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Ultrasound examination in the antenatal diagnosis of placenta accreta spectrum

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ABSTRACT

The rise in cesarean section rates worldwide has greatly increased the rates of placenta accreta spectrum. Accurate diagnostics of placenta accreta spectrum before delivery is still difficult, as one-half to two-thirds of placenta accreta spectrum cases remain undiagnosed until delivery. Local and foreign studies reported the diagnostic accuracy of ultrasonography (US) as the most commonly used method for placenta accreta spectrum imaging because of its inexpensiveness, noninvasiveness, and swiftness. This review highlighted the possibilities of prenatal US diagnosis of placenta accreta spectrum. Diagnostic accuracy may be reduced by the localization of the placenta in the posterior wall and a higher body mass index. US and magnetic resonance imaging (MRI) are highly specific and useful in diagnosing or ruling out placenta accreta spectrum. Unlike MRI, the accuracy of US depends on the qualification; therefore, single-center studies often overestimate the accuracy of US. More studies of the diagnostic methods for placenta accreta spectrum are needed for the selection of logical obstetric techniques for managing pregnant women with this pathology.

Keywords: placenta accreta spectrum; ultrasonography; magnetic resonance imaging.

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Ультразвуковое исследование в антенатальной диагностике врастания плаценты

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АННОТАЦИЯ

Рост частоты проведения операции кесарева сечения во всём мире за последние десятилетия привёл к фундаментальному увеличению распространённости врастания плаценты. Точная идентификация патологически приросшей плаценты до родов — сложная проблема, и от половины до двух третей случаев врастания плаценты остаются не диагностированными до родов. В отечественной и зарубежной литературе оценивается диагностическая точность ультразвукового исследования (УЗИ) как наиболее часто используемого метода визуализации врастания плаценты, поскольку это недорогой, неинвазивный, а также быстрый метод.

В данном обзоре мы осветили возможности дородовой диагностики врастания плаценты при помощи УЗИ. Диагностическая точность метода может быть снижена из-за расположения плаценты по задней стенке матки и высокого индекса массы тела. УЗИ и магнитно-резонансная томография (МРТ) — высокоспецифичные и чувствительные методы диагностики или исключения врастания плаценты. В отличие от МРТ, УЗИ зависит от опыта специалиста, и, следовательно, одноцентровые исследования часто завышают точность этого метода. Необходимо продолжить изучение методов диагностики врастания плаценты для выбора правильной акушерской тактики ведения беременных с этой патологией.

Ключевые слова: врастание плаценты; ультразвуковое исследование; магнитно-резонансная томография.

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超声检查在胎盘植入产前诊断中的应用

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摘要

近几十年来，全球剖腹产率不断上升，导致胎盘植入的发生率也随之大幅上升。在分娩前准确识别异常胎盘是一个难题。有一半到三分之二的植入胎盘病例直到分娩才得到诊断。超声检查是观察胎盘生长情况最常用的方法，其诊断准确性已在国内外文献中进行了评估，因为它成本低廉、无创伤且是一种快速的方法。

在本综述中，我们强调了产前超声诊断胎盘植入的可能性。由于胎盘位于子宫后壁且体重指数较高，该方法的诊断准确性可能会降低。超声检查和磁共振成像是诊断或排除胎盘植入的高度特异性和敏感性的方法。与核磁共振成像不同，超声检查依赖于专家的经验，因此单中心研究往往会高估这种方法的准确性。有必要进一步研究胎盘植入的诊断方法，以便选择正确的产科策略来治疗患有这种病症的孕妇。

关键词：胎盘生长；超声检查；磁共振成像.

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INTRODUCTION

Placenta accreta spectrum is abnormal trophoblast invasion of part or all of the placenta into the myometrium of the uterine wall [1]. By the invasion depth, *placenta accreta* (when the placenta reaches and grows into the basement membrane), *placenta increta* (trophoblast invasion of the myometrium), and *placenta percreta* (invasion of the serous membrane with possible damage to surrounding structures) are classified [2]. Placenta accreta spectrum is no longer a rare condition in current practice.

A meta-analysis by Jauniaux et al. found that in 2019, the prevalence of placenta accreta spectrum ranged 0.01% to 1.1%, with an overall pooled prevalence of 0.17%. The overall incidence of adhesive and invasive degrees of placenta accreta spectrum was 0.5 and 0.3 cases per 1000 births, respectively [3]. It should be noted that more than 90% of cases of placenta accreta spectrum occur in women with a history of previous cesarean section and a low-lying placenta or placenta previa [4]. A national case-control study using the UK Obstetric Surveillance System found that the incidence of placenta accreta spectrum increased from 1.7 per 10,000 births to 577 per 10,000 births in women with a history of cesarean section and placenta previa [5], i.e. the risk of placenta accreta spectrum increases dramatically with the number of previous cesarean sections. A large multicenter cohort study in the United States found that in women with placenta previa and a history of cesarean section, the risk of placenta accreta spectrum was 3%, 11%, 40%, 61%, and 67% for the first, second, third, fourth, fifth, and subsequent cesarean sections, respectively [6].

Placenta accreta spectrum is a condition that can cause massive bleeding in a pregnant woman, resulting in forced hysterectomy or death. A meta-analysis by Jauniaux et al. (2019) reported prior surgical interventions, including cesarean section, uterine curettage, and myomectomy, in 314/441 women with placenta previa complicated by placenta accreta. Five maternal deaths were reported in 387 (1.3%) patients with placenta previa complicated by placenta accreta spectrum. The overall incidence of peripartum hysterectomy was 52.2% and 46.9% for cases of bleeding requiring blood transfusion. The pooled estimate for maternal mortality was 0.05% [7–8].

Placenta accreta is a serious obstetric complication. The increased incidence of cesarean sections worldwide in recent decades has led to a significant increase in the prevalence of placenta accreta [9]. If growth trends continue, the incidence will increase annually, as will the number of hysterectomies, hemorrhages, and deaths. However, accurate identification of placenta accreta before delivery remains a challenge, with half to two-thirds of placenta accreta cases remaining undiagnosed before delivery, as confirmed by recent studies [10]. Difficulties in diagnosis complicate the choice of the right obstetrical strategy, so the paper highlights the possibilities of prenatal diagnostics of this disorder.

ULTRASOUND DIAGNOSIS OF PLACENTA ACCRETA SPECTRUM

A meta-analysis by Zhong et al. (2021) showed that patients with timely diagnosis of placenta accreta spectrum had a higher gestational age at delivery, a lower amount of blood transfusion, a shorter length of hospital stay (in days), a lower risk of maternal intensive care unit admission and severe maternal morbidity compared with mothers who underwent emergency delivery with undiagnosed condition. Neonatal outcomes were also better in mothers with elective deliveries, as their newborns weighed more and were less likely to be admitted to the intensive care unit. The effect on neonatal weight appears to be mediated by increasing gestational age. The optimal management of placenta accreta spectrum depends on the ability to diagnose invasive placenta preoperatively, the depth of villous invasion, clinical symptoms, and the clinician's experience. It should also be mentioned that the clinical diagnosis of placenta accreta spectrum should be made as early as possible and the pregnant woman should be thoroughly examined at the slightest suspicion [11].

Prenatal diagnosis of placenta accreta spectrum is usually performed by ultrasound (US) in the second and third trimesters of pregnancy and has been shown to have generally good diagnostic accuracy in women at risk, such as those with placenta previa and a history of cesarean section, especially when a combination of maternal risk factors and imaging sings are considered in a personalized diagnostic algorithm [12–15].

In 2016, Collins et al. published an article standardizing the ultrasound signs of placenta accreta spectrum [16–17]. Table 1 shows the ultrasound characteristics of placenta accreta spectrum, included in the meta-analyses.

Pagani et al. (2018) conducted a meta-analysis to evaluate the overall diagnostic accuracy of ultrasound in determining the severity of placenta accreta spectrum. The topography of placental invasion was assessed using the anatomical classification of abnormal placental invasion proposed by Palacios-Jaraquemada et al. (2013). From the anatomical point of view, S1 invasion is a lesion of the uterine body, while S2 invasion is the location of abnormal attachment of the placenta mainly in the lower segment of the uterus or even lower. The topography of the invasion identified during surgery is accepted as the reference [18]. Ultrasound had generally good diagnostic accuracy in determining the depth of placental invasion. Only two studies evaluated the role of ultrasound in determining the topography of invasion. Placenta accreta spectrum was confirmed at surgery in 93.4% of women with S1 invasion and 90.3% of women with S2 invasion. Thinning of the myometrium, rupture of the uterine wall, and hypervascularity of the uterus were associated with the most severe types of placenta accreta spectrum and showed good prognostic accuracy. Furthermore, most studies evaluating the prognostic accuracy of ultrasound

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Table 1. Standardized ultrasound signs of *placenta accrete*

Ultrasound sign	Standard definition	References
	2D Grey scale imaging	
Loss of clear area	Loss or heterogenity of the retroplacental clear area	[14, 16, 17, 19, 20, 27, 28, 29, 30, 31]
Abnormal placental lacunae	The presence of multiple lacunae, including large and irregular (Finberg grade 3), often with turbulent flow (the Swiss cheese sign)	[14, 16, 17, 19, 20, 27, 28, 29, 30, 31]
Abnormal structure of the interface between the uterus and the bladder wall.	Loss or rupture of the clear bladder wall (hyperechoic band or "line" between the uterine serosa and the bladder lumen)	[14, 16, 17, 19, 20, 27, 28, 29, 30, 31, 32]
Thinned myometrium	Thinning of the myometrium over the placenta to <1 mm or undetectable	[16, 17, 19, 20, 29, 30, 31, 32]
Protrusion of placental fragments ("placental hernia")	Deviation of the uterine serosa from the expected plane caused by protrusion of placental tissue into an adjacent organ, usually the bladder; the uterine serosa appears intact but the outline is distorted	[16, 17, 20, 28, 30, 32]
Focal exophytic mass	Placental tissue is seen to break through the uterine serosa and extend beyond its boundaries; most commonly observed within a full bladder	[14, 16, 17,19, 29, 30]
	2D color flow mapping	
Hypervascularity of the vesicouterine area	Excessive color Doppler signal is seen between the myometrium and the posterior bladder wall, likely indicating multiple closely spaced tortuous vessels in this area (demonstrating multidirectional flow and aliasing artifact)	[14, 16, 17, 19, 20, 27, 28, 30, 32]
Subplacental hypervascularity	Excessive color Doppler signal is seen in the placental bed, likely indicating multiple closely spaced tortuous vessels in this area (demonstrating multidirectional flow and aliasing artifact)	[16, 17, 19, 20, 28, 30]
Vascular bridges	Vessels extend from the placenta through the myometrium and across the serosa into the bladder or other organs; often run perpendicular to the myometrium	[16, 17, 28, 30, 32]
Placental lacunae and their feeding vessels	High blood flow vessels leading from the myometrium into the placental lacunae, causing turbulence at the entrance	[16, 17, 20]
Diffuse or focal placental lacunar flow (the presence of a color Doppler signal within the placental lacunae)	Diffuse lacunar flow was defined as diffusely dilated vascular channels scattered throughout the placenta and surrounding myometrial or cervical tissue. Focal lacunar flow was defined as a color Doppler pattern showing irregular anechoic vascular lakes with turbulent lacunar flow distributed within the placental area	[19, 20, 30, 32]
	3D ultrasound ± power Doppler	
Intraplacental hypervascularity	Complex, irregular arrangement of numerous placental vessels with tortuous passages and varying diameters	[16, 17]
Placental hernia	Similar to 2D grayscale imaging	[16, 17]
Focal exophytic mass	Similar to 2D grayscale imaging	[16, 17]
Vesicouterine hypervascularity	Similar to 2D grayscale imaging	[16, 17]
Connective vessels	Similar to 2D grayscale imaging	[16, 17]

Note. ЦДК, color Doppler mapping; ЦДС, color Doppler signal.

in detecting placenta accreta spectrum did not report the diagnostic value of ultrasound in determining the topography of placenta accreta spectrum according to the classification system of Palacios-Jaraquemada et al. (2018) [19].

D'Antonio et al. (2013) considered ultrasound as the main method for prenatal diagnosis of the placenta accreta spectrum. Prenatal magnetic resonance imaging (MRI) may complement ultrasound, as it may be helpful in cases where ultrasound is inconclusive in assessing the extent of invasion (e.g., mixed ultrasound findings, posterior placenta). This review shows that prenatal ultrasound has prognostic value in the diagnosis of placenta accreta spectrum in a high-risk population. However, the authors believe that isolated ultrasound signs should be treated with caution. The discovery of one sign is likely to increase the potential for the discovery of others, since signs do not exist in isolation. This review found high sensitivity and specificity of the proposed method for multiple vascular lacunae. However, lacunae may also be present in women with placenta previa without placenta accreta spectrum. The invasion of trophoblastic tissue through the myometrium and the absence of the basal decidua in placenta accreta spectrum lead to a gradual decrease in myometrial thickness and loss of the hypoechoic area between the myometrium and the placenta. At the end of the third trimester, the lower uterine segment appears as a thin line on transabdominal ultrasound, and the interface between myometrium and placenta may be difficult to assess, which may explain the low sensitivity of this ultrasound sign. A higher grade of the placenta accreta spectrum is associated with destruction of the outer third of the myometrium and serous membrane of the uterus, followed by involvement of the bladder. This condition can be diagnosed using ultrasound by examining the interface between the myometrium and bladder, which is normally echogenic and smooth. This condition is a reliable sign for making the diagnosis, but its absence does not rule out lower grades of the placenta accreta spectrum.

However, these findings do not apply to placenta accreta located on the posterior wall or fundus of the uterus. Results apply only to women with placenta previa and a history of cesarean section or uterine surgery. The authors suggest that patients with an anterior placenta and a previous cesarean section represent the largest group of women with placenta accreta spectrum, who are most likely to have complications and for whom prenatal diagnosis is likely to be of greatest value. Abnormalities on color Doppler imaging and the presence of abnormal blood vessels were the best predictors of placenta accreta spectrum in high-risk women. However, this is not always an objective criterion and clarification is needed [14].

Poder et al. (2020) believe that in transabdominal 2D ultrasound, disruption, thickening or irregularity of the serosa–bladder interface is a sign of placenta accreta spectrum with high sensitivity and specificity. The reliability of the sign increases with increasing depth of invasion. Special attention is paid to increased placental vascularity, subplacental vascularity and vascularity at the serosa–bladder interface. Vascular lacunae in the placenta are thought to be due to the effect of pulsatile blood flow, high-speed blood flow from the myometrium into the lacunae. The presence of placental lacunae on second trimester ultrasound is proven to have the highest sensitivity and positive predictive value for determining placenta accreta spectrum. Three-dimensional color Doppler ultrasound is reported to aid in the diagnosis and demonstrate multiple coherent vessels involving the placental base, which has been shown to be a reliable prognostic sign [20].

The study by Jauniaux et al. (2017), which included 3889 pregnant women with placenta previa or low-lying placenta and a history of cesarean section, identified 328 (8.4%) cases of placenta accreta, of which 298 (90.9%) were diagnosed prenatally by ultrasound. The incidence of placenta accreta spectrum was 4.1% in women who had one cesarean section and 13.3% in women who had two cesarean sections. The overall value of ultrasound for the antenatal diagnosis of placenta accreta spectrum was higher in prospective studies; sensitivity was 97.0% (95% CI 93.0, 99.0), specificity 97.0% (95% CI 97.0, 98.0), and diagnostic odds ratio (DOR) 228.5 (95% CI 67.2, 776.9). In retrospective studies, sensitivity was 88.0% (95% CI 81.0, 93.0), specificity was 90.0% (95% CI 88.0, 93.0), and DOR was 80.8 (95% CI 13.0, 501.4). Some signs, such as multiple placental lacunae and placental hernia, as well as focal placental exophytic mass, were more frequently associated with deeper placental invasion of the myometrium. In the largest prospective studies, positive correlations were found between the cumulative incidence of more invasive forms of the placenta accreta spectrum and the sensitivity and specificity of ultrasound imaging, but not with the diagnostic odds ratio values. The authors found no data on ultrasound screening for placenta accreta spectrum during routine second trimester ultrasound in non-specialized ultrasound departments. In contrast to MRI, ultrasound results depend on the experience of a specialist, and therefore single-center studies often overestimate the accuracy of ultrasound because it is performed by trained specialists in specialized centers, but the total number of cases of placenta accreta spectrum diagnosed prenatally in some cohorts is small [21].

D'Antonio et al. (2014) compared the diagnostic accuracy of ultrasound and MRI. They only included studies that used both imaging modalities on an equal number of women, regardless of knowledge of the ultrasound diagnosis. Histopathologic data and/or surgical records were used as the gold standard. The depth of invasion was classified as no invasion, *placenta accreta*, *placenta increta*, and *placenta percreta*. The topography of placental invasion was classified as invasion into S1, S2, or parametrium. MRI and ultrasound had similar diagnostic value in detecting placenta accreta spectrum. Only four studies performed MRI and ultrasound in women in the same risk group, and the

radiologists interpreting the images were blinded to both the ultrasound results and the final diagnosis. When the analysis was stratified by these studies alone, MRI showed a sensitivity of 92.9% (95% CI 82.4%, 97.3%), specificity of 93.5% (95% CI 82.2%, 97.8%), positive likelihood ratio (LR+) of 14.22 (95% CI 4.92, 41.1), negative likelihood ratio (LR-) of 0.08 (95% CI 0.03, 0.20), and DOR of 186.0 (95% CI 40.0, 864.5). Ultrasound showed a sensitivity of 87.8% (95% CI 75.8%, 94.3%), specificity of 96.3% (95% CI 74.4%, 99.6%), LR+ 24.0 (95% CI 2.81, 205.0), LR- 24.0 (95% CI 2.81, 205.0). There was no significant difference in sensitivity (p=0.24) or specificity (p=0.91) between ultrasound and MRI for detection of the placenta accreta spectrum. It was not possible to perform a meta-analysis to compare the diagnostic accuracy of ultrasound and MRI in assessing the depth and topography of placental invasion because only one study could provide different data on their diagnostic value [13].

A systematic review and meta-analysis by De Oliveira Carniello et al. (2022) included 17 studies involving 1,301 women with available MRI and ultrasound data. The study population included 457 cases of placenta accreta spectrum diagnosed by the gold standard method (intraoperative or histopathologic analysis). The authors found no statistically significant difference between two methods and also reported a high degree of heterogeneity in the sensitivity and specificity data of ultrasound and MRI across studies [22].

Table 2 presents statistical data on sensitivity and specificity from meta-analyses and studies.

Ultrasound is the most commonly used imaging modality to diagnose placenta accreta spectrum because it is inexpensive, noninvasive, and rapid. Color and power Doppler ultrasound and the use of a transvaginal probe appear to improve the value of conventional ultrasound in assessing placenta accreta spectrum. Color and power Doppler ultrasound can identify areas of increased vascularity with dilated blood vessels crossing the placenta and uterine wall [13]. A transvaginal probe may improve near-field resolution at the interface between the placenta and lower uterine segment, especially in cases of placenta previa or posterior placenta [23–24]. High-frequency transducers are reported to improve the spatial resolution of superficial structures, thereby improving the accuracy of ultrasound [25].

CONCLUSION

Prenatal ultrasound has good prognostic accuracy in diagnosing placenta accreta spectrum in high-risk women. However, isolated ultrasound signs should be treated with caution. The discovery of one sign is likely to increase the potential to discover others, since signs are not evaluated in isolation. It should be noted that vascular lacunae may be present even in women with placenta previa without placenta accreta spectrum, and the lower uterine segment may appear as a thin line on transabdominal ultrasound in the late third trimester, making assessment of the myometrial-placental interface difficult. A higher grade of the placenta accreta spectrum is associated with destruction of the outer third of the myometrium and serous membrane of the uterus, followed by involvement of the bladder. This condition can be diagnosed using ultrasound by examining the interface between myometrium and bladder, which is normally echogenic and smooth. This condition is a reliable sign for making the diagnosis, but its absence does not rule out lower grades of the placenta accreta spectrum. Some signs, such as multiple placental lacunae and placental hernia, as well as focal placental exophytic mass, were more frequently associated with deeper placental invasion of the myometrium. Color and power Doppler ultrasound and the use of a transvaginal probe, improve the effectiveness of conventional ultrasound in assessing placenta accreta spectrum. High-frequency transducers improve the spatial resolution of superficial structures, thereby improving the accuracy of ultrasound.

Although ultrasound can accurately detect placenta accreta spectrum, its diagnostic value in determining the severity of placenta accreta spectrum needs to be established. Approximately 20% of women with *placenta percreta* cannot be correctly diagnosed, so more accurate predictive models need to be developed to diagnose severe forms of the placenta accreta spectrum. The diagnostic accuracy of ultrasound in detecting placenta accreta spectrum may be reduced by several clinical parameters, including unfavorable placental location (i.e., posterior one) and high body mass index (BMI). Later gestational age at ultrasound (>30 weeks) may affect the detection of abnormalities; heterogeneous signal intensity and infarcts are more common in later pregnancy due to physiologic aging of the placenta.

Some authors believe that there is no significant difference in the diagnostic value of ultrasound and MRI in placenta accreta spectrum. Both ultrasound and MRI are highly specific and sensitive methods for diagnosing (or excluding) placenta accreta spectrum. In contrast to MRI, ultrasound results depend on the experience of a specialist, and therefore single-center studies often overestimate the accuracy of ultrasound because it is performed by trained specialists in specialized centers, but the total number of cases of placenta accreta spectrum diagnosed prenatally in some cohorts is small, leading to inaccurate results. It is necessary to continue studying the diagnostic methods for placenta accreta spectrum to select the effective obstetrical strategy for management of pregnant women with these disorders.

ADDITIONAL INFO

Authors' contribution. All authors confirm that their authorship meets the international ICMJE criteria (all authors made a substantial contribution to the conception of the work, acquisition, analysis, interpretation of data for the work, drafting and revising the work,

Table 2. Sensitivity and specificity of ultrasound signs of *placenta accreta*

Parameter	Grade of invasion	Sensitivity	Specificity
Overall efficiency	–	85.7% (95% CI 77.2, 91.4) [13] 90.72% (95% CI 87.2, 93.6) [14] 97.0% (95% CI 93.0, 99.0) [21] 83.8 (95% CI 78.6, 87.9) [22] 83% [26] 73.7% [27] 90.7% [31]	88.6% (95% CI 73.0, 95.7) [13] 96.94% (95% CI 96.3, 97.5) [14] 97.0% (95% CI 97.0, 98.0) [21] 83.1 (95% CI 77.0, 87.8) [22] 95% [26] 96.3% [27]
Performance of color Doppler signal	–	90.74% (95% CI 85.2, 94.7) [14]	87.68% (95% CI 84.6, 90.4) [14]
Determining the depth of invasion	Placenta accreta	90.6% (95% CI 80.7, 96.5) [19]	97.1% (95% CI 95.4, 98.3) [19]
	Placenta increta	93.0% (95% CI 80.9, 98.5) [19]	98.4% (95% CI 97.0, 99.2) [19]
	Placenta accreta/increta	89.5% (95% CI 73.2, 96.3) [19]	94.7% (95% CI 91.0, 96.9) [19]
	Placenta percreta	81.2% (95% CI 51.8, 94.6) [19]	98,9% (95% ДИ 95,0–100) [19] / 98.9% (95% CI 95.0, 100.0) [19]
Determining the topography of invasion	S1	93.4% (95% CI 64.7, 100.0) [19]	
	S2	90.3% (95% CI 80.7, 97.4) [19]	
Loss of clear area	Placenta accrete	74.9% (95% CI 33.5, 94.6) [19]	92.0% (95% CI 68.8, 98.3) [19]
	Placenta increta	91.6% (95% CI 59.9, 98.8) [19]	76.9% (95% CI 45.4, 93.0) [19]
	Placenta percreta	88.1% (95% CI 64.7, 96.8) [19]	71.1% (95% CI 42.2, 89.2) [19]
	General parameters	66.24% (95% CI 58.3, 73.6) [14]	95.76% (95% CI 94.9, 96.5) [14]
Abnormal placental lacunae	Placenta accreta	74.8% (95% CI 55.4, 87.6) [19]	87.9% (95% CI 52.6, 97.9) [19]
	Placenta increta	88.6% (95% CI 55.3, 98.0) [19]	77.4% (95% CI 46.8, 93.0) [19]
	Placenta percreta	76.3% (95% CI 42.2, 93.4) [19]	74.0% (95% CI 45.0, 90.9) [19]
	General parameters	77.43% (95% CI 70.9, 83.1) [14]	95.02% (95% CI 94.1, 95.8) [14]
Abnormal structure of the interface between the uterus and the bladder wall.	Placenta accreta	17.0% (95% CI 0.06, 85.8) [19]	96.8% (95% CI 86.0, 99.3) [19]
	Placenta increta	46.1% (95% CI 11.0, 85.5) [19]	97.3% (95% CI 91.0, 99.3) [19]
	Placenta percreta	62.0% (95% CI 23.2, 89.8) [19]	62.0% (95% CI 23.2, 89.8) [19]
	General parameters	49.66% (95% CI 41.4, 58.0) [14]	99.75% (95% CI 99.5, 99.9) [14]
Thinned myometrium	Placenta accreta	100% (95% CI 31.0, 100.0) [19]	85.0% (95% CI 72.9, 92.5) [19]
	Placenta increta	100% (95% CI 47.8, 100.0) [19]	74.3% (95% CI 62.4, 84.0) [19]
	Placenta percreta	85.7% (95% CI 57.2, 98.2) [19]	76.0% (95% CI 66.4, 84.0) [19]
Protrusion of placental fragments (placental hernia)	The sign was identified by Collins et al. [16, 17]		
Focal exophytic mass	Placenta percreta	16.7% (95% CI 0.42, 64.2) [19]	100% (95% CI 88.6, 100.0) [19]
Placental lacunar flow	Placenta accreta	81.2% (95% CI 57.2, 93.3) [19]	84.0% (95% CI 65.4, 93.6) [19]
	Placenta increta	84.3% (95% CI 50.8, 96.5) [19]	79.7% (95% CI 57.4, 91.9) [19]
	Placenta percreta	45.2% (95% CI 27.3, 64.0) [19]	75.3% (95% CI 69.8, 80.2) [19]
Hypervascularity of the vesico-uterine area	Placenta accreta	12.3% (95% CI 2.59, 100.0) [19]	90.8% (95% CI 75.2, 97.0) [19]
	Placenta increta	94.4% (95% CI 29.2, 100.0) [19]	88.0% (95% CI 72.8, 95.3) [19]
	Placenta percreta	86.2% (95% CI 60.0, 96.3) [19]	88.2% (95% CI 71.9, 95.6) [19]
	General parameters	90.74% (95% CI 85.2, 94.7) [14]	87.7% (95% CI 84.6, 90.4) [14]
Subplacental hypervascularity	Placenta accreta	40.7% (95% CI 22.4, 61.2) [19]	95.5% (95% CI 91.3, 98.0) [19]
	Placenta increta	17.4% (95% CI 5.0, 38.8) [19]	93.8% (95% CI 88.8, 97.0) [19]
	Placenta percreta	40.0% (95% CI 12.2, 73.8) [19]	92.5% (95% CI 85.1, 96.9) [19]

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