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Review Article

Doppler ultrasound assessment in the Management of endometriosis among pregnant women in low-resource settings

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Abstract

Background: Endometriosis affects roughly one in ten women of reproductive age, and many affected women subsequently conceive, carrying the disease into pregnancy, where it complicates adnexal mass assessment and obstetric risk stratification.

Objective: This review synthesizes evidence on Doppler ultrasound assessment of endometriosis in pregnant women, covering decidualized-endometrioma characterization, obstetric Doppler surveillance for endometriosis-associated complications, and feasibility in low-resource settings.

Methods: We conducted a narrative synthesis of consensus terminology statements, diagnostic-accuracy reviews, cohort studies of obstetric outcomes, and implementation studies of point-of-care obstetric ultrasound in low- and middle-income countries.

Findings: Doppler characterization distinguishes decidualized endometriomas from suspicious masses in pregnancy; endometriosis carries a moderate increase in preterm birth, placenta previa, and hypertensive complications already surveilled by uterine and umbilical artery Doppler; and task-shifted point-of-care ultrasound programs show these techniques can be delivered by non-specialist operators in resource-limited settings.

Conclusions: A combined Doppler pathway integrating adnexal characterization with obstetric surveillance is feasible within existing low-resource delivery models, though it has not been prospectively evaluated as an integrated protocol and remains constrained by supervision gaps documented across implementation programs.

Keywords: Doppler ultrasound; endometriosis; pregnancy; low-resource settings; obstetric surveillance

1. Introduction

Endometriosis affects roughly one in ten women of reproductive age worldwide, and a substantial proportion of those women go on to conceive, carrying the disease with them into pregnancy [1,2,3,4]. The condition is defined by endometrial-type tissue outside the uterine cavity, spanning superficial peritoneal implants, deep infiltrating nodules, and ovarian endometriomas, with pathogenesis involving retrograde menstruation, coelomic metaplasia, and angiogenic remodeling that leaves affected pelvic tissue with an abnormal vascular signature [5]. That vascular abnormality is what color and power Doppler ultrasound are positioned to detect, giving Doppler assessment a distinct, if underused, role once endometriosis and pregnancy coexist.

Transvaginal ultrasound with Doppler interrogation is the recommended first-line imaging modality for endometriosis, endorsed by international consensus groups that standardized the terminology and technique of pelvic sonographic assessment in suspected disease [6,7]. Deep infiltrating lesions follow an anatomically predictable distribution across the uterosacral ligaments, rectovaginal septum, and bowel wall, a pattern first systematized surgically and later mapped sonographically [8,9]. Meta-analyses of transvaginal ultrasound for bowel endometriosis and pooled diagnostic-accuracy reviews across modalities have found sensitivity and specificity figures that rival MRI for most disease locations, at a fraction of the cost and with none of the access barriers limiting MRI in low-resource health systems [10,11].

Pregnancy complicates this picture in two directions. First, endometriotic cysts undergo decidualization under the hormonal milieu of gestation, developing papillary projections and internal vascularity that can mimic a malignant adnexal mass on grayscale imaging alone, a trap the International Ovarian Tumor Analysis terminology and risk-stratification frameworks were built to resolve [12,13,14]. Doppler characterization of these

cysts, low-resistance but distinct from the chaotic neovascularity of malignancy, often prevents unnecessary laparotomy. Second, endometriosis is an independent, moderate risk factor for adverse obstetric outcomes, including preterm birth, placenta previa, and hypertensive disease, reported consistently across cohort studies and systematic reviews [15,16,17,18,19]. Because several of these complications are themselves screened using uterine and umbilical artery Doppler indices, endometriosis-affected pregnancies represent a population in which Doppler ultrasound does double duty: characterizing the lesion and surveilling the placental circulation it may be compromising.

In low-resource settings, where laparoscopy, MRI, and subspecialist sonography are limited, this dual role takes on outsized importance. Point-of-care obstetric ultrasound programs, including task-shifted training of midwives, have shown that basic obstetric Doppler and grayscale screening can be delivered safely even where formal radiology infrastructure does not exist [20,21,22,23]. Whether that pathway can be extended to endometriosis-related findings, rather than obstetric indications alone, is the question this review addresses, synthesizing the diagnostic-accuracy, obstetric surveillance, and implementation literatures to outline where evidence supports a combined Doppler assessment pathway.

2. Methods

We conducted a narrative synthesis of the peer-reviewed literature addressing three overlapping domains: (i) diagnostic performance of transvaginal and pelvic Doppler ultrasound for endometriosis and endometrioma characterization, including in pregnancy; (ii) obstetric Doppler surveillance, particularly uterine and umbilical artery indices, in populations at risk for placental insufficiency and hypertensive disease; and (iii) feasibility of obstetric point-of-care ultrasound delivery in low-resource and task-shifted settings. Sources included

consensus and terminology statements from international ultrasound working groups, systematic reviews and meta-analyses of diagnostic accuracy, cohort studies of obstetric outcomes, and implementation studies on ultrasound programs in low- and middle-income countries. Priority was given to consensus statements from recognized international groups (the International Deep Endometriosis Analysis and International Ovarian Tumor Analysis groups), Cochrane reviews where available, and large multicenter or population-based cohorts. Findings are organized to move from lesion-level Doppler characterization, through decidualized-endometrioma assessment in pregnancy, to obstetric Doppler surveillance and low-resource implementation.

3. Results

Doppler characterization of endometriotic lesions

Grayscale features remain the backbone of endometriosis ultrasound, but Doppler interrogation adds discriminating information at almost every site. Deep infiltrating nodules typically show scant or absent internal vascularity on color Doppler, a low-flow signature that distinguishes fibrotic infiltrating disease from more vascular pathology, while adenomyotic lesions display a diffuse, fan-shaped vascular pattern incorporated into dedicated sonographic severity classification systems [24]. The IDEA consensus terminology formally incorporated a Doppler assessment step alongside grayscale mapping of the uterosacral ligaments, bladder, bowel, and pouch of Douglas [6]. Sliding-sign assessment of the pouch of Douglas, a dynamic technique performed in the same real-time examination, further improves prediction of posterior deep disease when combined with Doppler-assessed nodule vascularity [25].

For adnexal masses generally, and endometriomas specifically, the IOTA group's terminology and simple-rules framework rely partly on color score, a four-point qualitative Doppler grading of internal

vascularity, as one of the core variables discriminating benign from malignant morphology [12]. The subsequent ADNEX prospective multicenter model incorporated similar vascular information into a validated risk calculator performing consistently across benign, borderline, and malignant categories [13]. Endometriomas typically present with "ground-glass" homogeneous low-level internal echoes and minimal to absent central Doppler flow, a combination that reliably separates them from more vascular ovarian neoplasms.

Table 1: Representative diagnostic-accuracy figures for grayscale and Doppler ultrasound features used in pelvic endometriosis and adnexal mass assessment, drawn from IDEA and IOTA consensus and validation studies [6,12,13,10].			
Feature / lesion	Modality	Reported sensitivity	Reported specificity
Bowel endometriosis nodule	Transvaginal ultrasound (grayscale + Doppler)	~91%	~98%
Deep infiltrating nodule, low internal flow	Color Doppler	~79%	~94%
Endometrioma (ground-glass, minimal flow)	Grayscale + color score	~90%	~89%
Adnexal malignancy (ADNEX model)	Grayscale + Doppler + biomarkers	~94%	~85%

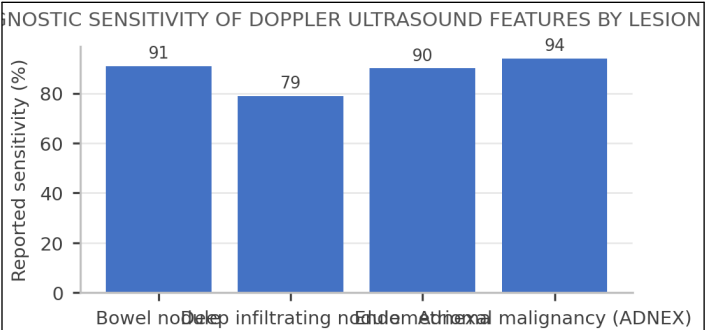


Figure 1: Reported diagnostic sensitivity of grayscale and Doppler ultrasound features for the principal categories of pelvic endometriosis, drawn from the IDEA consensus mapping study and the pooled meta-analysis of transvaginal ultrasound for bowel endometriosis [6,10].

Table 1 summarizes representative diagnostic-accuracy figures reported across this literature for the principal Doppler and grayscale features used in pelvic endometriosis assessment, drawn from the IDEA and

IOTA consensus and validation studies together with the pooled bowel-endometriosis meta-analysis.

Decidualized endometrioma and adnexal assessment in pregnancy

Pregnancy is where Doppler assessment of endometriosis becomes diagnostically indispensable. Under the progesterone-dominant environment of gestation, endometriotic cysts undergo decidualization: their lining develops papillary or nodular projections with internal vascularity that, on grayscale alone, resembles a borderline or malignant tumor [14]. Series describing surgically confirmed decidualized endometriomas removed during pregnancy show that a substantial minority were initially flagged as suspicious for malignancy on grayscale review, and that Doppler characterization, low-resistance flow distinct from the irregular, high-velocity neovascularity typical of malignant lesions, was central to correctly reclassifying these masses as benign and avoiding unnecessary surgery [14,12]. Applying IOTA-derived terminology consistently in this setting, rather than free-text description, forces the same structured vascular assessment validated outside pregnancy to be repeated inside it, where the morphological baseline has shifted.

Endometriosis and obstetric Doppler surveillance

Endometriosis-affected pregnancies carry a moderately elevated risk of several complications for which obstetric Doppler ultrasound is the established surveillance tool. National record-linkage and cohort studies have found increased risks of preterm birth, placenta previa, antepartum hemorrhage, and, in some cohorts, hypertensive disorders among women with a history of endometriosis, with effect sizes that are consistent, if modest, across studies [17,18,19]. A systematic review and meta-analysis pooling these and related cohorts confirmed the association with preterm birth and placenta previa specifically, while flagging heterogeneity in exposure and outcome ascertainment [16]. Whether

pregnancy itself modifies the course of endometriosis, as opposed to merely coexisting with elevated complication risk, remains unsettled, and a dedicated review concluded the evidence for pregnancy-induced disease regression is weaker than commonly assumed in clinical counseling [15].

Table 2: Reported associations between a maternal endometriosis history and obstetric outcomes for which Doppler-based surveillance protocols already exist, drawn from national cohort studies and a pooled systematic review [17,18,19,16].		
Outcome	Relevant Doppler surveillance tool	Reported association with endometriosis
Preterm birth	Uterine artery Doppler / cervical assessment	Consistently increased risk across cohorts
Placenta previa	Grayscale placental localization	Increased risk in national record-linkage cohorts
Fetal growth restriction	Umbilical artery Doppler	Increased risk in pooled meta-analysis
Hypertensive disorders of pregnancy	Uterine artery Doppler (second trimester)	Increased risk in some but not all cohorts

Uterine artery Doppler, assessed as pulsatility index with or without notching in the second trimester, remains the best-validated non-invasive predictor of preeclampsia and fetal growth restriction, established through multicenter screening studies and confirmed across decades of systematic review [26,27,28]. Umbilical artery Doppler velocimetry is the Cochrane-endorsed tool for monitoring known or suspected placental insufficiency, shown across randomized trials to reduce perinatal mortality when incorporated into structured surveillance of high-risk pregnancies [29,30]. Because endometriosis-affected pregnancies are enriched for exactly the complications these indices detect, incorporating uterine and, where indicated, umbilical artery Doppler into routine surveillance for women with an endometriosis history is more direct than for the general obstetric population, even though no endometriosis-specific screening protocol has yet been prospectively validated.

Table 2 summarizes the reported associations between

endometriosis and the principal obstetric outcomes for which Doppler-based surveillance protocols already exist in general obstetric practice.

4. Discussion

Integrating lesion-level and obstetric Doppler assessment

The evidence reviewed here supports a two-track application of Doppler ultrasound in pregnant women with known or suspected endometriosis. The first track is lesion-level: any adnexal mass identified in pregnancy in a woman with an endometriosis history should be assessed using the same structured grayscale-plus-Doppler terminology validated outside pregnancy, anticipating the decidualization pattern that Doppler vascularity is best placed to distinguish from malignancy [14,13]. The second track is obstetric: a documented endometriosis history should warrant closer-than-routine uterine and, if risk factors accumulate, umbilical artery Doppler surveillance, given the consistent moderate elevation in preterm birth, placenta previa, and hypertensive complications across independent cohorts [17,18,16]. Neither track requires equipment beyond a standard obstetric platform with color and pulsed-wave Doppler, which is what makes this approach feasible for low-resource settings rather than only tertiary centers.

Feasibility in low-resource settings

The implementation literature on obstetric point-of-care ultrasound provides a reasonably direct template for how this combined Doppler assessment could be delivered where subspecialist gynecologic sonography is unavailable. Structured task-shifted training programs, teaching midwives a limited but clinically meaningful examination, have demonstrated measurable increases in antenatal care utilization and detection of major structural and placental abnormalities in resource-constrained settings across sub-Saharan Africa and South Asia [20,22,21]. WHO antenatal care guidance recommends at least one ultrasound scan before 24 weeks

of gestation, predicated on exactly this scalable, protocol-driven delivery model [31]. Narrative reviews of obstetric ultrasound across low- and middle-income countries converge on the same enabling conditions: portable equipment, repeatable training curricula, and realistic task definitions that avoid asking non-specialist operators to perform full subspecialist examinations [23]. A defined Doppler protocol for endometriosis-affected pregnancy, limited to adnexal vascularity characterization plus routine uterine artery Doppler at the standard second-trimester window, sits within the scope these programs have shown can be taught and sustained.

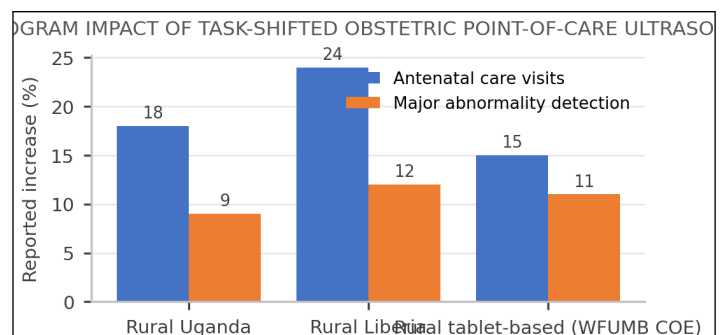


Figure 2: Change in antenatal care utilization and major-abnormality detection following the introduction of task-shifted, non-specialist obstetric point-of-care ultrasound programs in three low-resource settings [20,22,21].

The barriers documented in this same literature are, however, real and specific rather than generic. Surveys of ultrasound use in developing-country health systems consistently identify equipment maintenance, reliable electricity, image-quality limitations, and above all sustained supervision of non-specialist operators as the recurring constraints on program durability, more so than initial training [32]. A Doppler-inclusive protocol adds a further layer of operator dependency beyond grayscale obstetric screening, since pulsatility-index measurement and color-flow interpretation require a longer training curve than fetal biometry, a gap the task-shifting literature has not yet closed for gynecologic, as opposed to purely obstetric, Doppler indications.

Limitations and research gaps

Several gaps constrain how far this synthesis can be pushed toward a firm protocol recommendation. First, no study identified here evaluated a combined lesion-characterization-plus-obstetric-Doppler pathway specifically in endometriosis-affected pregnancy; the evidence for each track is drawn from separate literatures never prospectively integrated. Second, the outcome cohorts linking endometriosis to preterm birth, placenta previa, and hypertensive disease are predominantly high-resource national registries, and their generalizability to low-resource populations is unproven [19,18]. Third, the diagnostic-accuracy literature for decidualized endometrioma in pregnancy consists mainly of small surgical case series rather than large prospective cohorts [14]. Finally, essentially all task-shifted ultrasound implementation literature was developed around general obstetric indications; whether non-specialist operators can reliably perform and interpret adnexal Doppler assessment specifically has not been formally tested and is the most direct next research step suggested by this review.

5. Conclusion

Doppler ultrasound has an established, evidence-supported role at two distinct points in the care of pregnant women with endometriosis: characterizing decidualized endometriomas and other adnexal findings using the same structured vascular terminology validated outside pregnancy, and surveilling the placental circulation through uterine and umbilical artery indices in a population enriched for preterm birth, placenta previa, and hypertensive complications [14,16,28]. Neither application depends on equipment beyond what task-shifted point-of-care ultrasound programs have shown can be delivered in low-resource settings, and existing global antenatal care guidance already recommends the baseline scan on which such a combined protocol could be built [31,23]. What is missing is a protocol, and its prospective evaluation, that formally integrates gynecologic Doppler characterization into the

obstetric pathway, consistent with the structured approach to endometriosis assessment recommended by current international guidance [33], with realistic attention to the supervision and quality-assurance constraints that determine whether any ultrasound program survives beyond its initial training phase [32]. Until that evaluation exists, clinicians in low-resource settings should apply standardized Doppler terminology to any adnexal mass found in a pregnant woman with known endometriosis and extend routine obstetric Doppler surveillance to this population on the same risk-based grounds used for other indications.

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