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Editorial

Proposal for standardized ultrasound descriptors of abnormally invasive placenta (AIP)

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Abnormally invasive placenta (AIP) is a clinical term used to describe a placenta that does not separate spontaneously at delivery and cannot be removed without causing abnormally high blood loss[1]. It encompasses the histopathological diagnoses of placenta accreta, placenta increta and placenta percreta. It is a spectrum disorder, ranging from placentae containing a small area of abnormally adherent tissue (focal accreta) to those which have invaded into the adjacent viscera (percreta). It is potentially life-threatening, as forced removal of an AIP can lead to catastrophic maternal hemorrhage[2,3].

In developed countries, AIP is the most common reason cited for Cesarean hysterectomy[4]. Maternal mortality for the most severe end of the AIP spectrum (placenta percreta) has been reported to be as high as 7%[5], although this information was published in 1996 and may now be an overestimate given the advances in perinatal care and facilities. Prior Cesarean section (CS), other uterine surgery, assisted reproduction techniques and placenta previa are all risk factors for AIP and their prevalence has increased steadily over the last few decades[6–8]. The incidence of AIP has increased from 1:25 000 in the 1950s to 1:2500[8,9] in the 1980s, paralleling the rise in CS rates, and AIP rates as high as 1:533 (USA)[7] and 1:588 (Canada)[10] have been reported recently. If these trends continue, it has been estimated that, by 2020, the USA will have a 56% CS rate, accounting for an additional 4504 cases of AIP and 130 maternal deaths annually[11].

Maternal mortality and morbidity are reduced when AIP is diagnosed antenatally and women deliver in a tertiary care hospital with a multidisciplinary care team[12–14]. Currently, diagnosis relies on 'typical' sonographic findings[15,16], such as 'placental lacunae' and 'loss of the retroplacental clear zone'[17]. Magnetic resonance imaging, although employed widely in cases of suspected AIP, has yet to be demonstrated clearly to improve management or pregnancy outcome[15]. Irrespective of the imaging modality, diagnosis of AIP is subjective, with accuracy depending on the training and level of experience of the operator.

Several studies have assessed the predictive value of different ultrasound markers of AIP. However, the performance of these markers shows considerable variability among studies using the same signs[16]. These differences have been attributed previously to a combination of limited sample size, retrospective design and variability of study inclusion criteria and eventual diagnosis of AIP[16]. Furthermore, as with all diagnostic techniques reliant on subjective opinion, the recorded presence or absence of each sign will be influenced by the operator's interpretation of what constitutes that marker. This is particularly important to clinicians, who may not have much experience with ultrasonography of the placenta or diagnosing AIP. Additionally, there is no published consensus on the definition of the ultrasound markers used commonly for AIP. Many signs have been described under different names, and in other cases the same term has been used for different findings. The aim of our study, therefore, was to provide unified definitions of ultrasound markers used commonly for AIP ('ultrasound descriptors of AIP').

The 'European Working Group on Abnormally Invasive Placenta' (www.EW-AIP.org) is an international non-profit group, currently consisting of 29 obstetricians, gynecologists, pathologists, anesthesiologists and basic science researchers from 11 European countries. The aim of the group is to advance diagnosis and treatment and to promote research and knowledge on AIP. To improve comparability of future studies, to increase diagnostic capabilities and to facilitate international collaboration, the EW-AIP here proposes standardized definitions of the AIP imaging descriptors.

These standardized definitions were produced by analysis of all 23 studies included in a recent systematic review of the antenatal sonographic diagnosis of AIP[16] (Appendix S1). The exact wording used to describe the ultrasound signs of AIP was extracted,

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Table 1 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 1)	Loss, or irregularity, of hypoechoic plane in myometrium underneath placental bed ('clear zone')
Abnormal placental lacunae (Figure 2)	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 3)	Loss or interruption of bright bladder wall (hyperechoic band or 'line' between uterine serosa and bladder lumen)
Myometrial thinning (Figure 4)	Thinning of myometrium overlying placenta to < 1 mm or undetectable
Placental bulge (Figure 5)	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 (Figure 6)	Placental tissue seen breaking through uterine serosa and extending beyond it; most often seen inside filled urinary bladder
2D color Doppler	
Uterovesical hypervascularity (Figure 7)	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 8)	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 9)	Vessels appearing to extend from placenta, across myometrium and beyond serosa into bladder or other organs; often running perpendicular to myometrium
Placental lacunae feeder vessels (Figure 10)	Vessels with high-velocity blood flow leading from myometrium into placental lacunae, causing turbulence upon entry
3D ultrasound ± power Doppler	
Intraplacental hypervascularity (Figure 11)	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)

2D, two-dimensional; 3D, three-dimensional.

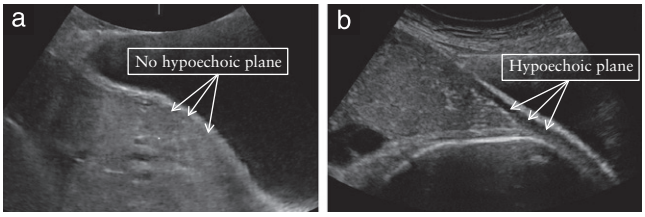

Figure 1 Loss of the 'clear zone' (a) and a normal example for comparison (b) on grayscale ultrasound.

the descriptions were grouped according to ultrasound modality (two-dimensional (2D) grayscale ultrasound, 2D color Doppler and three-dimensional (3D) ultrasound) and synonymous or identical terms were unified under a common heading (Table S1). Following discussion by an expert panel (EW-AIP members present at the 7th EW-AIP meeting in Nancy, November 2014) the various wordings were unified into a set of 11 descriptors, six for 2D grayscale ultrasound, four for 2D color Doppler and one for 3D power Doppler (Table 1). The occurrence of each descriptor in the 23 papers used, grouped according to ultrasound modality, are listed in Table S2. Four of the papers[18–21] included descriptions considered by the expert panel to be insufficiently comprehensive or specific and were not included in the unifying descriptors.

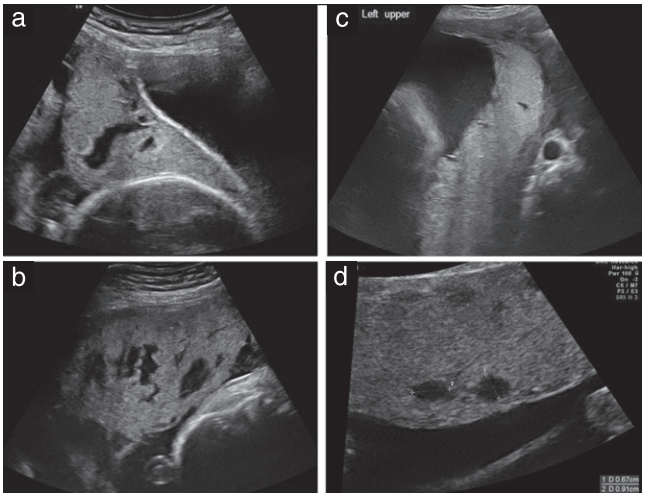

Figure 2 Abnormal placental lacunae (a,b) and normal examples for comparison (c,d) (calipers) on grayscale ultrasound.

Compound signs (e.g. 'uterovesical hypervascularity AND bridging vessels') were divided and included in the individual descriptors.

During the meeting in Nancy, and in the following discussions among all EW-AIP members, importance was placed on defining each sign unambiguously, irrespective

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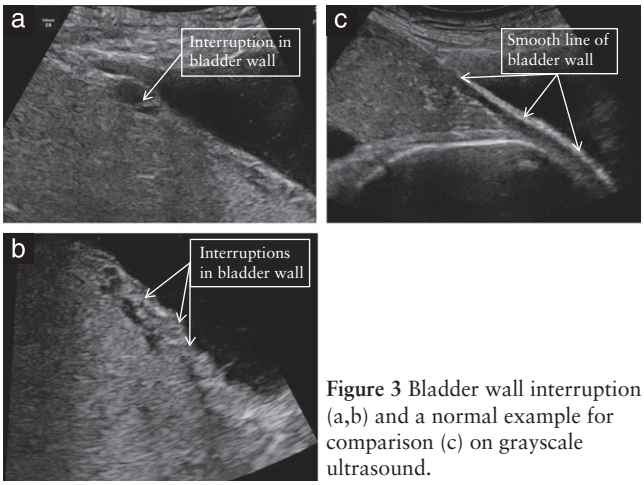

Figure 3 Bladder wall interruption (a,b) and a normal example for comparison (c) on grayscale ultrasound.

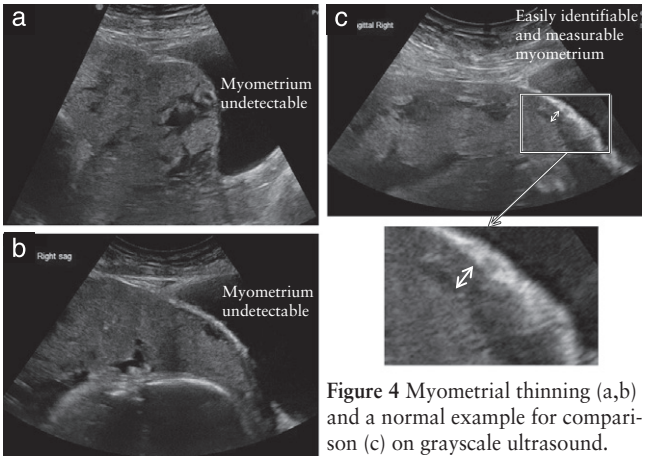

Figure 4 Myometrial thinning (a,b) and a normal example for comparison (c) on grayscale ultrasound.

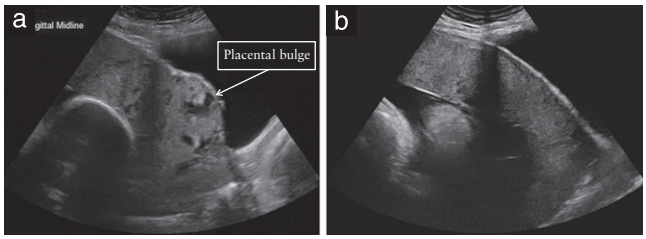

Figure 5 Placental bulge (a) and a normal example for comparison (b) on grayscale ultrasound.

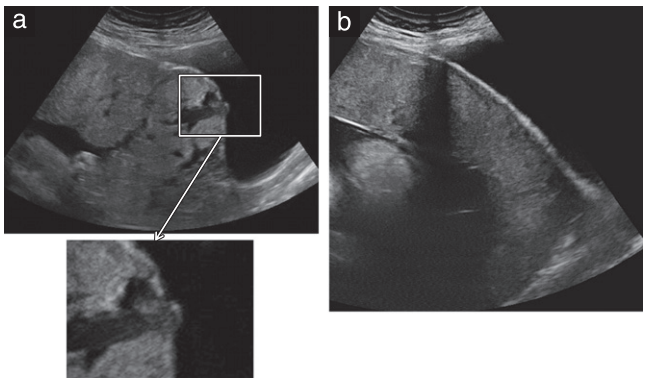

Figure 6 Focal exophytic mass (a) and a normal example for comparison (b) on grayscale ultrasound.

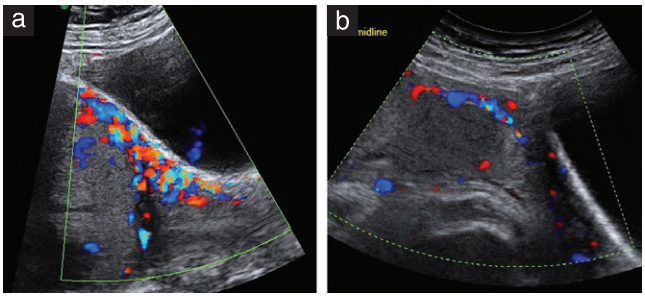

Figure 7 Uterovesical hypervascularity (a) and a normal example for comparison (b) on color Doppler imaging.

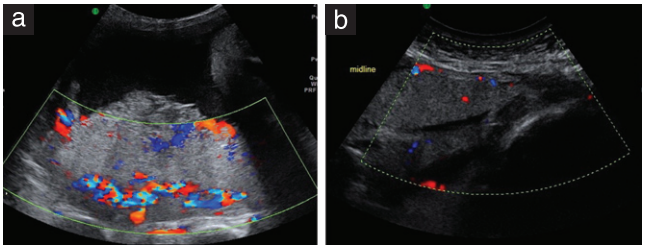

Figure 8 Subplacental hypervascularity (a) and a normal example for comparison (b) on color Doppler imaging.

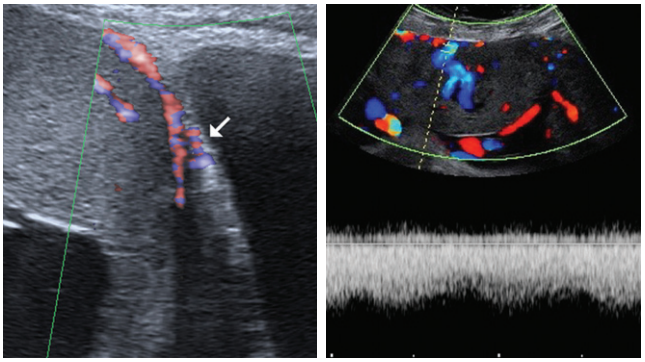

Figure 9 Bridging vessels on color Doppler imaging.

Figure 10 Placental lacunae feeder vessels on color Doppler imaging.

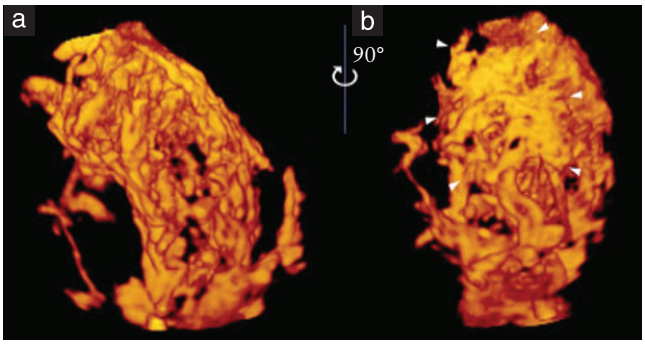

Figure 11 Intraplacental hypervascularity on three-dimensional power Doppler: (a) lateral view; (b) basal view. Reproduced from Shih *et al.*[25] with permission.

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of opinions regarding the predictive value of each descriptor. The unified descriptors were augmented by images that the expert panel agreed were characteristic; these images, accompanied by examples of normal appearance where appropriate, of the unified descriptors are provided here (Figures 1–11 and S1–S11) and a description of technical aspects of the sonographic examination of AIP, with suggestions for obtaining such images in cases suspicious for AIP, are provided in Appendix S2.

AIP is a clinically relevant, difficult-to-manage problem with rising incidence worldwide[22]. Accurate antenatal diagnosis, the basis for appropriate risk assessment and delivery planning, improves maternal outcome[12–14], but is currently dependent on subjective interpretation of imaging findings. Until now, there has been no agreed terminology for these findings. We have identified and analyzed terms commonly used in the literature and unified them. We propose standardized unambiguous definitions of these AIP descriptors and accompany them with characteristic ultrasound images.

These descriptors for AIP should be useful for clinical use, education, teaching and future research projects. In addition to using common terminology, describing precisely the location of the placenta and the part suspicious for abnormal invasion (the topography of AIP) should be considered a standard requirement for describing affected cases.

Maternal mortality and morbidity associated with AIP are reduced when cases are delivered in a tertiary referral center with an experienced multidisciplinary team[12–14,23]. Referral to such a team depends on the prenatal diagnosis of AIP by the primary healthcare providers. By defining clearly the sonographic signs of AIP we hope to facilitate this referral process. Furthermore, the rarity of this condition necessitates collaboration between centers, both nationally and internationally. Ensuring that all investigators are reporting the same ultrasound findings when referring to a specific sign will improve homogeneity of data collection, making results more valid.

Based on these new descriptors we are currently collecting evidence and expert opinions regarding the predictive value of these signs, aiming to develop guidelines for the diagnosis and management of AIP.

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APPENDIX

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SUPPORTING INFORMATION ON THE INTERNET

The following supporting information may be found in the online version of this article:

Figures S1–S11 Full-size versions of Figures 1–11.

Appendix S1 The 23 studies of pregnancies at risk for invasive placentation analyzed by the European Working Group on Abnormally Invasive Placenta (EW-AIP) to produce the proposed standardized definitions of the abnormally invasive placenta imaging descriptors

Appendix S2 Technical aspects to consider when performing an ultrasound scan for AIP markers

Table S1 Wording used in the literature to describe signs for abnormally invasive placenta, grouped according to ultrasound modality

Table S2 Occurrence of each abnormally invasive placental descriptor in the literature, grouped according to ultrasound modality

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