Prenatal diagnosis of morbidly adherent placenta using gray-scale, color doppler, three-dimensional power doppler ultrasound and magnetic resonance imaging – A case report*

By Paulette A. Maquiran-Tambalo, MD, FPOGS and Anita Matilda F. Poblete, MD, FPOGS, FPSUOG, FPSMFM

Department of Obstetrics and Gynecology, Cardinal Santos Medical Center

ABSTRACT

Background: Morbidly adherent placenta (MAP) refers to a spectrum of conditions characterized by abnormal adherence of the placenta to the implantation site. It is usually associated with peripartum hysterectomies, excessive blood loss, and bladder and bowel injuries. Reliable antenatal diagnosis of MAP is needed as unexpected encounter with such condition can lead to catastrophic outcomes. It allows the pre-operative assembly of a multidisciplinary team in the surgical management of such cases, an approach which has been shown to improve maternal and fetal outcomes.

Case summary: A case of a morbidly adherent placenta diagnosed antenatally using gray-scale, Color Doppler, 3-Dimensional power Doppler ultrasound and Magnetic Resonance Imaging is reported. A multidisciplinary team consisting of OB - GYN ultrasonologist, radiologist, maternal fetal medicine specialist, gynecologic oncologist, anesthesiologist, neonatologist, internist, urologic-oncologist, vascular and general surgeons, was used to manage the case. Favorable maternal and fetal outcomes resulted from the use of this team.

Conclusion: Prenatal diagnosis of MAP with gray-scale, Color Doppler, 3-Dimensional power Doppler ultrasound and Magnetic Resonance Imaging and the use of standardized imaging descriptors for AIP allowed the development of a multidisciplinary care team approach during delivery which provided a safe outcome for both mother and baby.

Keywords: Morbidly adherent placenta, Abnormally Invasive Placenta, Gray-scale ultrasound, Color Doppler ultrasound, Three-Dimensional power Doppler ultrasound, Magnetic Resonance Imaging

INTRODUCTION

Morbidly adherent placenta (MAP), also known as abnormally invasive placenta (AIP), refers to a spectrum of conditions characterized by pathologic adherence of the placenta to the uterine implantation site. It occurs when there is a defect of the decidua basalis, resulting in abnormally invasive implantation of the placenta into the substance of the uterus by the placental trophoblasts. The degree of adherence and invasion of the placenta varies from the superficial layer (accreta), into the myometrium (increta), and right through the myometrium to breach the serosa or beyond (percreta), involving adjacent structures such as the bladder and cervix. MAP is associated with peripartum hysterectomies, excessive blood loss, bladder and bowel injuries and a long list of postpartum complications, particularly when attempts are made to separate the placenta in unrecognized cases. It also creates surgical challenges due to uterine and adjacent organ invasion by trophoblast tissue.[1,2]

The incidence of MAP was previously thought to be rare but it appears to be in the rise in more recent medical literature. The increasing rate of cesarean section (CS) deliveries corresponds with the rising incidence of MAP. It occurs in 9.3% of women with placenta previa and in 0.04% of women without placenta previa, the risk being 5% in placenta previa cases with no previous uterine surgery, 24% in those with a previous CS, and the risk increased to 67% in those with four previous CS. In addition to previous CS, a maternal age over 35 years, multiparity, previous curettage and placenta previa are risk factors associated with MAP.[3]

An accurate prenatal diagnosis of MAP is essential to prepare both patient and health providers for possible complications and to reduce the risk of maternal or fetal morbidity and mortality. The diagnosis of MAP is possible using gray-scale sonography, color Doppler imaging, Three-dimensional (3D) power Doppler ultrasound and Magnetic Resonance Imaging (MRI) through studying the relation of placenta to the uterine wall. The technology of 3D power Doppler ultrasound has the potential for providing additional information and increase the diagnostic accuracy of MAP over two-dimensional (2D) ultrasound by assessing the extent, location, and quantification of

*First Place, Philippine Society of Ultrasound in Obstetrics and Gynecology (PSUOG) Interesting Case Paper Contest, October 27, 2018, 3rd Floor Function Room, Dr. Jose Fabella Memorial Hospital, Philippine Blood Center Compound, Diliman, Quezon City

abnormal uteroplacental neovascularization.[4,5]

A case of morbidly adherent placenta diagnosed prenatally with gray-scale , color Doppler, 3D Power Doppler ultrasound and MRI is reported emphasizing on the accuracy of such technologies in the diagnosis of such cases. Updates on newer diagnostic approaches based on extent of neovascularization with implications for improved surgical outcome is discussed.

PATIENTS INFORMATION

A 41-year-old, gravida 4, para 2, with a history of two prior cesarean deliveries and completion curettage for miscarriage between the two deliveries - the last delivery of which was a repeat full term CS ten years prior to the current pregnancy - was admitted for pre-operative optimization for planned elective delivery at 34 weeks gestation. She is a known case of placenta percreta diagnosed by gray-scale and 3D power Doppler ultrasound at 20 weeks gestation. The patient had been previously admitted for planned elective laparoscopic cholecystectomy at 25 weeks gestation for symptomatic gallstones during which administration of steroids and prophylactic tocolysis were given. She had been maintained on oral Nifedipine for prophylactic tocolysis and was on regular maternal and fetal surveillance with reassuring findings up to the time of delivery.

PHYSICAL EXAM

Physical examination revealed vital signs within normal range, a gravid abdomen with a fundic height of 39 cm, fetal heart tone at 140 beats per minute at the right maternal side and breech by Leopold's maneuver 1. Internal examination was initially deferred, but a very gentle internal examination done pre-operatively revealed a soft, short and closed cervix, with no blood noted on the examining finger.

DIAGNOSTIC ASSESSMENT

At 20 weeks gestation, gray-scale ultrasound imaging showed placenta previa with sonographic characteristics suspicious of placenta percreta: an anteriorly located placenta totally covering the cervical os, with the placental edge extending to the posterior lower segment with overlap of 2.43 cm (Figure 1); multiple irregularly shaped placental hypoechoic areas (Figure 2); and complete loss of the retroplacental sonolucent zone. The myometrium at the fundus was identifiable but became indistinguishable from the placenta at the mid to lower segment which appeared to be bulging toward the bladder (Figure 3). No myometrial layer was appreciated at the interface of the

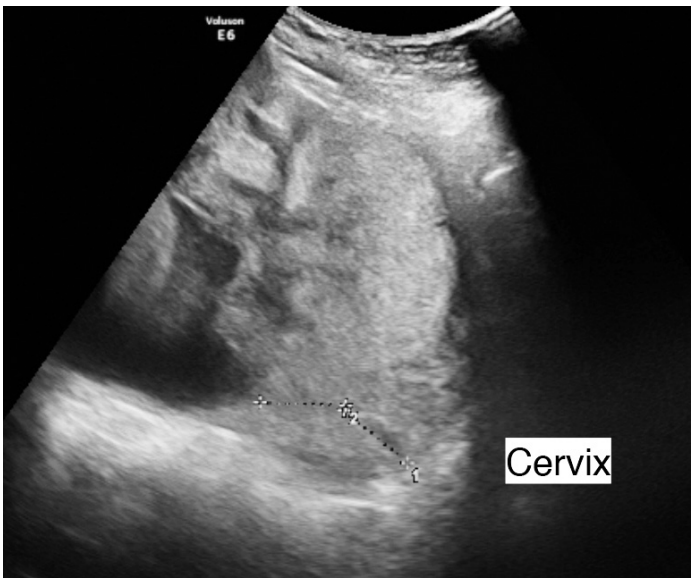


Figure 1. Gray - scale ultrasound. Bulging lower uterine segment with anteriorly located placenta totally covering the cervical os; the placental edge extended to the posterior lower segment with overlap of 2.43 cm.

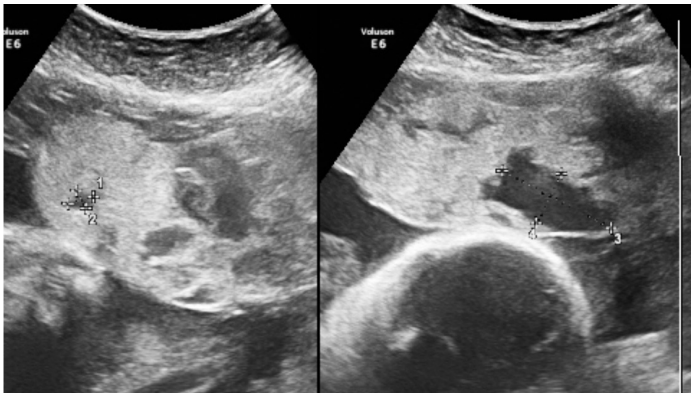


Figure 2. Gray - scale ultrasound. Multiple lacunae within the anteriorly implanted placenta.

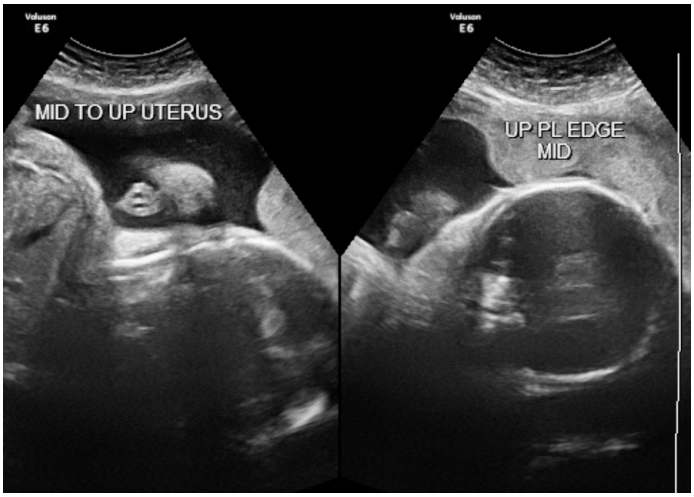


Figure 3. Gray-scale ultrasound. Fundal myometrium was identified, however, it becomes indistinguishable at the mid to the lower segment with loss of the normal subplacental hypoechoic zone.

lower uterine segment and bladder (Figure 4).

Color flow mapping showed lacunar flow pattern and turbulent flow within the variable-sized hypoechoic areas, more pronounced at the lower placental area and beneath the centrally inserted cord, with multiple vascularities linking the placenta to the posterior bladder wall, with apparent extension of markedly dilated vessels inferiorly toward the cervix (Figure 5).

To analyze and define the vasculature of the lower uterine segment and placenta, 3D power Doppler examination was done. Two views were successively evaluated: the sagittal or lateral view was used to observe the intraplacental vasculature and serosa - bladder complex along the longitudinal axis of the maternal pelvis, and the basal view illustrated the transverse view of the serosa-bladder interface in a 90 degrees rotation of the lateral view as described by Shih et al.[6] The lateral view showed intraplacental hypervascularity with tortuous vascularity and chaotic branching while the basal view showed confluent vascularities extending to the posterior bladder wall and inferiorly to the cervix (Figure 6).

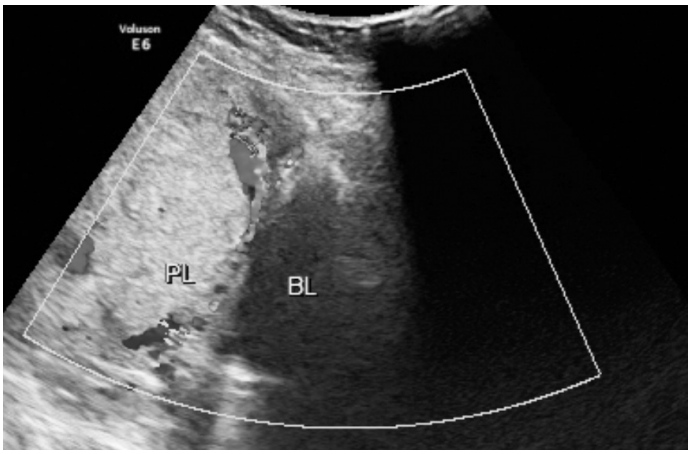


Figure 4. Gray-scale with color mapping. No myometrial layer appreciated at the interface of the lower uterine segment and bladder. Color flow outlined this interface.

Figure 5. Color flow mapping. Multiple vascularities extending to the bladder wall.

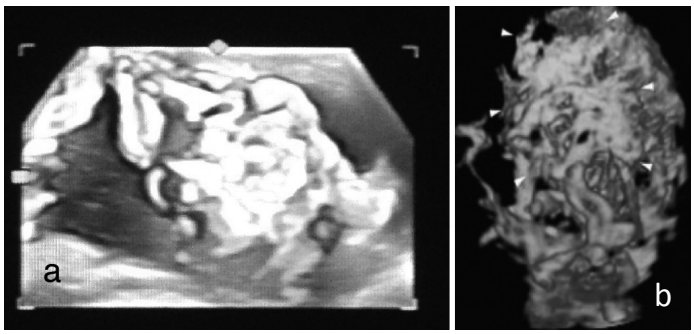


Figure 6. 3D Power Doppler. Lateral view (a) showed intraplacental hypervascularity with tortuous vascularity and chaotic branching. Basal view (b) showed confluent vascularities extending to the posterior bladder wall and inferiorly to the cervix.

The patient was advised complete bed rest and was given Nifedipine for prophylactic tocolysis. At 25 weeks, she developed on and off right upper quadrant pains and was diagnosed to have multiple gallstones. A follow-up scan at this time revealed an anteriorly located placenta occupying the entire lower uterine segment, totally covering the cervical os and overlying the cervix and extending to the left posterior lower segment. The previously noted 3D power Doppler findings were still present. Maternal and fetal waveforms and indices were also evaluated and revealed normal values. It was decided to manage the gallstones electively to decrease the risk of emergent surgery at a more advanced gestation. She underwent laparoscopic cholecystectomy under general anesthesia without complications.

Thereafter, fetal biometry and serial biophysical scoring including non-stress testing were done every 2 weeks which revealed appropriate growth and reassuring fetal status. Of note, the patient did not experience significant contractions throughout the pregnancy.

Upon admission at 34 weeks gestation, MRI of the pelvis with contrast was also done to determine the extent of placental invasion. It revealed a gravid uterus with a single male fetus in cephalic presentation, placenta is located in the anterior aspect of the uterus up to the maternal supraumbilical level, entirely covering the anterior lower uterine segment including the cervical os, invading the uterine myometrium and serosa inferiorly, bulging into the bladder and penetrating through the anterior cervix, consistent with placenta percreta (Figure 7).

Our findings were summarized using the Ad-hoc International Abnormally Invasive Placenta (AIP) Expert Group ultrasound report form[7] (Figure 8). Based on the ultrasound and MRI findings, there was high probability of clinically significant abnormally invasive placenta with diffuse extension and adjacent organ involvement.

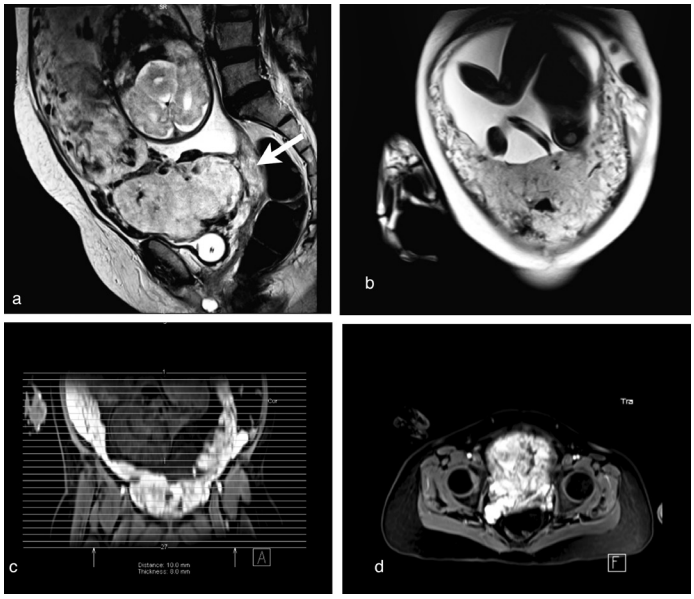


Figure 7. MRI of the pelvis with contrast. Right parasagittal view (a) showed a placenta located in the anterior aspect of the uterus up to the maternal supraumbilical level, entirely covering the anterior lower uterine segment, invading the uterine myometrium and serosa inferiorly. Note that the placenta is bulging into the bladder with penetration into the anterior cervix (arrow). Axial view (b) showed lateral placental extensions to parametria with breach in the continuity of the anechoic myometrial layer suggestive of placenta percreta. Axial and coronal views (c & d) showing the lowest level where placenta can still be seen.

SUSPECTED ABNORMALLY INVASIVE PLACENTA (AIP)

Ultrasound report

Demographics and Risk Factors

Date: _ _/_ _/ _ _ _ _ Gestational age: 20 weeks _ days

Parity 2 Mode of conception: Spontaneous ☒ IVF ☐

Number of previous CS 2 Number of classical CS ☐

Number of previous surgical evacuations (including TOP) 1

Was Cesarean scar pregnancy suspected/diagnosed in first trimester? Yes ☐ No ☒ Not known ☐

Previous uterine surgery (e.g. myomectomy, endometrial ablation) Yes ☐ No ☒ Not known ☐

History of AIP Yes ☐ No ☒ Not known ☐

Placenta previa on ultrasound Yes ☒ No ☐ Not known ☐

If yes: Anterior placenta previa < 2 cm from internal os ☐ Covering internal os ☒

Posterior placenta previa < 2 cm from internal os ☐ Covering internal os ☐

Ultrasound Signs

Cervical length (without funnel or placental tissue)			**mm**
Grayscale ultrasound parameters and definition	**Yes**	**No**	**Unsure**
Loss of 'clear zone' *- Loss, or irregularity, of hypoechoic plane in myometrium underneath placental bed ('clear zone')*	X		
Myometrial thinning *- Thinning of myometrium overlying placenta to <1mm or undetectable*	X		
Abnormal placental lacunae *- Presence of numerous lacunae including some that are large and irregular, often containing turbulent flow visible on grayscale imaging*	X		
Bladder wall interruption *- Loss or interruption of bright bladder wall (hyperechoic band or 'line' between uterine serosa and bladder lumen)*	X		
Placental bulge *- Deviation of uterine serosa away from expected plane, caused by abnormal bulge of placental tissue into neighboring organ, typically bladder; uterine serosa appears intact but outline shape is distorted*	X		
Focal exophytic mass *- Placental tissue seen breaking through uterine serosa and extending beyond it; most often seen inside filled urinary bladder*		X	
Color Doppler ultrasound parameters and definition	**Yes**	**No**	**Unsure**
Uterovesical hypervascularity *- Striking amount of color 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)*	X		
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)*	X		
Bridging vessels *- Vessels appearing to extend from placenta, across myometrium and beyond serosa into bladder or other organs; often running perpendicular to myometrium*	X		
Placental lacunae feeder vessels *- Vessels with high-velocity blood flow leading from myometrium into placental lacunae, causing turbulence upon entry*	X		
Parametrial involvement	**Yes**	**No**	**Unsure**
- Suspicion of invasion into parametrium	X		

Clinical Significance of Ultrasound Findings

Probability of clinically significant AIP High ☒ Intermediate ☐ Low ☐

Extent of AIP Focal ☐ Diffuse ☒

Figure 8. Pro forma for ultrasound reporting in suspected abnormally invasive placenta (AIP): An international consensus.

INTERVENTIONS

A multidisciplinary team consisting of OB - GYN ultrasonologist, radiologist, maternal fetal medicine specialist, gynecologic oncologist, anesthesiologist, neonatologist, internist, urologic - oncologist, vascular surgeon and general surgeon was put together for cohesive management of the case. Pre-operative cystoscopy and ureteral stent insertion were considered but due to potential ureteral involvement the urologic oncologist opted to address the issue intra-operatively under direct observation. Partial bladder resection was anticipated. An interventional radiologist was consulted for possible embolization of uterine arteries but was not optimistic about success and feasibility of the procedure due to presence of lower pelvis collaterals. The team agreed on intra-op ligation of the internal iliac arteries. Vascular clips were prepared by the vascular surgeon.

Magnesium sulfate was administered both for neuroprotection and tocolysis. Antenatal and neonatal counseling were done. Spiritual counseling and psycho-emotional support were also given to the patient and her entire family, knowing the possible risks of the condition. Blood bank staff also prepared for the expected blood product requirements.

Upon laparotomy, the lower uterine segment was markedly thinned-out and very vascular. There were numerous engorged and clustering vessels in a "bag of worm" pattern over the anterior and lateral lower segment of the uterus. A primary high classical section with vertical incision on the anterofundal wall of the uterus was done, with complete breech extraction to deliver a live preterm male (AS 9, 9; BW 2570 grams, 33 weeks AGA). Delayed clamping of the umbilical cord was done and essential intrapartum newborn care observed, affording time for further inspection of the uterus and tracing the cord and placenta to its attachments. The placenta occupied the lower uterine segment, more on the right, invading the myometrium, traversing the uterine serosa and penetrating thru the urinary bladder. The lower uterine segment was densely adherent to the dome and posterior wall of the urinary bladder. The placenta was left in place.

Bilateral internal iliac artery ligation was performed as planned. Vascular clips were applied to the lower uterine segment, however, an initial attempt to dissect the urinary bladder from the uterus caused massive bleeding hence it was immediately aborted. Hysterectomy followed with recurrent brisk bleeding from the paracervical and paravaginal collateral vessels. Due to the dense bladder involvement, partial bladder resection was done to complete the hysterectomy with subsequent cystorrhaphy using 3-layer repair. Left distal

ureter was traced and identified to have been transected at the distal third hence left ureteroneocystostomy and left antegrade DJ stent insertion were done. Upon bowel run and inspection, there was a note of 1 cm full thickness tear at the proximal ileum, 25 cm from the ileocecal valve hence repair of ileal tear followed. Intraoperative blood loss was 12,500 mL. She was transfused 12 units PRBC, 9 units of fresh whole blood, 6 units FFP, and albumin infusions. Surgery lasted 7 hours and 20 minutes. She was transferred to the ICU for close monitoring for 4 days. JP drain was removed on the 5th day. She was transferred to a regular room on the 7th day and foley catheter was removed on the 10th day. She was given lactation assistance and subsequently discharged, with her baby, 2 weeks post - op.

FOLLOW-UP AND OUTCOMES

Gross inspection of the uterus showed a myometrium that was markedly thinned out at the region of the uterine isthmus. The bulk of the placenta is at the right anterolateral portion of the lower uterine segment. It invaded the entire thickness of the myometrium adjacent to it, with multiple vessels seen traversing the serosal layer (Figure 9). The cervix and bilateral adnexa appeared grossly normal. Histopathological diagnosis was placenta percreta. Microscopic sections of the placenta showed all degrees of invasion (Figure 10).

DISCUSSION

Prenatal diagnosis of MAP and its variants can help reduce maternal and fetal morbidity and mortality by allowing choice of the best time and place of delivery. Multidisciplinary surgical management, neonatal intensive care, prophylactic hypogastric artery occlusion and an adequate number of blood units available in the operating room can only be achieved effectively through early detection of the placental pathology.

In our case, the diagnosis of MAP was made possible using gray-scale sonography, color Doppler imaging, 3D power Doppler sonography and MRI. The technology of three-dimensional (3D) and 3D color power Doppler ultrasound has the potential for providing additional information and increase the diagnostic accuracy of MAP over two-dimensional (2D) ultrasound by assessing the extent, location, and quantification of pathologic uteroplacental neovascularization. Most recently, Shih et al. [6] compared prospectively 3D power Doppler with grayscale and color Doppler techniques in 170 women of whom 72 had had a previous caesarean section. Thirty-eight of the women with a previous caesarean section

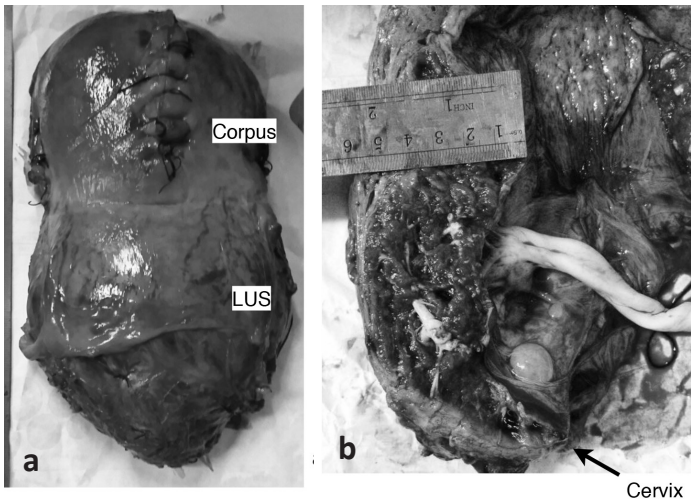


Figure 9. Gross specimen. (a) The uterus showed a markedly enlarged and thinned out lower uterine segment (LUS). Cut section (b) showed bulk of the placenta implanted on the right anterolateral portion of the lower uterine segment, with areas of invasion to the serosal surface.

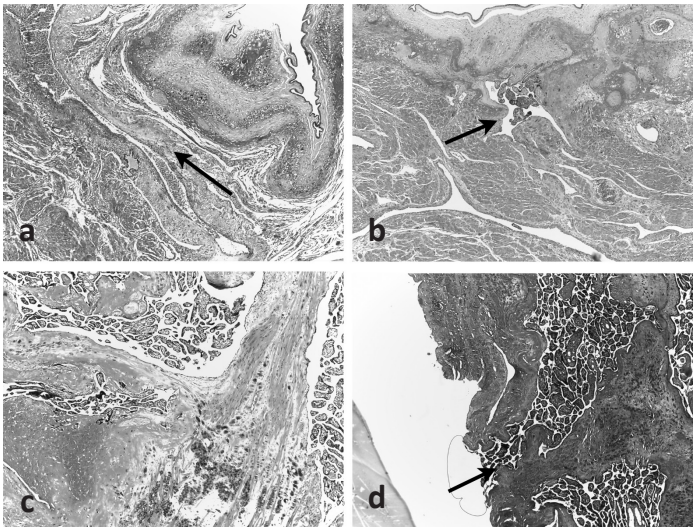


Figure 10. Microscopic sections of placenta showing all degrees of invasion. (a) Normal section at the mid anterior corpus: the myometrial layer is separated from the chorionic plate by the decidua basalis layer (arrow). (b) Placenta accreta. There is partial absence of decidua with chorionic villi seen at the superficial myometrium (arrow). (c) Placenta increta. Chorionic villi invade into but not through the myometrium. (d) Placenta percreta. Chorionic villi invade through the full thickness of myometrium to the serosa (arrow)

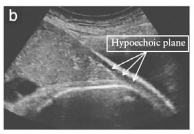
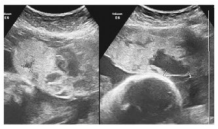
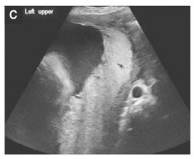
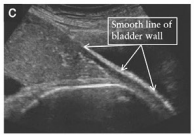
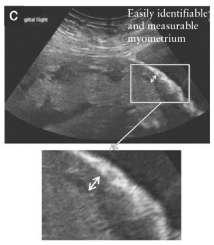
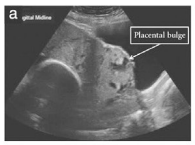
Table 1. Diagnostic performance of different ultrasound modalities.

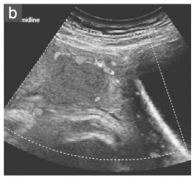
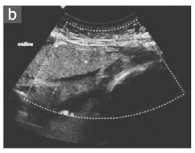
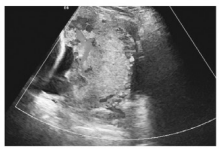
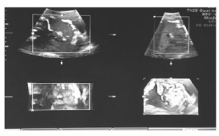
	Sensitivity (%)	Specificity (%)	PPV (%)	Risk
Grayscale	95	76	82	93
Color Doppler	92	68	76	89
3D power doppler	100	85	88	100

Table 2. Unified descriptors, as suggested by the European Working Group on Abnormally Invasive Placenta (EW-AIP), for ultrasound (US) findings in AIP.

US finding	*EW-AIP suggested standardized definition*
2D grayscale	
Loss of 'clear zone' (Figure 11)	Loss, or irregularity, of hypoechoic plane in myometrium underneath placental bed ('clear zone')
Abnormal placental lacunae (Figure 12)	Presence of numerous lacunae including some that are large and irregular (Finberg Grade 3), often containing turbulent flow visible on grayscale imaging
Bladder wall interruption (Figure 13)	Loss or interruption of bright bladder wall (hyperechoic band or 'line' between uterine serosa and bladder lumen)
Myometrial thinning (Figure 14)	Thinning of myometrium overlying placenta to < 1 mm or undetectable
Placental bulge (Figure 15)	Deviation of uterine serosa away from 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
US finding	*EW-AIP suggested standardized definition*
2D color Doppler	
Uterovesical hypervascularity (Figure 16)	Striking amount of color 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 (Figure 17)	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 vessels (Figure 18)	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 (Figure 19)	Vessels with high-velocity blood flow leading from myometrium into placental lacunae, causing turbulence upon entry
3D ultrasound ± power Doppler	
Intraplacental hypervascularity (Figure 20)	Complex, irregular arrangement of numerous placental vessels, exhibiting tortuous courses and varying calibers
Placental bulge	(as in 2D)
Focal exophytic mass	(as in 2D)
Uterovesical hypervascularity	(as in 2D)
Bridging vessels	(as in 2D)

Table 3. Case imaging findings with normal images for comparison

Ultrasound Findings	Case Imaging Findings	Comparison with Normal
Loss of the clear zone (Figure 11)		
Abnormal placental lacunae (Figure 12)		
Bladder wall interruption (Figure 13)		
Myometrial thinning or undetectable myometrium (Figure 14)		
Placental bulge (Figure 15) 		

Ultrasound Findings	Case Imaging Findings	Comparison with Normal
Uterovesical hypervascularity (Figure 16)		
Subplacental hypervascularity (Figure 17)		
Bridging vessels on color Doppler imaging (Figure 18)		
Placental lacunae feeder vessels on color Doppler imaging (Figure 19)		
Interplacental hypervascularity on 3D power Doppler (Figure 20)		

had placenta accreta identified at delivery. The diagnostic performance of the different ultrasound modalities were itemized in Table 1; in each case the results reported were when at least one diagnostic criterion was present. It shows that three-dimensional power Doppler gives the best overall results when an isolated criterion is found, but as multiple diagnostic criteria were commonly found in the women with placenta accreta, these predictions can be improved upon.

Recently, the European Working Group on Abnormally Invasive Placenta (AIP) proposed standardized definitions of the AIP imaging descriptors (Table 2). The aim of the group is to advance diagnosis and treatment and to promote research and knowledge on AIP.[8] In our case, the imaging findings with reference to the AIP imaging descriptors is presented with normal images for comparison (Table 3).

Among the descriptors, the two-dimensional gray scale ultrasound finding of obliteration of retroplacental sonolucent zone in isolation has a high false positive rate - up to 50% was reported. The combination of vascular lacunae and myometrial thinning is more predictive of morbidly adherent placenta, with sensitivity reaching 100%, specificity of 72 - 79%, and positive predicitve value of 73%.[6]

In 3D power Doppler, the visualization of "numerous coherent vessels" - defined as complex, irregular arrangement of numerous placental vessels, exhibiting tortuous courses and varying calibers - in the basal view was the best single criterion for the diagnosis of placenta accreta, with sensitivity of 97% and specificity of 92%.[6]

Magnetic resonance imaging (MRI) is also a modality that is increasingly being utilized in the detection and investigation of MAP. MRI carries additional value in detecting the depth of placental invasion and depicting posterior placenta accreta, and in cases where ultrasonography is inconclusive. Uterine bulging, heterogenous signal intensity within the placenta, dark intraplacental bands on T2 - weighted images, tenting of the bladder, and direct visualization of placental invasion into pelvic structures have been reported as the MRI features of placenta accreta. In our case, however, MRI merely corroborated the ultrasound findings, hence MRI and ultrasound using the descriptors appear to be comparable in diagnosing accreta. The extent of the invasion was equally appreciated using

both modalities. The addition of MRI did not decrease the complications related to hemorrhage and the same surgical interventions would have been performed even if MRI was not done. This validates the statement of Sze-Yan Cheung et. al.[9] that the use of MRI does not seem to improve the management and obstetric outcome, and that, in terms of diagnosis, there is insufficient evidence to support its routine use in sonographically suspected placenta accreta.[9] However, in our case, the availability of the MRI plates allowed the non-obstetric members of the team to visualize and appreciate the extent of the placental invasion in a manner that is highly different from that which can be provided by ultrasound pictures alone. This is an important understanding for the entire surgical team and enabled a successful coordinated team approach both pre- and intra-operatively.

The conventional categories of MAP are traditionally known as accreta, increta, and percreta, but one or more types may actually be present in a single patient, such as that seen histologically in our case. This traditional classification is based on histology and is a post-operative diagnosis hence not very helpful in terms of anticipated risks in surgery.

The highly vascular lower segment and its relationship to the urinary bladder and adjacent structures are often the source of difficulties in what otherwise should be a simple hysterectomy. It is now recognized that there are newly-formed vessels (neovascularization) between the uterus and bladder, paracervical and paravaginal areas that lead to difficult bladder mobilization and protracted and surgically frustrating hemostasis in the pelvic floor. It is this area of neovascularization that is now the focus of newer concepts regarding diagnosis and management.

From a surgical morphological point of view, three main types of anterior placental adherences between the uterus and bladder may be distinguished as proposed by J.M. Palacios-Jaraquemada.[10] In type 1, the anterior segment is noticeably thinner and the placenta reaches the serous surface, no newly formed placental - vesical or vesico-uterine vessels are identified, and there is a lax dividing plane between the posterior bladder wall and the anterior surface of the uterine segment. In type 2, both the lower uterine segment and the posterior wall of the bladder are noticeably thinner, there is no lax plane between both organs and a fibrous scar connects them, and no newly formed placental - vesical or vesicouterine vessels are observed. Type 3 is characterized by a thinner uterine segment, vesical wall of variable thickness, presence of placental - vesical and vesicouterine neovascular circulation and vesicouterine plane with or without fibrous adherence. In this case, the type 3 anterior placental adherence was observed. J.M. Palacios-Jaraquemada, in his paper on "One - Step Conservative Surgery for Abnormal Invasive Placenta", suggested a surgical approach appropriate for each type. They utilized MRI in order to come up with these categories and have reported on the successful surgical outcome by individual ligation of MAP collaterals resulting in minimal blood loss and even avoidance of hysterectomy.

Recently, Palacios et al refined their classification into 5 types based on the extent of neovascularization within the entire uterus to include not just the bladder but the lateral parametria, paracervical, and paravaginal involvement, with implications for improved surgical approaches.[11] Using mid and lateral sagittal MRI images, the degrees of the "tumor-like" spread of abnormal placenta within the pelvis were described as follows: Type 0: The placenta reaches to the serosa through a uterine wall defect, without the presence of newly-formed vessels among the uterus, placenta and bladder (False AIP, excluded from statistics); Type 1: The placenta reaches to the serosa or beyond it with a presence of newly - formed vessels among the uterus, placenta and the bladder; Type 2: The placenta reaches to the serosa or beyond it in the lateral side of the uterus (parametrial invasion); Type 3: The placenta invaded the postero-inferior area of the bladder (trigon - cervical invasion); Type 4: The placenta reaches to the uterine serosa, invading the lower bladder, in the presence of newly-formed vessels with an intensive fibrous tissue between them. They described a technique of ligation for these neovascularities that significantly decreases blood loss. Given this newer concept of classifying and approaching extent of abnormal invasion, the sonologic descriptors currently in use may still be modified in the future.

Placenta percreta with bladder involvement is seen in most cases of MAP and is associated with a particularly high morbidity, including massive hemorrhage and bladder resection. In cases suspicious of placenta percreta, cystoscopy, if performed, should be done very carefully and bladder biopsy should be avoided because it may precipitate severe hemorrhage. Placing ureteral stents during cystoscopy may aid in intraoperative identification and prevent ureteral injury. Cystoscopy may often show posterior bladder wall abnormalities. Biopsy and/or fulguration of these abnormalities should be avoided, as this may precipitate massive hemorrhage. In our case, cystoscopy and stent insertion were considered but due to additional potential injuries, these were deferred by the urologic-oncologist who opted for direct visual assessment and intra-operative ureteral dissection if necessary.

In the presence of bladder wall invasion and in the setting of uncontrolled uterine bleeding following delivery, every attempt should be made to preserve the bladder, as this has been demonstrated to be a reasonable possibility provided that the integrity of the ureters is established

during and after the operation. However, in our case, initial attempts to mobilize the bladder resulted in profuse brisk bleeding hence it was aborted.

Although removal of the posterior bladder and distal ureters has been advocated if invasion is found at time of delivery, resection of the bladder base with the distal ureters can be performed, but it carries the risk of coagulopathy, transfusion reaction, sepsis, adult respiratory distress syndrome, multi-organ failure, and vesicovaginal fistula due to aggressive blood transfusion and extensive surgery. Regardless of the decision whether to remove the bladder, anterior bladder wall cystectomy is particularly helpful for defining dissection planes and determining whether posterior bladder wall resection is required.[9,12,13] Reconstructive surgery, if necessary, may be postponed until after the patient is hemodynamically stabilized.

CONCLUSION

Placenta accreta and its variants are rare complications of human placentation that may threaten maternal life due principally to their potential for massive hemorrhage. Its incidence is rising due to the increasing cesarean section rates worldwide. Our experience underscores the importance of making the diagnosis antenatally. Favourable outcome can only be achieved with preoperative multidisciplinary input and perioperative measures require adequate time in order to be instituted. The accuracy of gray-scale, color Doppler and 3D power Doppler sonography in the diagnosis of morbidly adherent placenta and the use of standardized imaging descriptors for AIP are reliable enough to allow development of multidisciplinary care team approach during delivery to decrease risk of massive obstetric hemorrhage and to provide a safe outcome for both mother and baby. In the presence of bladder wall invasion, attempts to preserve the bladder should be counterweighed with possibility of uncontrolled bleeding from neovascularities, hence partial bladder wall resection should always be considered, and this option taken without hesitation, but careful attention to injury to adjacent structures must be kept in mind. Newer approaches to the pre-operative investigation of the extent of neovascularities, as well as their surgical management, are currently under development. ■

REFERENCES

1. Gilboa Y, Spira M, Mazaki - Tovi S, Schiff E, Sivan E, Achiron R. A Novel Sonographic Scoring System for Antenatal Risk Assessment of Obstetric Complications in Suspected Morbidly Adherent Placenta. *J Ultrasound Med.* 2015; 34:561-567. www.aium.org

2. Edwin WH Thia, Lay-Kok Tan, Kanagalingam Devendra, Tze-Tein Yong, Hak-Koon Tan, Tew-Hong Ho. Lessons Learnet from Two Women with Morbidly Adherent Placentas and a Review of Literature. *Ann Acad Med Singapore.* 2007; 36:298-303.

3. G. Cali, L. Giambanco, G. Puccio, F. Forlani. Morbidly adherent placenta: evaluation of ultrasound diagnostic criteria and differentiation of placenta accreta from percreta. *Ultrasound Obstet Gynecol*. 2013; 41:406-412.

4. Abdel Moniem AM, Abdelazim IA, Aziz Khalifa AA, Kader Fahmy AA, Rabei NH. Accuracy of gray-scale and three-dimensional power doppler ultrasound parameters in the diagnosis of morbidly adherent placenta. *J Basic Clin Reprod Sci.* 2016; 5:12-20.

5. Thia EWH, Lee SL, Tan HK, Tan LK. Ultrasonographical Features of Morbidly Adherent Placentas. *Singapore Med J*. 2007; 48(9):799 -803.

6. J. C. Shih, J. M. Palacios Jaraquemada, YN Su, MK Shyu, CH Lin, SY Lin and CN Lee. Role of three - dimensional power Doppler in the antenatal diagnosis of placenta accreta: comparison with gray-scale and color Doppler techniques. *Ultrasound Obstet Gynecol.* 2009; 33:193-203.

7. Z Alfirevic, AW Tang, SL Collins, SC Robson, and J Palacios - Jaraquemada. Pro forma for ultrasound reporting in suspected abnormally invasive placenta (AIP): an international consensus. *Ultrasound Obstet Gynecol.* 2016; 47:276-278.

8. SL Collins, A Ashcroft, T Braun, P Calda, J Langhoff - Roos, O Morel, V Stefanovic, B Tutschek, and F Chantraine. Proposal for standardaized ultrasound of abnormally invasive placenta (AIP). *Ultrasound Obstet Gynecol.* 2016; 47:271-275.

9. Charlene Sze-Yan Cheung, Ben Chong - Pun Chan. Placenta Accreta - An updated approach to diagnosis and management. e-learning. http://elearning.mims.com/Philippines. 1 Feb 2014.

10. JM Palacios - Jaraquemada. One - Step Conservative Surgery for Abnormal Invasive Placenta (Placenta Accreta - Increta - Percreta). https://www.glowm.com/pdf/PPH_2nd_edn_Chap-31.pdf.

11. JM Palacios - Jaraquemada. Uterine Conservative Procedures in Adherent Placenta. Oral Presentation, 12th Asia Pacific Congress in Maternal Fetal Medicine, Penang, Malaysia, October 7, 2016.

12. Ramdev Konijeti, MD, Jacob Rajfer, MD, Asghar Askari, MD. Placenta Percreta and the Urologist. *Rev Urol.* 2009; 11(3):173-176.

13. Placenta Previa, Placenta Previa Accreta and Vasa Previa: Diagnosis and Management. Royal College of Obstetricians and Gynecologists. Green-top Guideline No. 27. Jan 2011.