysterectomy specimen showing villous tissue breaching the uterine serosa and invading the bladder wall tissue or urothelium
3c with invasion of other pelvic tissue or organ (Fig. 5.5)	At laparotomy: – Placental villi are seen to be invading into the broad ligament, vaginal wall, pelvic sidewall, or any other pelvic organ (with or without invasion of the bladder).	Hysterectomy specimen showing villous tissue breaching the uterine serosa and invading pelvic tissues/organs (with or without invasion of the bladder)

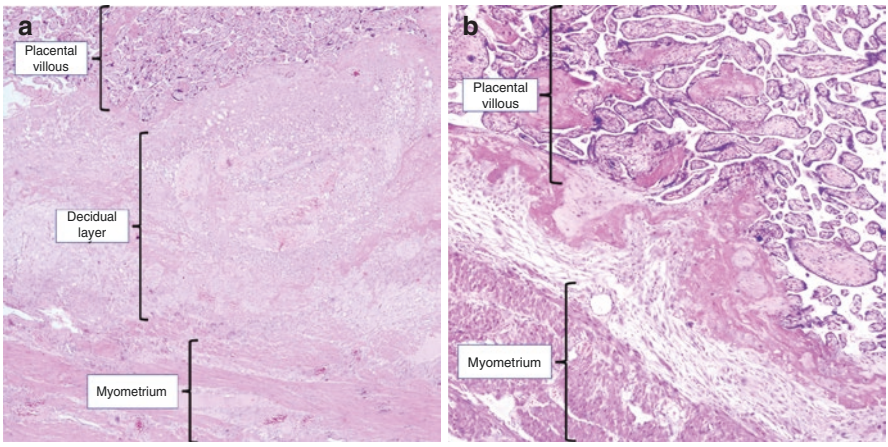

Fig. 5.1 (**a**) Area with normal implantation; decidual basalis layer is intact (orange arrow). H&E-stained section at ×10 magnification. (**b**) Placenta accreta; PAS grade 1. Loss of decidual layer in the area of placental implantation; placental villi attached directly to the superficial myometrium. H&E-stained section at ×100 magnification

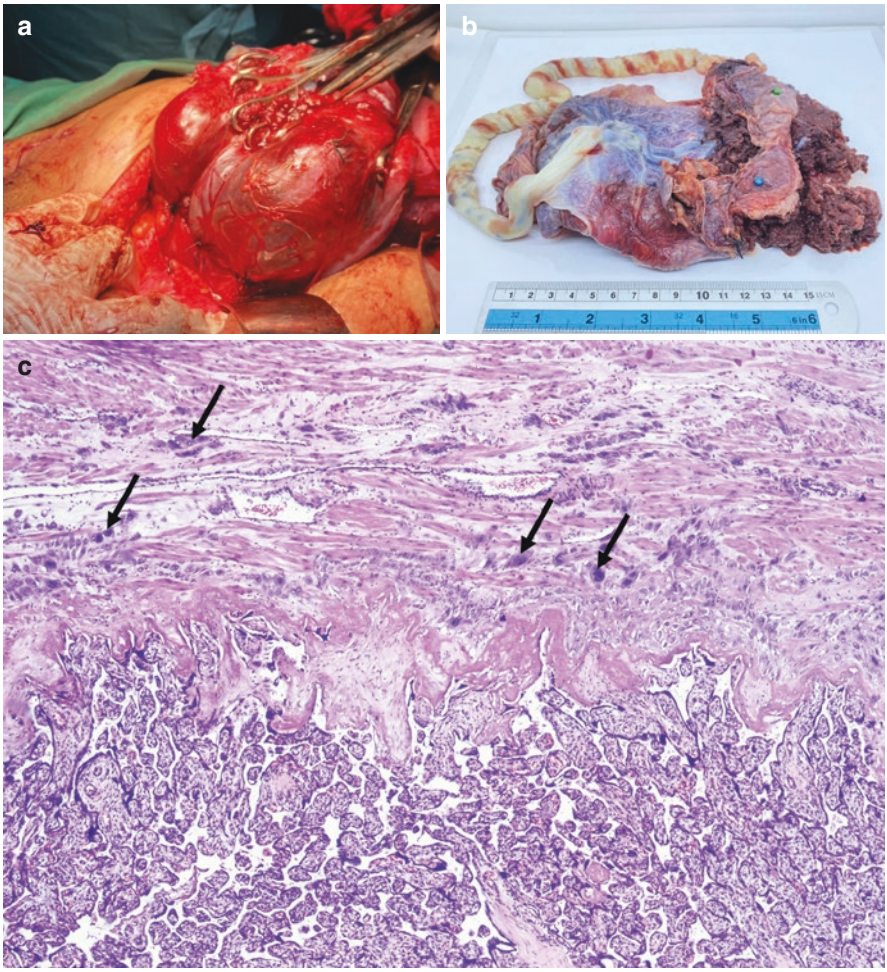

Fig. 5.2 (**a**) Bluish/purple coloring, distension (placental "bulge"); significant amounts of hypervascularity (dense tangled bed of vessels or multiple vessels running parallel craniocaudially in the uterine serosa). (**b**) Macroscopy of placenta with uterus implantation suspected placenta increta (blue and green marker). (**c**) Trophoblast extravillous within the myometrium (arrow) (Placenta increta; PAS grade 2), H&E-stained section at ×100 magnification

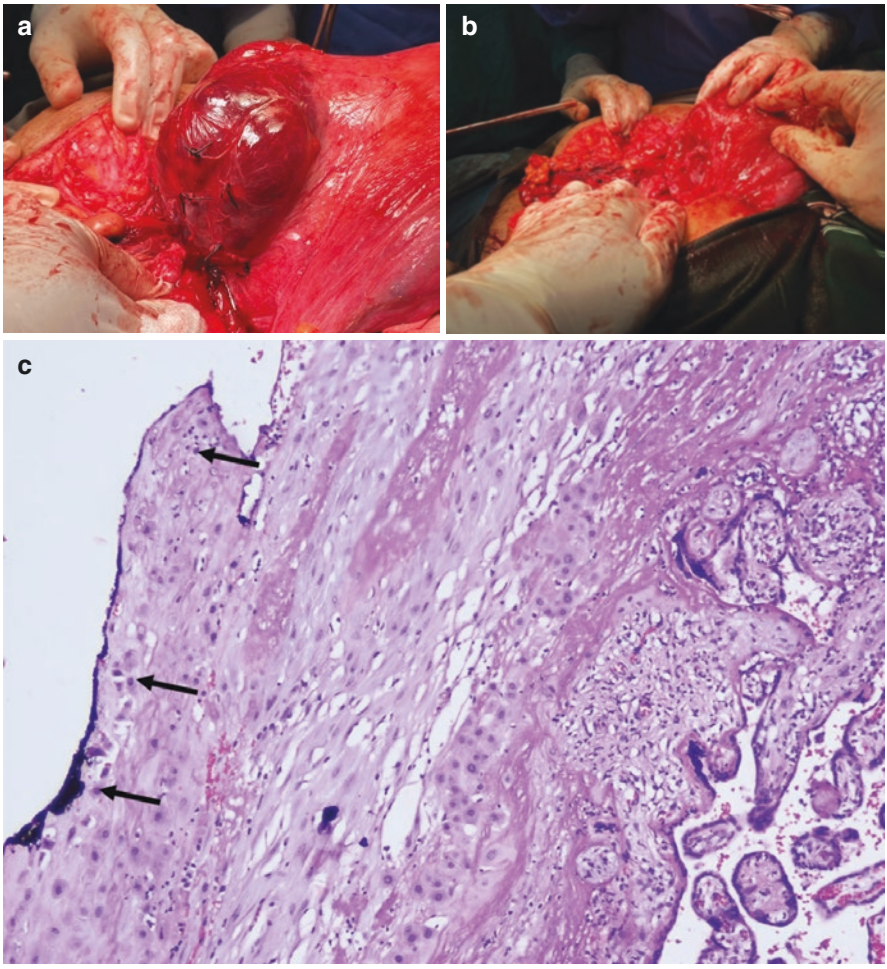

Fig. 5.3 (**a**) Serosal surface (as above) and placental tissue seen to be invading through the surface of the uterus after in the level of the above trigonal bladder after newly formed vascularies are ligated. (**b**) Local placental-myometrial resection during surgery to have sample tissue for histopathology analysis. (**c**) Trophoblast extravillous (arrow) reaching the uterine serosa (placenta percreta; PAS grade 3A) with H&E-stained section

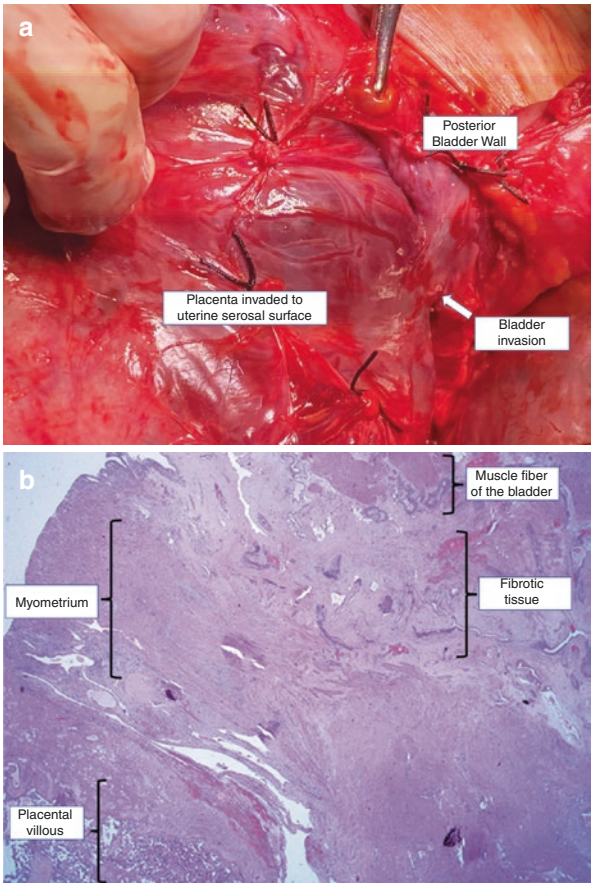

Fig. 5.4 (**a**) Clear surgical plane cannot be identified between the bladder and uterus. (**b**) Placental villi breach the uterine serosa and invade the bladder wall tissue (placenta percreta; PAS grade 3B). H&E-stained section at ×4 magnification

In Fig. 5.5, these two cases have the same grading as FIGO grade 3C but have different levels of surgical difficulties. In diffuse placental invasion, the sampling technique for histopathological examination has its challenges.

One placental invasion can have different grading of invasion and many cases of placenta accreta spectrum have both adherent and invasive areas. The separation between placental tissue from the uterine tissue in fresh specimens allowed us to differentiate between abnormally adherent and invasive areas, to evaluate the area of villous tissue invasion, and to accurately obtain a sample for histology to confirm the diagnosis of villous myometrial invasion in all cases [11, 12].

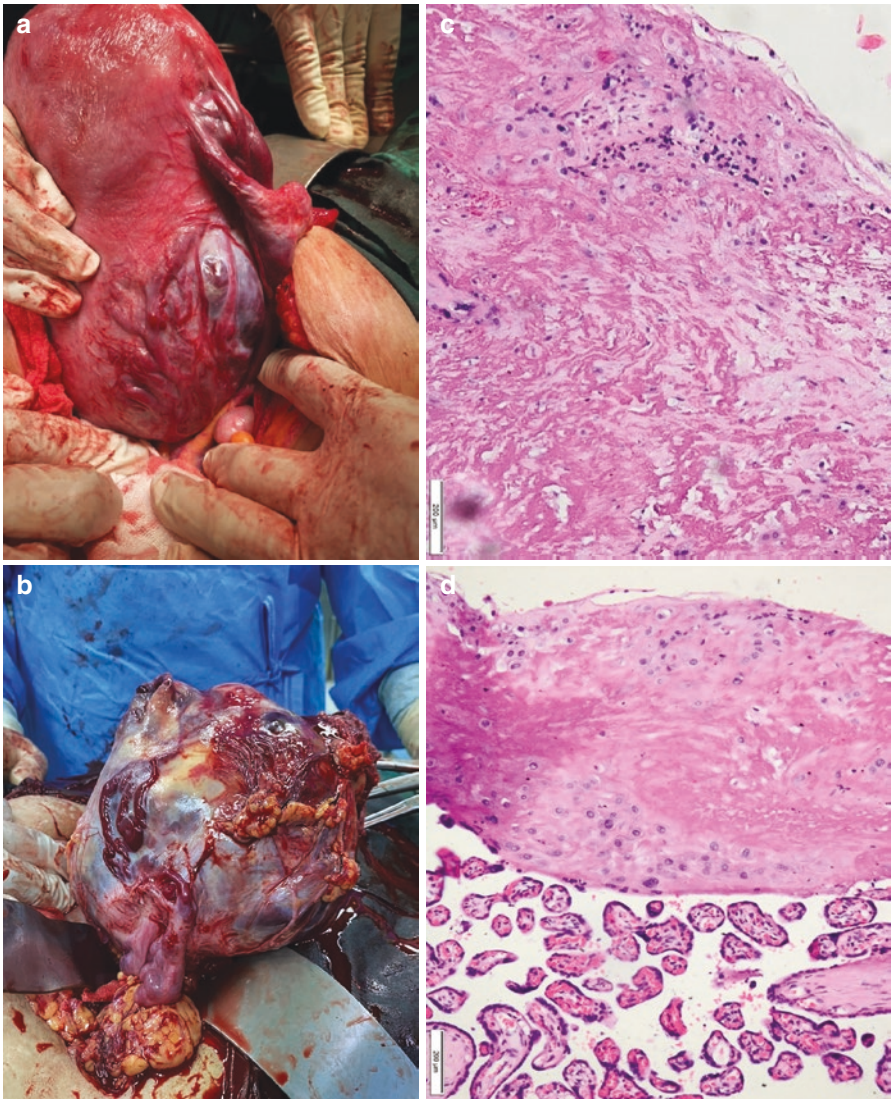

Fig. 5.5 (**a**) Placental villi are seen to be invading into the lower right parametrium with significant amounts of hypervascularity of the uterine serosa (placenta percreta; FIGO grade 3C). (**b**) Trophoblast extravillous reaching the uterine serosa with H&E-stained section. (**c**) Placental villi are seen to be invading all surfaces of right parametrium (placenta percreta; FIGO grade 3C). (**d**) Trophoblast extravillous reaching the uterine serosa with H&E-stained section

Vascular Classification

Although clinical criteria of PAS have been established by FIGO, in these criteria the difficulties at the time of PAS surgery are very difficult to describe. In clinical surgery, the level of difficulty of the surgery is strongly influenced by the location of the invasion of the placenta because it greatly affects the blood loss during surgery due to the vascular anastomoses that affect it. One of the criteria, FIGO classification of 3C with the clinical situation placenta invading through uterine serous to the parametrial-pelvic cavity, can cover upper parametrium with broad ligament and lower parametrium invasion, but these two have different prognosis due to complexity of vascular anastomosis [13].

Palacios-Jaraquemada et al. divided the uterine anastomose into S1 and S2 uterine sectors. In placental invasion above the trigonal bladder, the main vessels providing blood supply are from the uterine artery, superior vesical artery, and superior vaginal artery (Fig. 5.6a), whereas in placental invasion below the trigonal bladder, the vascular anastomoses are more complex (Fig. 5.6b) and risk of causing adverse outcomes at the time of surgery [14].

Imbalance of proangiogenic-antiangiogenic factor in PAS is the main factor that causes anastomotic vasodilation of the vascular net in the pelvic cavity area, and it depends on the degree (focal or diffuse) of placental invasion. Focal invasion shows the placenta is invading the uterine wall less than 50% of the uterine surface where diffuse invasion is more than 50% [9]. In some cases with diffuse lower PAS invasion, the vascularities are complex and the anastomosis is from extrauterine anastomosis like the branch of the rectal artery, periureteral artery, etc. [14, 15].

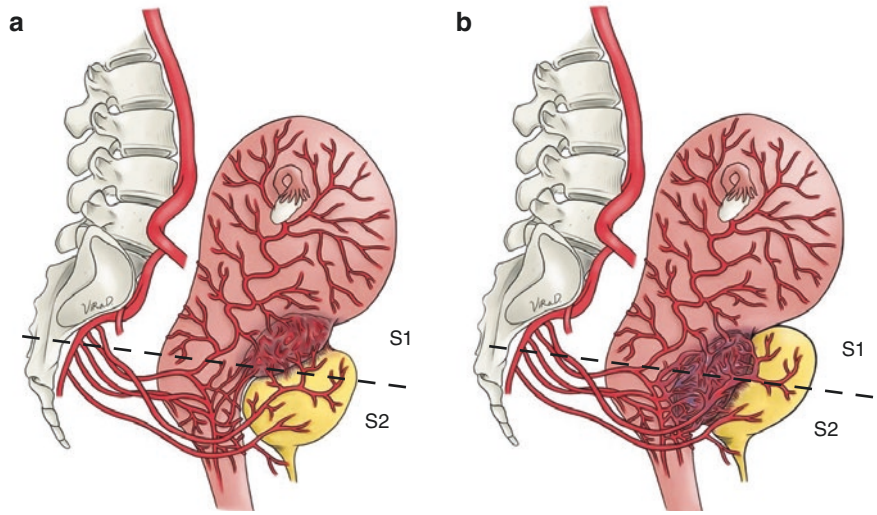

Fig. 5.6 (**a**) S1 uterine sector where the placental invasion above the trigonal bladder with major vascularities is from upper vesical-upper vaginal-uterine artery. (**b**) S2 uterine sector where the placental invasion is below the trigonal bladder which has more complex vascular anastomosis

Knowing this uterine vascular sector classification is very helpful in surgical strategies, especially the use of vascular control methods such as abdominal aortic balloon or aortic clamp [16], so this uterine sector needs to be described in detail as the surgical report for important information.

Placental-Type Invasion

The complexity of uterine vascular sector classification correlates with the location and degree of placental invasion. The other clinical classification is postponed by Palacios-Jaraquemada [17] which correlates between the complexity and the prognosis during surgery.

Type 1

This type of placental invasion is the majority of PAS which is located above the trigonal bladder and has a good prognosis for uterine resective-reconstructive surgery (Fig. 5.3a, b) [9, 17].

Type 2

The placental invasion is located in the parametrium uterine which divides the upper parametrium and lower parametrium. These two sectors have a different prognosis; lower parametrium has more complex vascularity and a high risk for maternal morbidity and mortality (Fig. 5.7) [13].

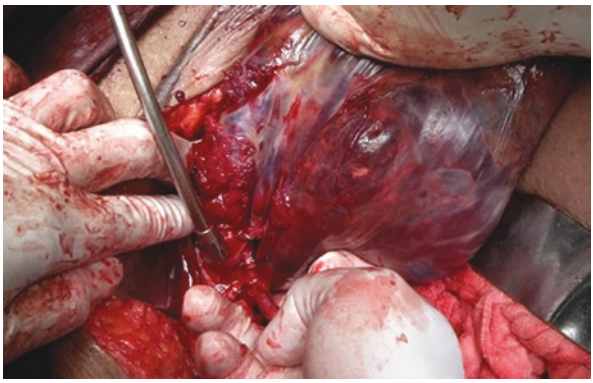

Fig. 5.7 Right lower parametrial invasion with ureter invasion

Type 3

The placenta is invaded in the lower bladder and has more complex anastomosis and lower success for uterine resective-reconstructive surgery compared with type 1 placental invasion. The importance of this type is the cervical tissue; the healthy cervix will give a higher possibility to "conserve" the uterus.

Type 4

This invasion is located in the lower bladder with massive fibrotic tissue followed by complex vascular anastomosis, and cervical invasion leads to impossible uterine resective-reconstructive surgery (lower bladder—cervical invasion).

Type 5

The placenta is invaded in the lower posterior uterus and has different vascular sources; thus, this type is more complex for vascular control. Vascular anastomosis is arrived from the branch of the superior rectal artery-inferior mesenteric artery (Fig. 5.8).

The difference between this clinical classification and the FIGO classification is that the classification relates to the prognosis and strategy at surgery, whereas the FIGO classification bridges the gap between surgical appearance and histopathology.

Both these classifications are very useful and have important meaning both during surgery and postsurgical diagnosis, so it is possible to do a combination of both classifications (Fig. 5.9).

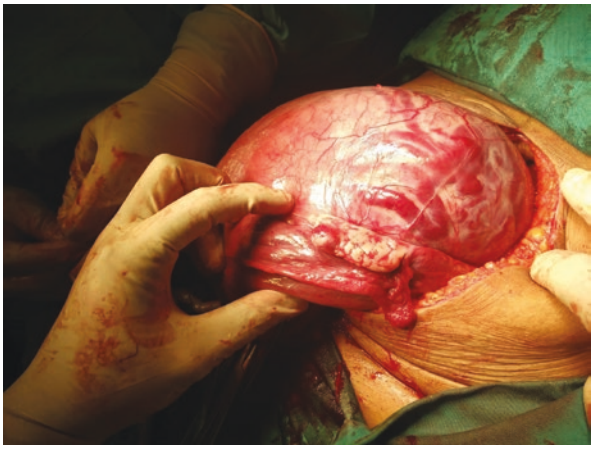

Fig. 5.8 Lower posterior invasion with a newly formed vessel from the branch of the superior rectal artery

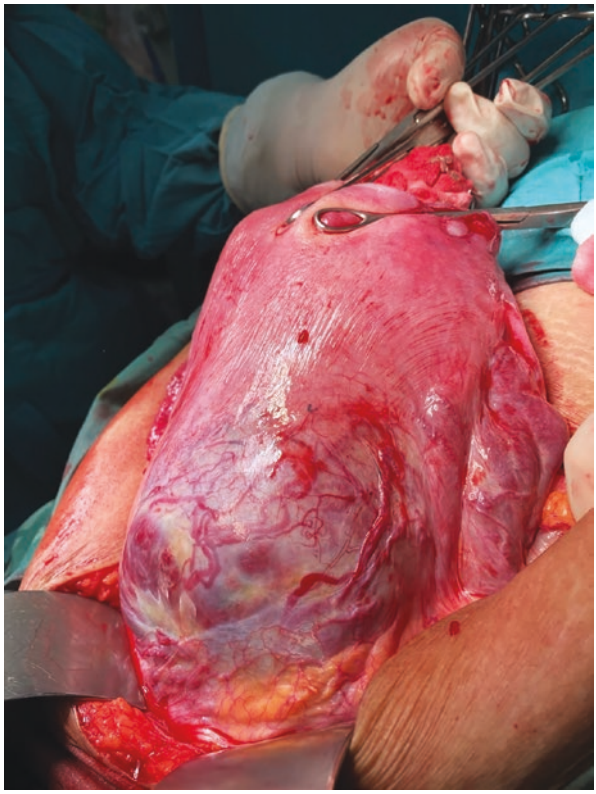

Fig. 5.9 Placenta accreta spectrum FIGO grade 3A with type 1 placental invasion—S1 uterine sector

Placental Mapping for Prenatal Diagnosis of Placenta Accreta Spectrum Grading

The concept of vascularity and placental grading is in line with the PAS pathogenesis. The placenta accreta spectrum occurs as the result of an imbalance pro-growth-inhibin factor that can lead to excessive placental invasion and vascularity growth [18].

The severity of the placenta accreta spectrum correlates with excessive angiogenesis seen on ultrasound in the form of abnormal lacunae and hypervascularity on Doppler ultrasound. The appearance of large and numerous irregular abnormal lacunae represents extensive focal or diffuse placental invasion [10, 19] (Table 5.2).

There is no single sign for ultrasound examination that is most superior because there are two things that are considered in the pre-surgical diagnosis of PAS: the depth of invasion and hypervascularity [27, 28]. The important sign which shows deep placental invasion like abnormal placental lacunae, three-dimensional power

Table 5.2 Ultrasound sign for placenta accreta spectrum [20–26]

	Ultrasound marker	Definition
Grayscale ultrasound	Loss of clear zone	Loss, or irregularity, of hypoechoic plane in myometrium underneath the placental bed ("clear zone")
	Placental bulge	Deviation of uterine serosa away from the expected plane, caused by abnormal bulge of placental tissue into neighboring organ, typically bladder; uterine serosa appears intact but outline shape is distorted
	Focal exophytic mass	Placental tissue seen breaking through uterine serosa and extending beyond it; most often seen inside filled urinary bladder
	Myometrial thinning	Thinning of myometrium overlying placenta to <1 mm or undetectable
	Bladder wall interruption	Loss or interruption in the echogenic bladder border
	Abnormal lacunae	Irregular vascular spaces within the placental parenchyma showing turbulent flow on grayscale or color doppler ultrasound
Color/power doppler ultrasound	Uterovesical hypervascularity	The presence of vessels visualized by color doppler crossing the myometrium and extending from the placenta to the posterior bladder wall or to other organs often running perpendicular to myometrium
	Subplacental hypervascularity	Striking amount of color 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 vessel	Vessels appearing to extend from placenta, across myometrium, and beyond serosa into bladder or other organs; often running perpendicular to myometrium
	Placental lacunae feeding vessel	Vessels with high-velocity blood flow leading from myometrium into placental lacunae, causing turbulence upon entry
	Parametrial invasion	Placental bulge in the parametrial region with sign of hypervascularity
3D rendering-3D doppler ultrasound	Three-dimensional rendering ultrasound	Disconnection of two parallel lines in uteroplacental-bladder interface
	Three-dimensional power doppler ultrasound	Intraplacental vascularization and vascularization of uterine serosa-bladder interface
Other sign	"Rail sign"	The parallel subplacental/uterovesical hypervascularity, and neovascularization of the bladder mucosa, together with interconnected bridging vessels
	Transvaginal ultrasound: Intracervical lacunae	Tortuous anechoic space within the cervix which appeared hypervascular at color doppler

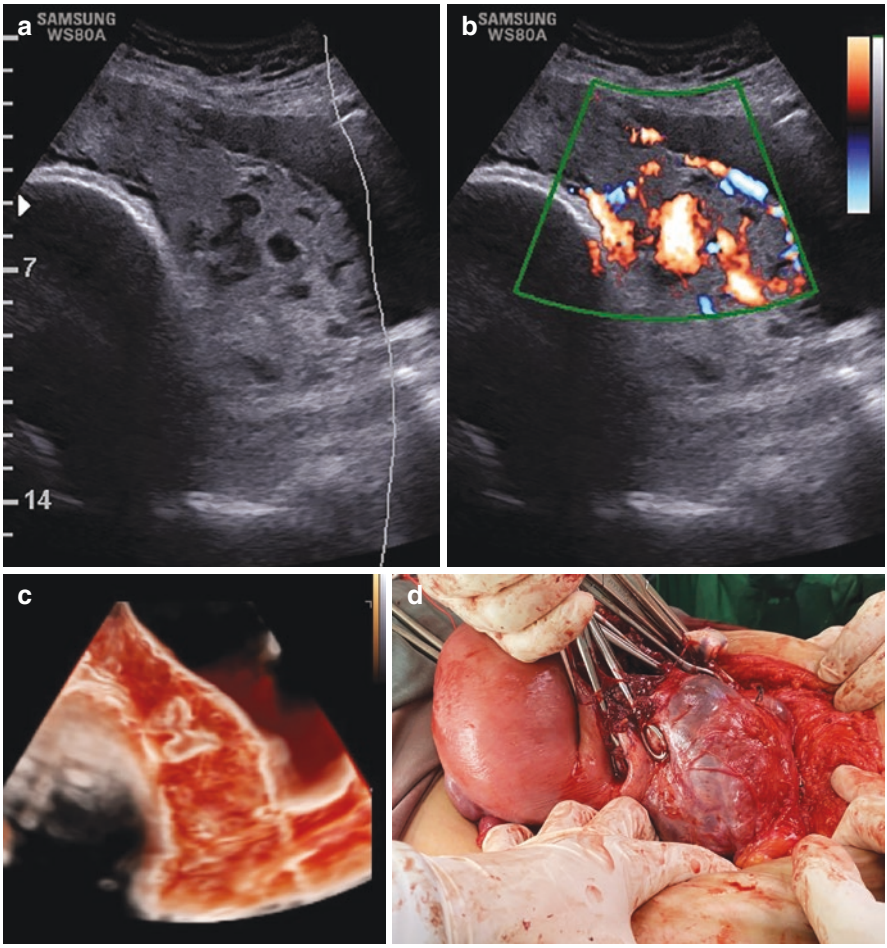

Fig. 5.10 (**a**) Grayscale ultrasound shows loss of clear zone, abnormal lacunae, placental bulge, and bladder wall interruption. (**b**) Color Doppler shows uterovesical hypervascularity, bridging vessel, and rail sign. (**c**) 3D rendering ultrasound shows loss of two parallel lines in uteroplacental-bladder interface with the placental tissue attached in the bladder wall which gives impression for highly suspicious lower bladder invasion. (**d**) Bladder invasion of PAS FIGO grade 3B with type 4 placental invasion—S2 uterine sector

Doppler ultrasound, and rail sign can help to know the deepest placental invasion (Fig. 5.10) [22, 23, 25].

The concept of S1/S2 uterine sector is very useful in pre-surgical diagnostic examination to know the possibility for uterine resective-reconstructive surgery. Lower bladder invasion can be evaluated using three-dimensional ultrasound or transvaginal ultrasound to analyze the cervical hypervascularity and cervical lacunae (Fig. 5.11). This concept is very important because high-grade PAS usually

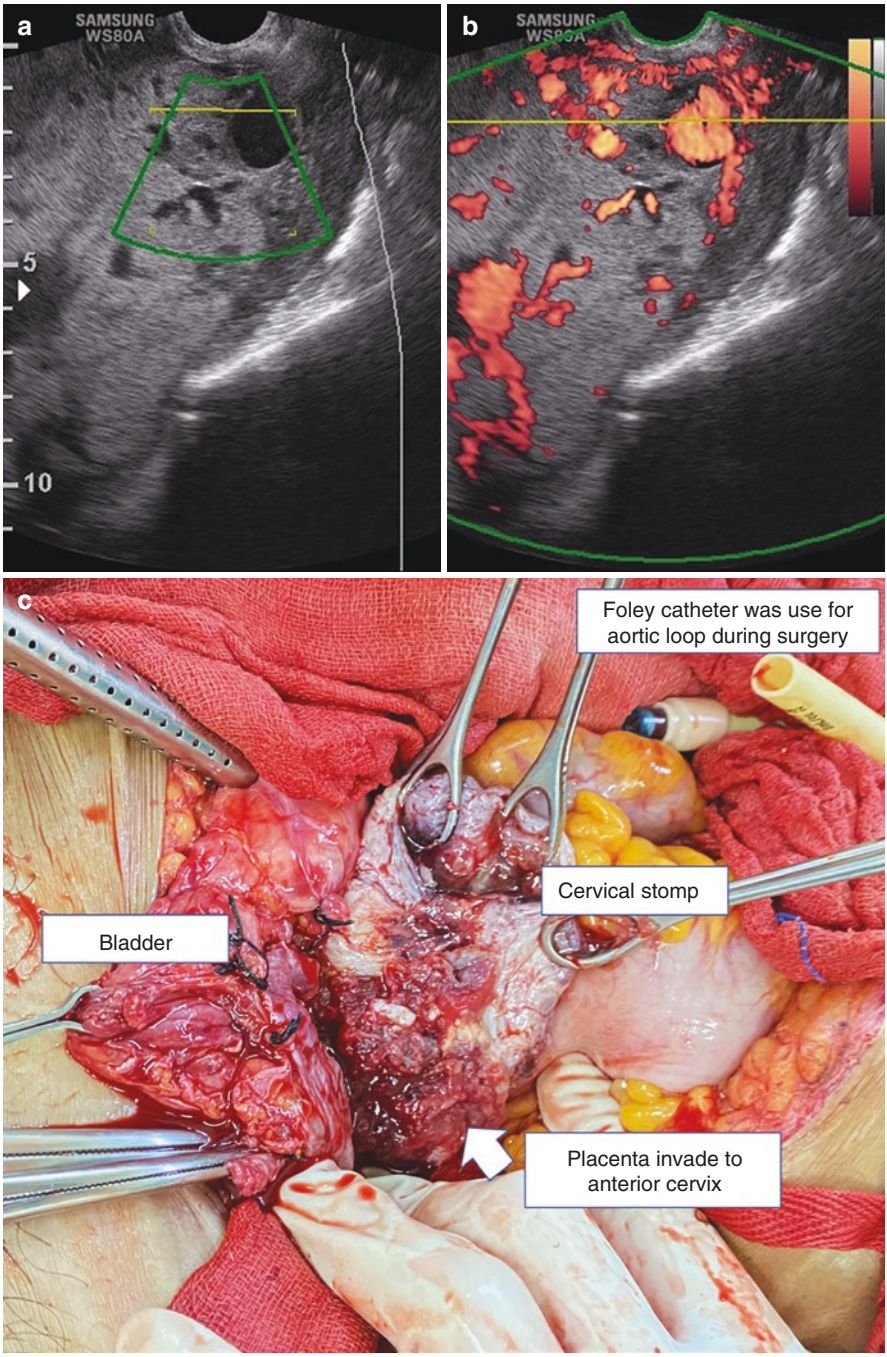

Fig. 5.11 (**a**) Transvaginal ultrasound shows the placenta invading the anterior cervix with abnormal lacunae. (**b**) Cervical hypervascularity and intracervical lacunae show S2 uterine sector of uteroplacental vascularity. (**c**) Cervical invasion (white arrow) during modified subtotal hysterectomy with abdominal aortic loop using Foley catheter

has correlation with lower invasion due to complex vascular anastomosis where aortic control may preferable to control the bleeding during surgery [16, 24, 26, 29].

Conclusion

The concept of classification of placenta accreta spectrum (PAS) is bridging the pre-, intra-, and postsurgical diagnosis. Combining classification between FIGO classification, placental invasion type, and S1/S2 uterine sector may useful for surgical strategies and sampling of placental tissue for histopathology and should be considered during placental mapping of ultrasound examination especially for advanced grading of PAS.

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