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Sonographic Assessment of Isthmocele and Its Obstetric Complications in Subsequent Pregnancies: A Pictorial Review

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Abstract

Cesarean scar defect represents a significant pathology attributed to the rising prevalence of cesarean deliveries. While not commonplace, these lesions can give rise to severe obstetric consequences during subsequent pregnancies. Given the potential complications, it is advisable to screen for uterine niches using transvaginal ultrasound (TVUS) or contrast-enhanced TVUS for individuals planning to conceive. Surgical repair and correction of these lesions can be crucial in averting obstetric and perinatal complications in future pregnancies. Furthermore, timely sonographic evaluation and reporting of isthmocele-related obstetric complications can help avoid serious issues.

Keywords
- cesarean section
- isthmocele
- placenta accreta spectrum
- cesarean scar pregnancy
- retained products of conception
- sonography

Introduction

Uterine isthmocele, also known as uterine niche, is a delayed complication of cesarean deliveries. Despite typically being asymptomatic, the cesarean scar defect (CSD) has been identified as a significant factor related to future gynecological and obstetric complications.[1] An isthmocele increases the risk of various pregnancy-related issues, such as placenta previa, cesarean scar pregnancy (CSP), placenta accreta spectrum (PAS), and scar dehiscence. Additionally, it is a potential space to retain products of conception (POC) and blood clots associated with an intrauterine pregnancy or a CSP.

The niche can be evaluated through two-dimensional (2D) or three-dimensional (3D) transvaginal ultrasound (TVUS), with or without saline or gel contrast, hysteroscopy, and magnetic resonance imaging.[2–5] Studies using TVUS and gel infusion sonography have reported a prevalence of uterine niche after cesarean section (CS) at 49.6 and 64.5%, respectively.[1] Evaluation of isthmocele is crucial because large CSD and other niche characteristics are associated with the severity of complications. However, while large niches occur less frequently, with an incidence varying from 11 to 45%, reporting small niches is equally important as such defects are not without complications.[2,5,6] Moreover, a thorough understanding of isthmocele-related obstetric complications and proficient skills in sonographic evaluation and reporting of these conditions are essential for clinically assessing symptoms and planning surgical interventions. The sonographic assessment of uterine niche and its obstetric complications in subsequent pregnancies is discussed herewith.

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Isthmocele

Uterine niche is defined as an anechoic defect within the myometrium of the isthmic portion of the uterine corpus, at a minimum of 2.0 mm in depth.[7,8] Although there is no universally considered gold standard diagnostic method,[9] the modified Delphi consensus by Jordans et al found that 2D-TVUS is the primary imaging approach for diagnosing isthmocele in nonpregnant individuals. Gel or saline infusion sonohysterography may provide additional value if a niche is suspected.[1,7] This consensus has been expanded to include a further statement on evaluating isthmocele in the first trimester.[10] On TVUS, an isthmocele typically appears as a triangular defect with its base oriented toward the uterine cavity (►Fig. 1).[2,7,8] The shape and morphology of the defect may vary, appearing as round, square, or wedge shaped.[2] The characteristics of the niche are related to the severity of obstetric complications in future pregnancies and may influence the management of related symptoms. Therefore, a uniform and accurate description and measurement of a niche are crucial.[1,7] Jordans et al recommended that only basic measurements, including niche length, depth, residual myometrial thickness (RMT), adjacent myometrial thickness (AMT) in the sagittal plane, and niche width in the transverse plane (►Fig. 2A–C) are essential.[7] Any branches should be reported, and additional measurements may be required (►Fig. 3A,B).[7] The severity of CSD can be determined by

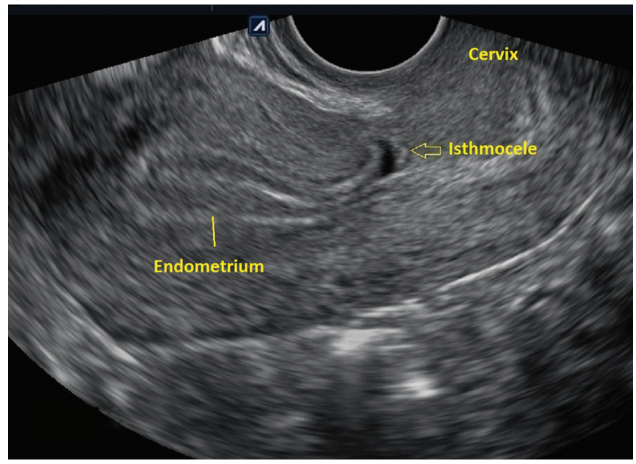

Fig. 1 TVUS in the sagittal plane shows a triangular defect with a base communicating with the endometrial cavity. Assessment of the CSD is recommended after 3 months of a CS, particularly during the mid-follicular phase when fluid is present in the uterine cavity.[7] CS, cesarean section; CSD, cesarean scar defect; TVUS, transvaginal ultrasound.

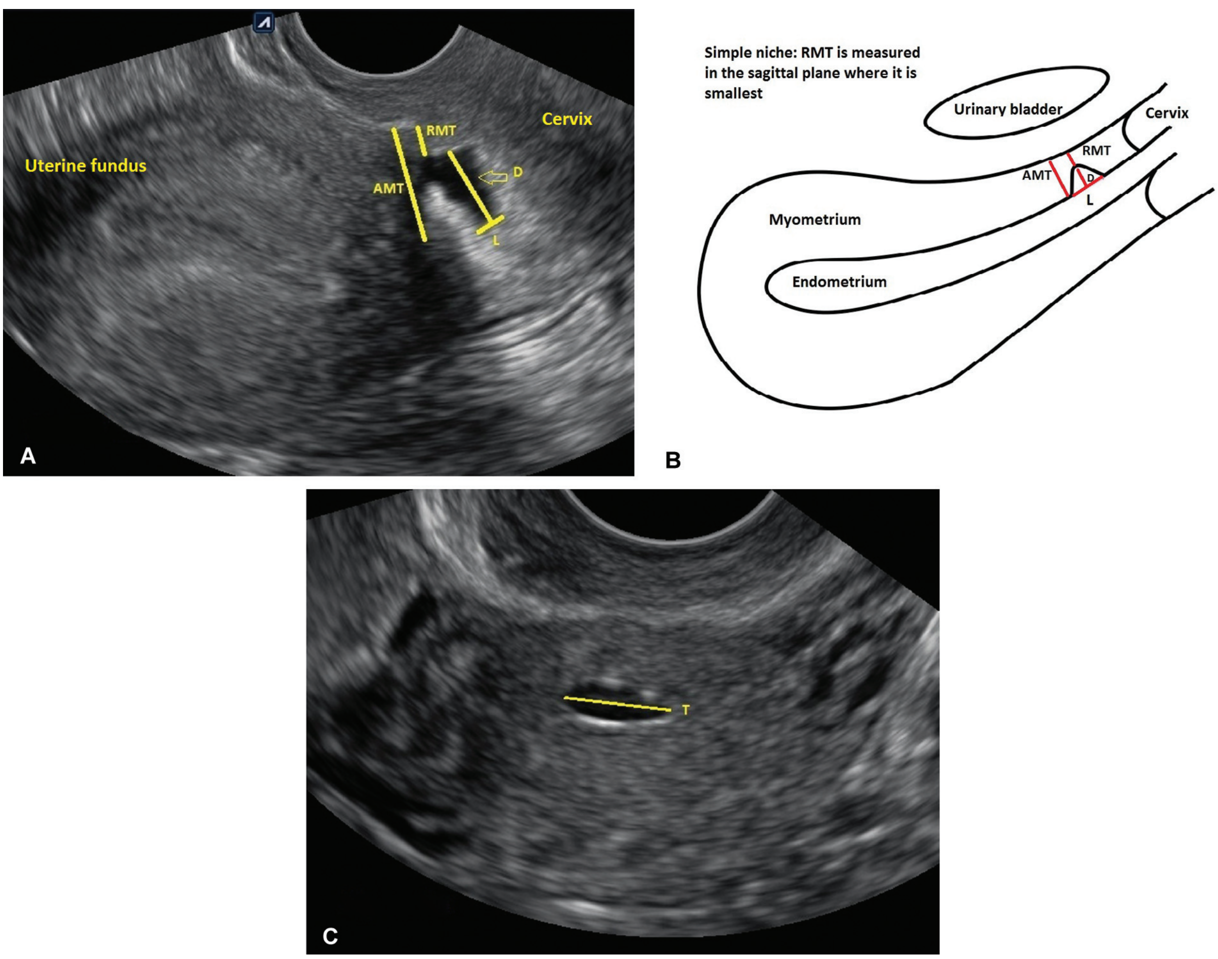

Fig. 2 (A,B) A simple niche in the longitudinal and (C) transverse planes: The L, D, and T of a niche are measured in a single plane where it appears largest.[7] The RMT is measured in the sagittal plane where it is the smallest.[7] (B) Schematic representation of simple niche. Drawings adapted from Antila-Långsjö et al.[11] AMT, adjacent myometrial thickness; D, depth; L, length; RMT, residual myometrial thickness; T, width.

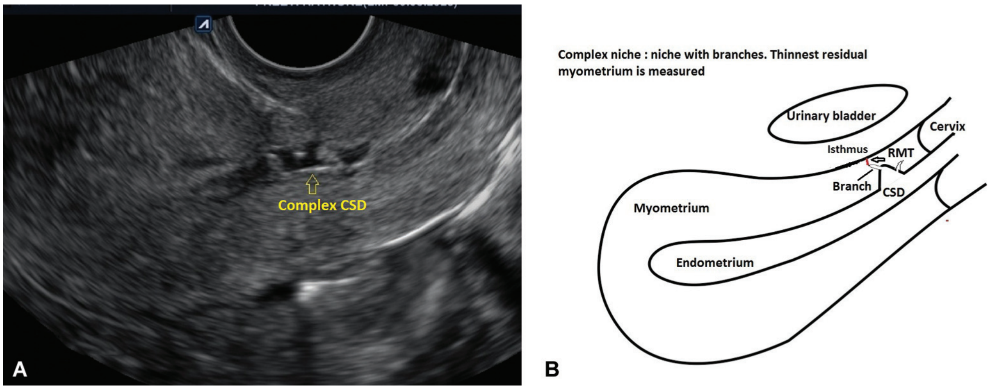

Fig. 3 (**A, B**) Complex niche (niche with branches): multiple planes might be needed. Length and depth measurements are taken in the same sagittal plane.[7] However, assessing the thinnest RMT of the main niche and its branch might require one or two different sagittal planes.[7] (**B**) Schematic diagram of a complex niche. Uterus line diagram adapted from Antila-Långsjö et al.[11] CSD, cesarean scar defect; RMT, residual myometrial thickness.

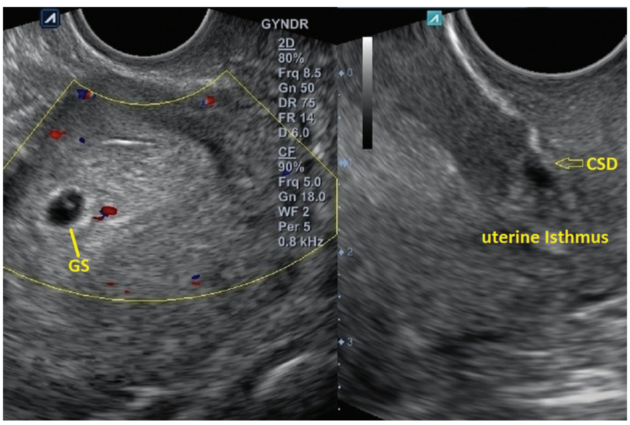

Fig. 4 TVUS reveals a 5-week intrauterine gestational sac with an isthmocele (arrow). The RMT/AMT ratio was $<50\%$. In such cases, the risk of PAS increases if the future placenta is anterior and low lying. The niche can retain POC in the event of spontaneous abortion or if MTP is chosen. AMT, adjacent myometrial thickness; CSD, cesarean scar defect; GS, gestational sac; MTP, medical termination of pregnancy; PAS, placenta accreta spectrum; POC, products of conception; RMT, residual myometrial thickness; TVUS, transvaginal ultrasound.

the RMT to AMT ratio[7] or the niche depth to AMT ratio[11]; it is considered severe when the RMT to AMT ratio is $\leq$ 50%[7] or the niche depth to AMT ratio is $\geq$ 50%.[11] Another method involves using a cutoff of 2.2 mm for RMT in TVUS and a value $<$ 2.5 mm in sonohysterography.[6] Pomorski et al measured a depth/RMT ratio and concluded that a depth/RMT ratio $>$1.30 is associated with severe obstetric complications such as scar rupture.[12] Although large CSDs have an increased risk of obstetric complications, incidental and asymptomatic CSDs must also be documented and reported because such niches are not free of obstetric complications in future pregnancies.[12] Assessing niche characteristics in non-pregnant women who desire future pregnancies allows identifying defects at higher risk, enabling correction before the next pregnancy.[12]

During the first trimester of pregnancy (►**Fig. 4**), the severity of a niche is evaluated by measuring the RMT and AMT in the sagittal plane.[10] Other measurements have been deemed inconsequential due to their variability as the pregnancy advances.[10] The CSD is no longer visible as the pregnancy progresses into the second and third trimesters. In these stages, assessment for potential obstetric

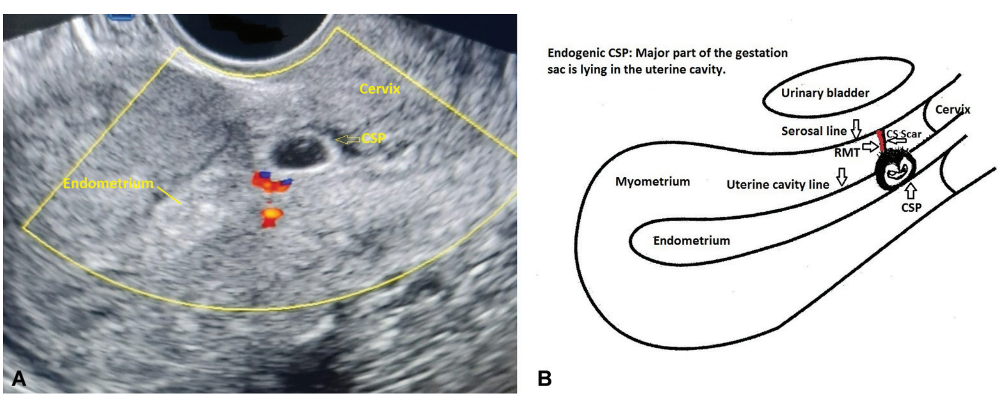

Fig. 5 (**A, B**) TVUS at 5 weeks of gestation: features of CSP (endogenic type) include an empty uterine cavity, a gestational sac with a yolk sac implanted in the isthmic part of the uterus, a thin anterior myometrium, and an empty cervical canal. (**B**) Diagrammatic representation of endogenic CSP. Uterus line diagram adapted from Antila-Långsjö et al.[11] CS, cesarean section; CSP, cesarean scar pregnancy; RMT, residual myometrial thickness; TVUS, transvaginal ultrasound.

complications involves measuring the thickness of the lower uterine segment (LUS) and the myometrial layer at the thinnest point of the scar region.[13] While the evaluation of CSD in the first trimester may prove valuable for the early identification of patients at risk of subsequent perinatal complications, it does not necessarily correlate with adverse pregnancy outcomes.[13]

Cesarean Scar Pregnancy

A CSP (►**Figs. 5–8**) is defined as implantation occurring within or near the scar tissue from a previous CS.[10] It arises solely in the presence of CSD and not in fully healed scars.[10] This condition is linked with severe complications such as uterine rupture and hemorrhage, often occurring early in pregnancy, necessitating a hysterectomy and occasionally leading to fatalities.[14] Consequently, it is advised that the initial evaluation of the cesarean scar, to exclude CSP, should be conducted as early as 7 weeks into the pregnancy (►**Fig. 5A, B**).[10] Early detection before 9 weeks significantly reduces the risk of adverse outcomes.[10] TVUS, alone or in conjunction with 3D TVUS and color Doppler, is generally considered the most reliable way to diagnose CSP.[9] Important sonographic details include the CSP's location concerning the uterine cavity, serosa, and uterine vessels.[10] Measurements of RMT and AMT in the sagittal plane are crucial.[10] Factors such as gestational age, viability, trophoblastic vascularity, enhanced myometrial vascularity (EMV)

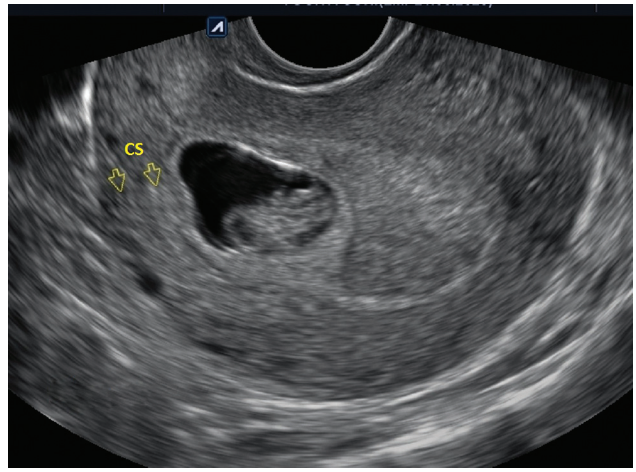

Fig. 6 TVUS at 7 weeks of gestation: The gestational sac is lying near the CS scar. No thinning of the anterior myometrium; a sliding sign was present suggesting ongoing miscarriage. Previous CS scar (arrows). CS, cesarean section; TVUS, transvaginal ultrasound.

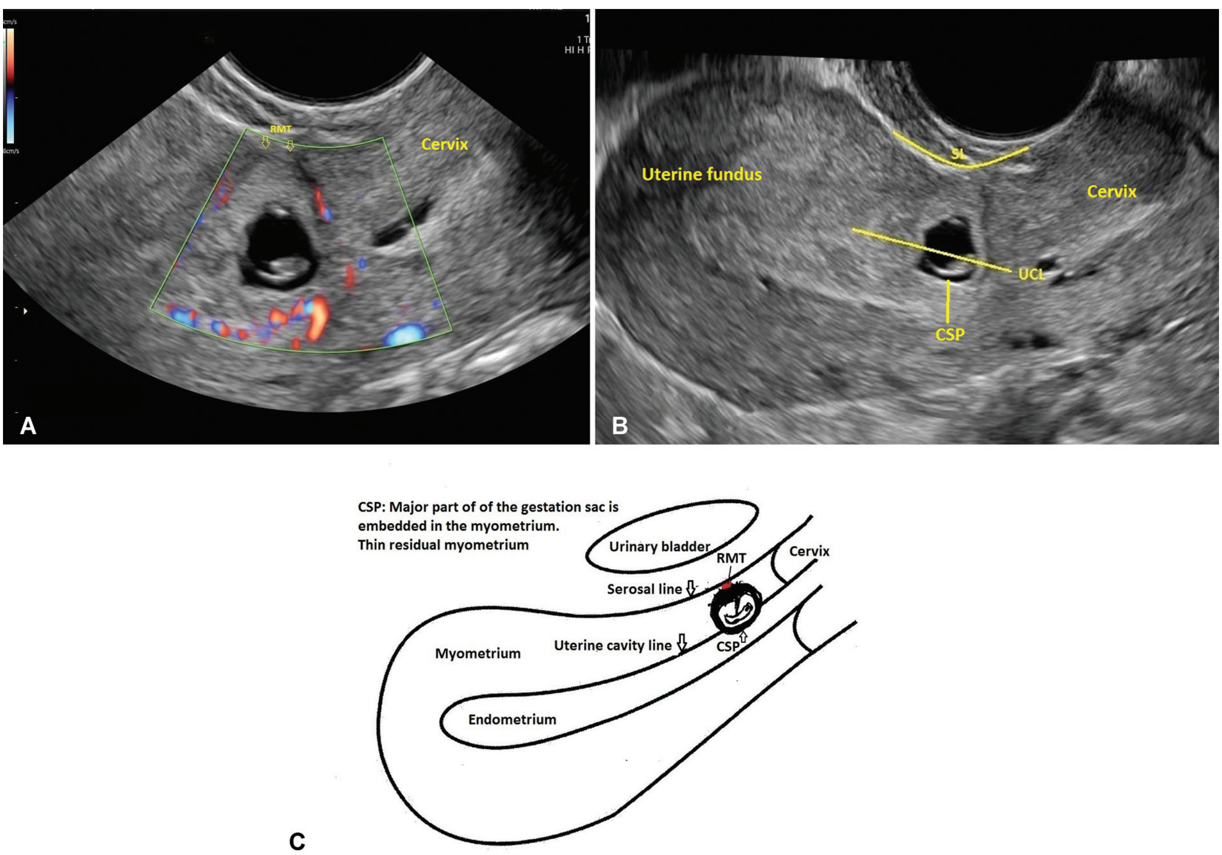

Fig. 7 (A) The gestational sac shows a well-formed fetal pole surrounded by a hyperechoic rim of choriodecidual reaction. Note the thinned-out anterior myometrium (arrows). Doppler reveals peripheral vascularity around the gestational sac. (**B**) Note the relation of the gestational sac with the UCL and SL. The major part of the gestational sac is embedded in the myometrium and does not extend beyond the serosal line. [With the kind permission of Dr Amol Karwande] (**C**) Diagrammatic representation of (**B**). Uterus line diagram adapted from Antila-Långsjö et al.[11] CSP, cesarean scar pregnancy; RMT, residual myometrial thickness; SL, serosal line; UCL, uterine cavity line.

in the adjacent myometrium, coexisting intrauterine pregnancy, and any molar changes[15] should be assessed. An ongoing abortion, where the gestation sac is lying near the internal os, is a major differential diagnosis of CSP (►Fig. 6).

The location of a CSP is assessed about two hypothetical lines: the uterine cavity line, delineating the boundary between the endometrium and myometrium, and the serosal line (►Fig. 7B,C), which signifies the outer margin of the myometrium at the uterine isthmus.[10] Depending on its placement, the pregnancy is categorized as follows[16,17]: (1) endogenic type, when the major portion of the gestation sac extends toward the uterine cavity (►Fig. 5A, B); (2) CSP, when the primary part of the gestation sac is embedded in the myometrium but does not breach the serosal contour (►Fig. 7A-C); and (3) exogenic type when the gestation extends beyond the serosal contour (►Fig. 8A-C).The literature review indicates that the exogenic type of CSP is associated with a higher risk of uterine rupture and heavy bleeding during the first trimester due to its association with the severe form of PAS.[17–19] Conversely, the endogenic type of CSP is associated with a milder form of PAS, which may be more manageable postnatally, ultimately leading to favorable pregnancy outcomes.[16–18] The precise location of a CSP concerning the uterine arteries becomes crucial when considering various treatment options.[10] Identifying the CSP location is feasible until 12 weeks of gestation; beyond this period, the type of CSP may evolve as the gestation progresses.[10,18,19] Evaluation of a CSP also includes assessment of adjacent myometrium for EMV.[20] The coexistence of both CSP and EMV represents a potentially life-threatening combination.[20]

Placenta Accreta Spectrum

PAS encompasses a range of disorders, from abnormal adherence to complete invasion of the placenta through the uterine wall. Various second- and third-trimester ultrasound features of PAS[21–23] at uteroplacental and uterovesical interfaces can be visible as early as the late first trimester, especially in pregnancies with an increased a priori risk for the condition. Severe forms of CSD and CSP are major risk factors for the disorder. In such cases, inadequate residual myometrium is exposed to the progressive invasion of the extravillous trophoblast, resulting in a more severe phenotype of PAS (►Fig. 9A, B). Additionally, the villi penetrating and traversing the Nitabuch layer of the decidua weaken the thin myometrial tissue layers and may cause placental bulge, scar dehiscence, and rupture.[23] A CSP and second-trimester PAS share histopathological features, suggesting a continuum in disease pathogenesis.[24]

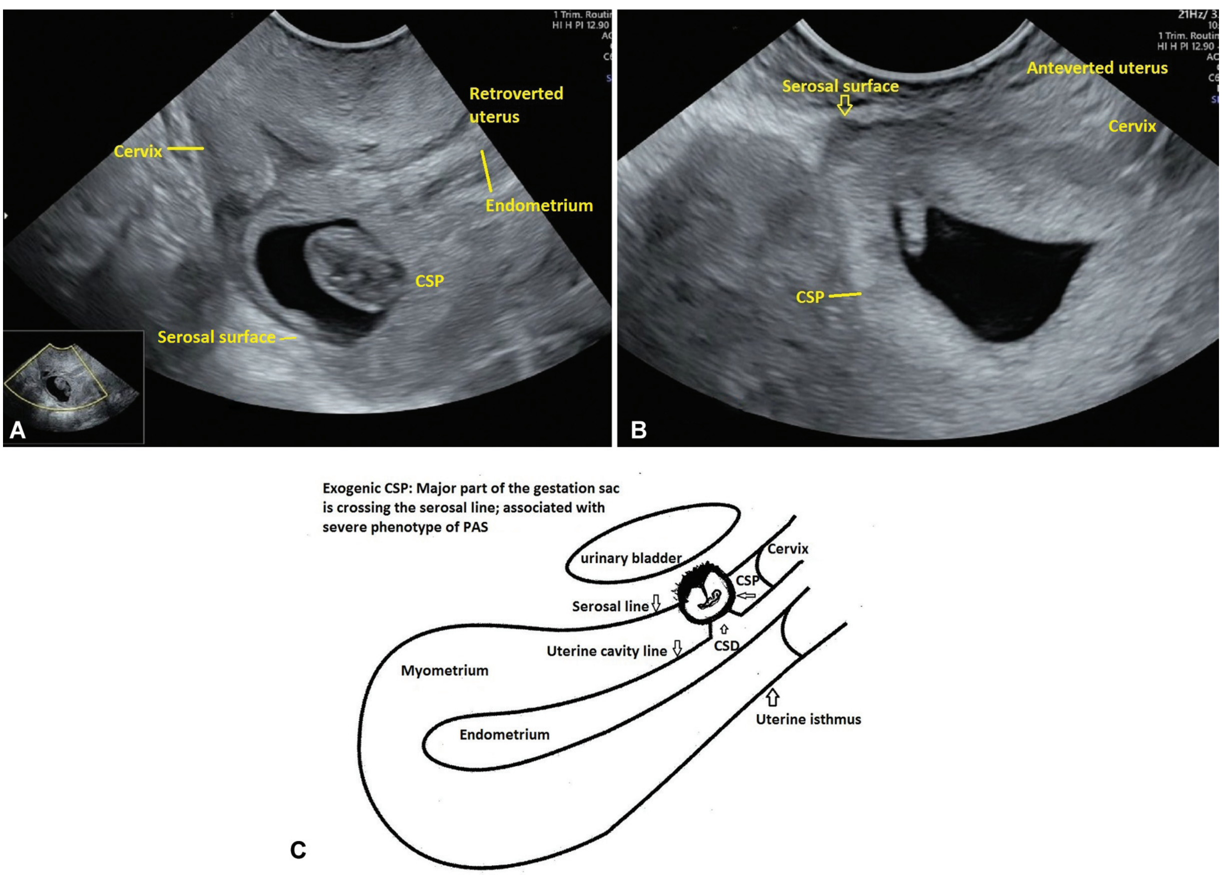

Fig. 8 (A–C) Sonographic appearances of exogenic type of CSP in retroverted (A) and anteverted uterus (B). The gestational sac is herniated through the serosa. The exogenic type of CSP is associated with absent residual myometrium and a severe form of PAS due to extensive trophoblastic invasion (with the kind permission of Dr. Nishant Patel). (C) Diagrammatic representation of exogenic CSP. Uterus line diagram adapted from Antila-Långsjö et al.[11] CSD, cesarean scar defect; CSP, cesarean scar pregnancy; PAS, placenta accreta spectrum.

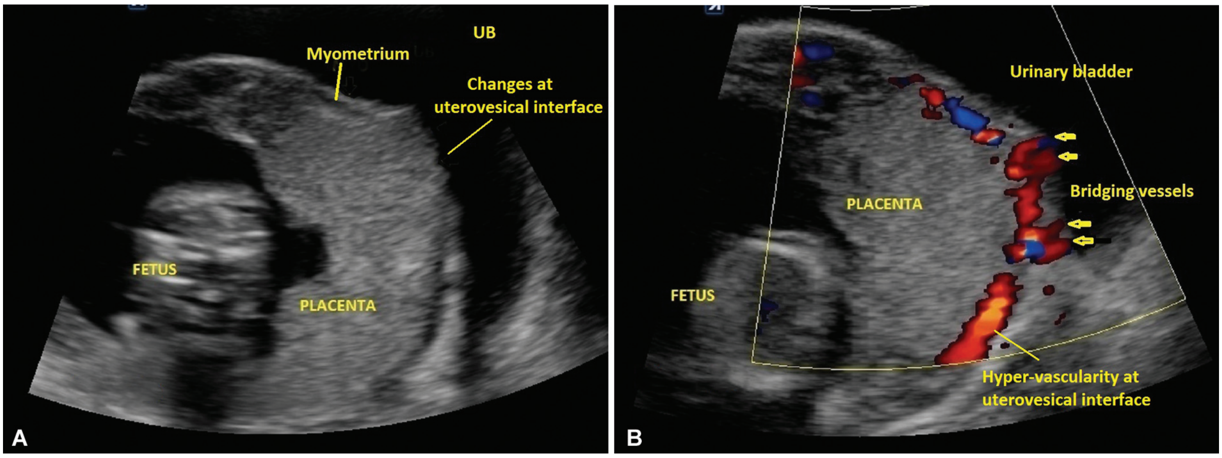

Fig. 9 (**A, B**) A known case of CSP diagnosed at 7 weeks of gestation, follow-up (**A**) grayscale and (**B**) color Doppler images at 13 weeks and 5 days show several observations. The absence of myometrium and irregularities in the echogenic bladder line (arrow) is due to abnormal placental vasculature at the ureterovesical interface (indicated by arrows). (**B**) depicts bridging vessels with the color Doppler, matching those seen in (**A**). CSP, cesarean scar pregnancy; UB, urinary bladder.

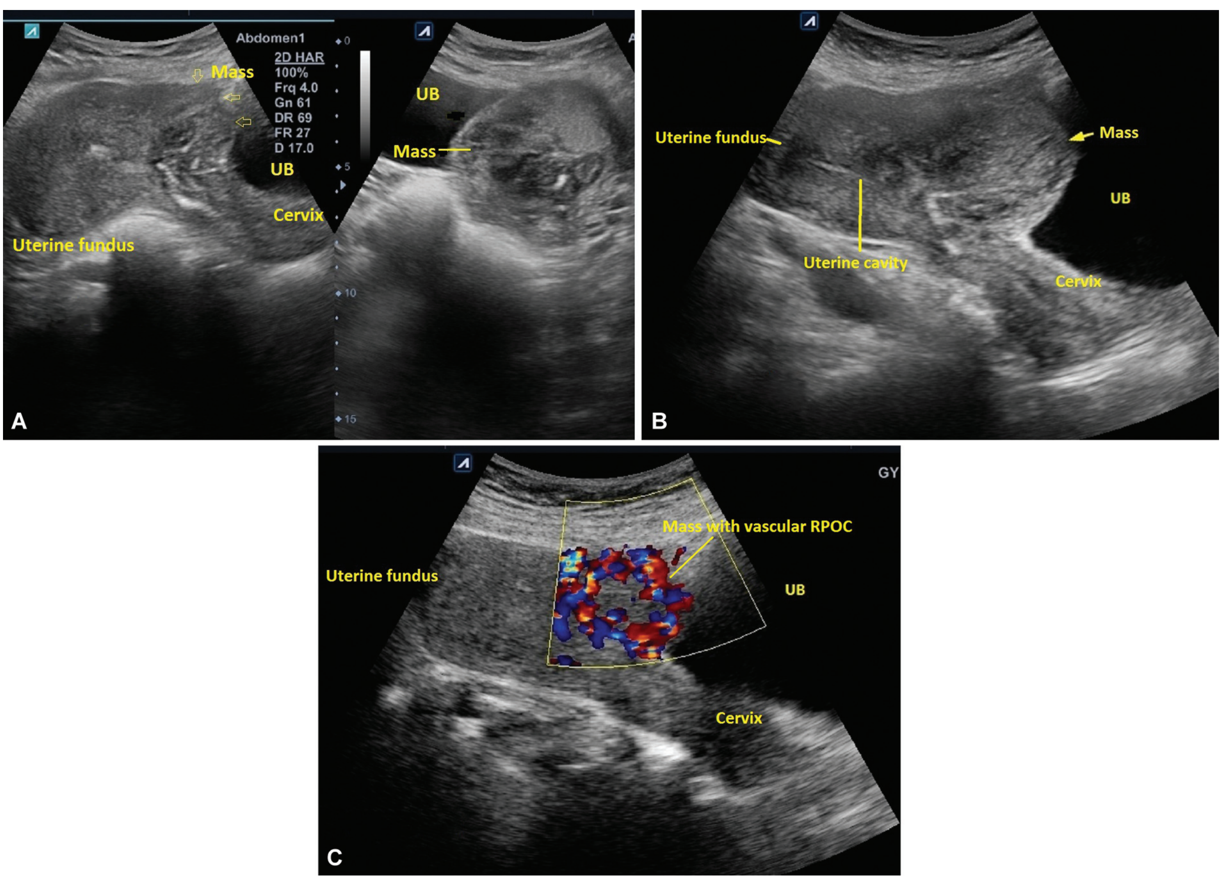

Fig. 10 Grayscale and color Doppler images of RPOC at cesarean scar diverticulum. The prior status of CSD was not known. (**A–C**) A 36-year-old woman, with two previous CS, had heavy vaginal bleeding on the 17th day of taking pills for the termination of a 7-week intrauterine viable pregnancy. (**A**) Transabdominal mid-sagittal and transverse grayscale ultrasound revealed a heterogeneous mass in the isthmic part of the uterus protruding through the anterior uterine wall (arrows). (**B**) Grayscale ultrasound performed after 10 days of conservative treatment demonstrated an increase in the size of the mass, resembling a myoma. (**c**) Doppler imaging indicated vascular RPOC. Surgical intervention following failed conservative treatment confirmed RPOC at CSD upon pathology examination. CS, cesarean section; CSD, cesarean scar defect; RPOC, retained products of conception; UB, urinary bladder.

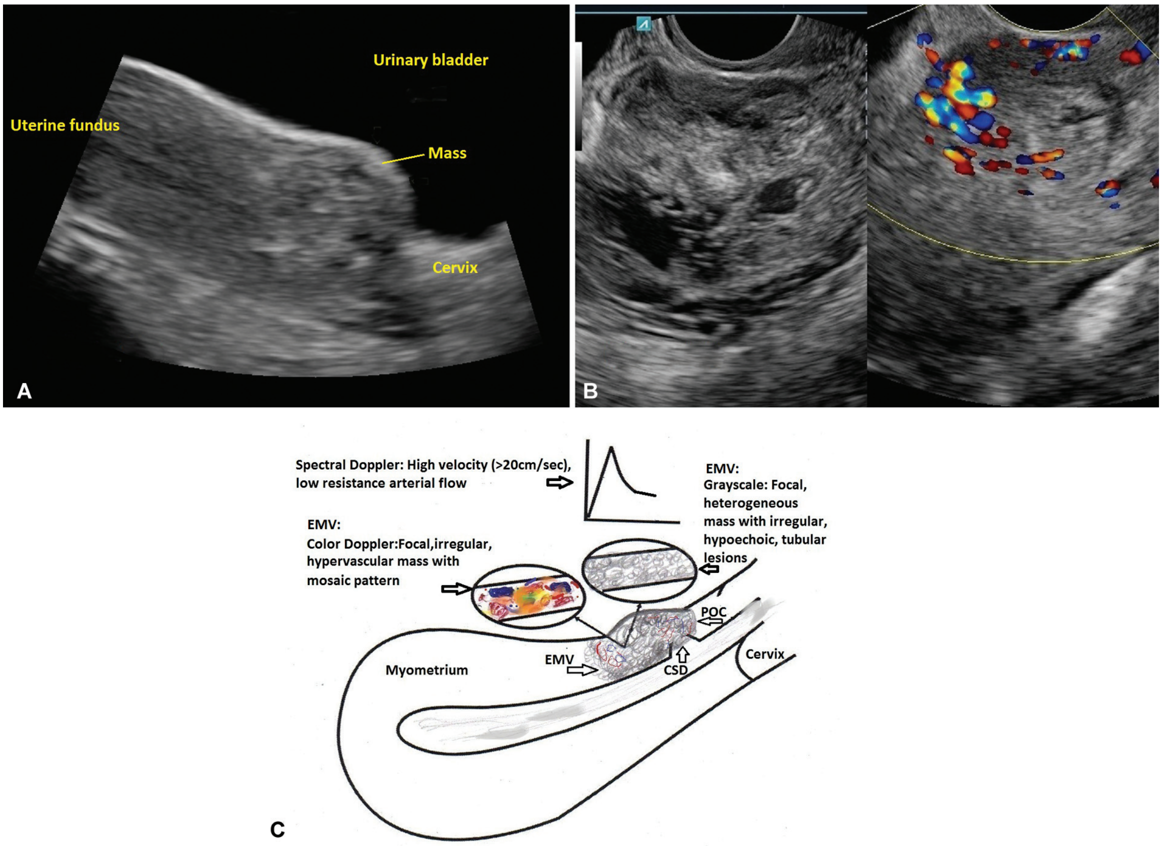

Fig. 11 Grayscale and color Doppler images of RPOC at cesarean scar diverticulum. The prior status of CSD was not known. (**A, B**) On the 15th day, postsurgical evacuation for a miscarriage involving a 9-week intrauterine pregnancy; (**A**) suprapubic grayscale scan revealed a heterogeneous mass at the previous CS scar. Doppler examination showed no vascularity, indicative of avascular RPOC. However, on (**B**) grayscale and color Doppler TVUS revealed multiple cystic lesions and turbulent flow involving the adjacent myometrium suggestive of EMV. The patient had persistent and uncontrollable vaginal bleeding that did not respond to conservative management or uterine artery embolization. Consequently, a hysterectomy was performed. (**C**) Diagrammatic representation of RPOC at CSD associated with EMV. Uterus line diagram adapted from Antila-Långsjö et al.[11] CS, cesarean section; CSD, cesarean scar defect; EMV, enhanced myometrial vascularity; RPOC, retained products of conception; TVUS, transvaginal ultrasound; UB, urinary bladder.

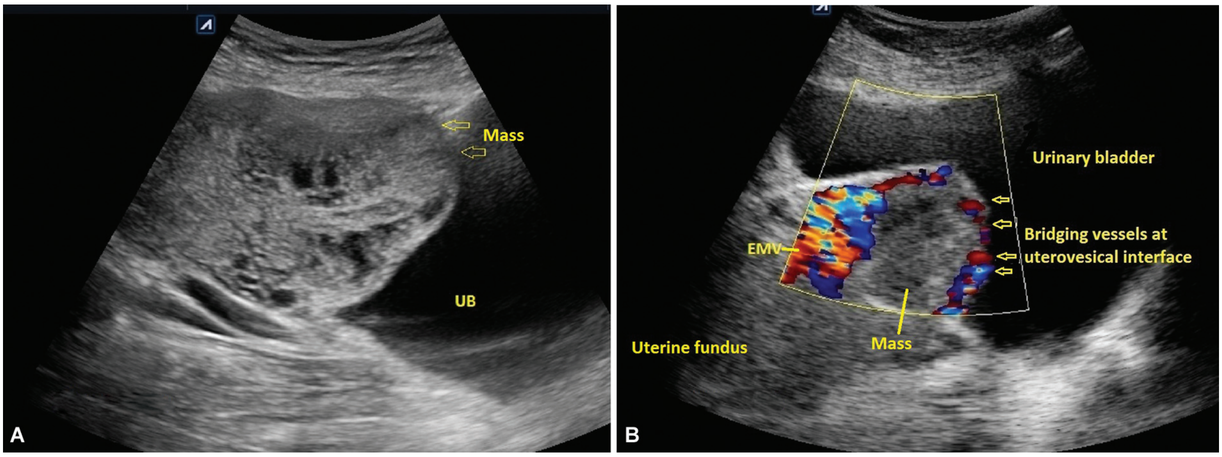

Fig. 12 Grayscale and color Doppler images of RPOC at cesarean scar diverticulum. (**A, B**) A suprapubic grayscale and color Doppler scan on the 7th day following termination of ~12 weeks' gestation. An earlier 7-week scan showed low implantation near the previous CS scar. The patient presented with heavy vaginal bleeding. (**A**) Grayscale scan revealed a heterogeneous mass displaying cystic regions, protruding through the isthmic part of the uterus, the mass exhibited an absence of residual myometrium and alterations at the uterovesical interface (arrows). (**B**) Color Doppler imaging identified abnormal vessels at the uterovesical interface, suggestive of PAS (arrows). Increased vascularity with bidirectional and turbulent flow in the adjacent myometrium suggested EMV (arrows). These findings led to the decision to perform a hysterectomy. CS, cesarean section; CSD, cesarean scar defect; EMV, enhanced myometrial vascularity; PAS, placenta accreta spectrum; POC, products of conception; RPOC, retained products of conception; UB, urinary bladder.

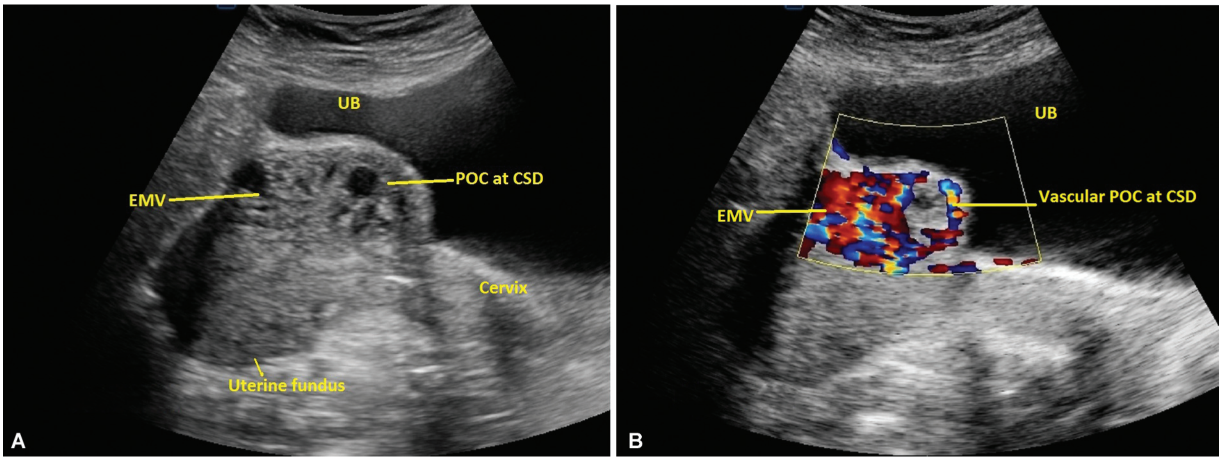

Fig. 13 Grayscale and color Doppler images of RPOC at cesarean scar diverticulum. (**A, B**) On the 18th day following methotrexate-treated CSP at 6-week gestation, (**A**) suprapubic grayscale and (**B**) color Doppler scans were performed. The patient presented with unmanageable vaginal bleeding. A mass characterized by numerous cystic regions, extending from the CS scar site and protruding through the anterior lower half of the uterus, resembling a molar pregnancy. (**B**) Color Doppler imaging revealed vascular RPOC and EMV. Despite undergoing uterine artery embolization, the bleeding persisted, ultimately leading to a hysterectomy. CS, cesarean section; CSD, cesarean scar defect; CSP, cesarean scar pregnancy; EMV, enhanced myometrial vascularity; POC, products of conception; RPOC, retained products of conception; UB, urinary bladder.

Retained Products of Conception

Cesarean scar diverticulum serves as a potential reservoir for retaining POC following either spontaneous or medically induced termination of an intrauterine pregnancy (►**Figs. 10** and **11**). These trophoblastic remnants can persist within the niche after medical treatment or incomplete surgical evacuation of a CSP (►**Figs. 12** and **13**). In large cesarean scar diverticula, a considerable amount of POC may linger. A localized inflammatory response, increased vascularity, and the formation of EMV[20,25] in the adjacent myometrium further complicate the condition (►**Figs. 11B, C**, **12B**, and **13B**).[26] Together, these factors can lead to the development of a mass at the site of the CSD, typically localized in the LUS and protruding through the thin isthmic portion of the uterine corpus where the RMT is minimal. Although grayscale ultrasound imaging often lacks specificity,[27] the presence of vascularity within the mass (►**Figs. 10C** and **13B**), especially in cases where trophoblastic remnants are suspected based on clinical presentation, strongly indicates the presence of retained POC.[28] In cases where there is viable trophoblastic tissue from an incompletely evacuated or medically treated CSP, one might observe features of PAS at the interfaces of the uteroplacental or uterovesical regions (►**Fig. 12A, B**). This may especially occur with an exogenic type of CSP or a CSP with advanced gestational age. The vascular RPOC, associated EMV, and PAS pose a risk for severe complications. Conservative management in such instances may prove inadequate, potentially necessitating a hysterectomy for patient management.

Uterine Scar Rupture/Dehiscence

The risk of uterine rupture (►**Fig. 14**)/dehiscence increases in subsequent pregnancies with CSDs. While the incidence of uterine rupture in successive pregnancies is 2%, it rises to 5% in cases of isthmocele.[29] The likelihood of uterine rupture is presumed to rely on myometrial resistance, primarily governed by the RMT of the uterine niche.[8] Assessing RMT in the nonpregnant state might predict scar dehiscence in subsequent pregnancies. Studies suggest that larger niches elevate the risk of scar dehiscence up to 42.9%.[30] Recent consensus states that the ratio of niche depth to RMT accurately predicts CS scar dehiscence in subsequent pregnancies. A depth/RMT ratio of <0.785 indicates a lower likelihood of scar separation, while a ratio >1.3035 raises the risk to more than 50%.[12] These values have a 71% sensitivity and 94% specificity for predicting uterine dehiscence/rupture.[12]

During pregnancy, isthmocele can be assessed in the first trimester. However, there is no significant correlation between CSD-related indices and uterine rupture during this trimester.[29] Furthermore, uterine rupture is rare in the first trimester and occurs mostly in cases of CSP, particularly with placenta percreta.[31] Assessing obstetric complications in

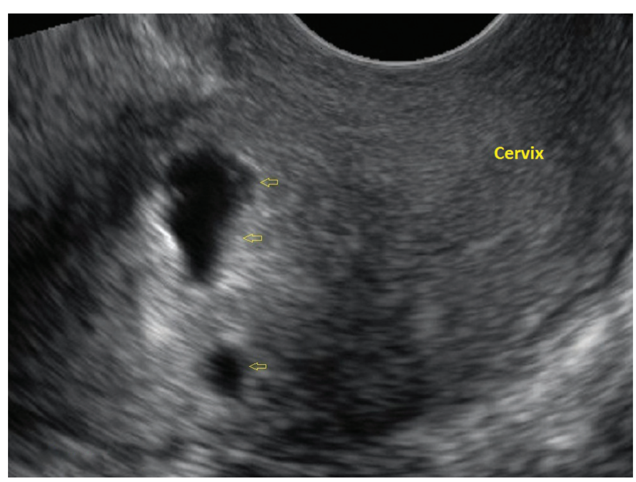

Fig. 14 TVUS after 10 days of a vaginal delivery; ruptured CS scar (arrows). CS, cesarean section; TVUS, transvaginal ultrasound.

the second and third trimesters involves measuring the LUS thickness at the scar's thinnest part.[12,32] Various studies have categorized LUS values as indicating a higher or lower risk for scar dehiscence, but a universally defined cutoff value remains elusive. For instance, Rozenberg et al[32] noted that no uterine rupture occurred when the myometrial thickness exceeded 4.5 mm, with most ruptures occurring when thickness measured equal to or less than 2.5 mm.[32] Uharček et al similarly suggested that myometrial thickness < 2.5 mm is a significant predictor.[33] A 2013 meta-analysis found that LUS thickness of 3.1 to 5.1 mm and residual myometrium of 2.1 to 4.0 mm were negatively predictive of dehiscence or rupture during a trial of labor.[34] Conversely, residual myometrium of 0.6 to 2.0 mm predicted its occurrence.[34]

Conclusion

To conclude, CSD is a grievous pathology. Though not frequent, the lesion may lead to catastrophic obstetric consequences in subsequent pregnancies. Given these complications, the uterine niche should be excluded using TVUS/contrast-enhanced TVUS for those who wish to conceive. Surgical repair correction of these lesions may prevent obstetric and perinatal complications in subsequent pregnancies.

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Conflict of Interest
None declared.

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