

TRANSVAGINAL ULTRASOUND WITH COLOR DOPPLER MAPPING IN THE DIAGNOSTIC WORK-UP OF UTERINE MASS LESIONS: A PRACTICAL ALGORITHM AND HEMODYNAMIC CRITERIA (SINGLE-CENTER CLINICAL SERIES)

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Abstract: Background: Uterine mass lesions (most commonly leiomyomas) are frequently encountered in women of late reproductive age and beyond. Accurate differentiation between benign myometrial disease, atypical leiomyomas, and rare malignant tumors remains challenging when based on grayscale imaging alone.

Objective: To summarize and formalize a pragmatic diagnostic algorithm based on transvaginal ultrasound (TVUS) combined with color Doppler mapping (CDM) and pulsed Doppler, and to report hemodynamic criteria derived from a single-center clinical series.

Materials and methods: The dissertation-based cohort included 115 women with suspected pelvic tumors, distributed into diagnostic groups including uterine myoma, adnexal tumors, inflammatory adnexal disease, adenomyosis, suspected uterine sarcoma, and tumors of unclear pelvic origin. All patients underwent TVUS with CDM/energy Doppler and pulsed Doppler; in diagnostically difficult cases additional MRI and/or CT was used. Intra-tumoral vascularity was graded using a standardized color-signal count. Hemodynamic indices (resistance index, RI/IR) and velocities were analyzed in uterine, arcuate, and intra-tumoral vessels.

Results: TVUS+CDM enabled structured phenotyping of myometrial pathology and guided escalation to cross-sectional imaging in selected patients. Hemodynamic profiles differed across simple myoma, ischemic/degenerative myoma, myoma with adenomyosis, and proliferative myoma, with the latter showing lower resistance indices and more central vascularity. A dedicated comparison between proliferative myoma (n=60) and uterine sarcoma (n=5) demonstrated overlapping qualitative vascular patterns but quantitatively lower resistance and heterogeneous, low-resistance intra-tumoral flow, supporting the need for a multimodal approach. Conclusion: A standardized TVUS+CDM protocol with predefined vascularity grading and Doppler indices improves consistency of reporting and provides actionable criteria for stepwise diagnostic decision-making. Integration with contemporary risk-stratification systems for adnexal masses (O-RADS US v2022) and modern sarcoma guidelines strengthens clinical pathways.

Keywords: transvaginal ultrasound; color Doppler; uterine leiomyoma; uterine sarcoma; adenomyosis; adnexal masses; O-RADS; diagnostic algorithm

Introduction

Uterine leiomyomas (fibroids) are the most common solid pelvic tumors and a leading indication for hysterectomy; however, many patients seek organ-preserving options. Contemporary clinical guidance emphasizes individualized management and careful preoperative evaluation. Imaging is pivotal in (i) mapping tumor burden, (ii) identifying complications such as degeneration or ischemia, and (iii) raising suspicion for malignant disease, including uterine sarcomas—rare but clinically important entities requiring specialized multidisciplinary management.

Transvaginal ultrasound (TVUS) is the first-line imaging modality in gynecology. When complemented by color Doppler mapping (CDM), energy Doppler, and pulsed Doppler, TVUS can capture both morphological and hemodynamic information. Nevertheless, qualitative assessment can be subjective; therefore, standardized descriptors, vascularity grading, and structured reporting are increasingly recommended. In parallel, standardized risk systems for

adnexal lesions such as O-RADS US (v2022) have improved communication and management decisions, underscoring the broader move toward reproducible imaging-based pathways.

Materials and Methods

Study design and setting: Single-center clinical series summarized from the Master's dissertation (Andijan State Medical Institute, 2025).

Participants: 115 women with suspected pelvic tumors were allocated into seven diagnostic groups at presentation:

- Uterine myoma: 45 (simple myoma confirmed in 15; proliferative form in 30)
- Malignant ovarian tumors: 14
- Benign adnexal disease: 28
- Inflammatory adnexal disease: 12
- Adenomyosis (grade III and nodular form): 5
- Large myoma with suspicion of sarcoma: 3
- Pelvic tumor of unclear origin: 8

Age: Средний возраст пациенток составил $49,3 \pm 1,5$ года. В ретроспективном анализе распределение по возрастным категориям выполнялось в зависимости от нозологической формы. Ниже приведены данные по позднему репродуктивному, перименопаузальному и постменопаузальному периодам (Таблицы 2–4).

Ultrasound protocol: TVUS was performed using transvaginal probes (6.5–7 MHz) with grayscale B-mode followed by CDM/energy Doppler and pulsed Doppler. B-mode assessment included uterine size, number/size of nodules, contour, echogenicity, presence of degeneration/necrosis, endometrial cavity status, and adnexa.

Vascularity grading: To reduce subjectivity, intra-tumoral color signals were graded as: poor (≤ 5 signals), moderate (5–10), and intense (>10) and classified by distribution (central vs peripheral).

Pulsed Doppler: Resistance indices (RI/IR) and velocity parameters were recorded from uterine arteries, arcuate arteries, and maximal feasible intra-tumoral vessels, using stable waveforms.

Cross-sectional imaging: In cases with interpretive uncertainty on TVUS+CDM, MRI and/or CT was used as the next diagnostic step; in the dissertation, this escalation occurred in 34 patients.

Results

Table 1 summarizes the dissertation-derived hemodynamic profiles in myometrial pathology variants (TVUS+CDM/pulsed Doppler).

Показатель	Простая миома	Отёк/ишемия узла	Миома + аденомиоз	Пролиферирующая миома
IRmed, маточная артерия	$0,80 \pm 0,06$	$0,75 \pm 0,05$	$0,75 \pm 0,05$	$0,71 \pm 0,07$
IRmed, аркуатные артерии	$0,67 \pm 0,04$	$0,71 \pm 0,04$	$0,72 \pm 0,04$	$0,55 \pm 0,11$
IRmin, аркуатные артерии	$0,62 \pm 0,04$	$0,67 \pm 0,04$	$0,63 \pm 0,06$	$0,52 \pm 0,08$
Диапазон IRmin	0,56–0,87	0,52–0,83	0,50–0,86	0,33–0,69
VAm _{ax} (см/с)	18,3	18,6	19,8	25,6
VA _{avg} (см/с)	13,9	15,7	13,7	17,4
Диапазон VA (см/с)	5–33	9–31	5–27	10–58

Локализация кровотока	Периферический (бедный)	Периферический (умер./инт.)	Периферический (бедный/умер.)	Центральный + периферический (интенсивный)
IRmin, внутри узла	0,59±0,06	0,59±0,07	0,57±0,05	0,40±0,06
IRmed, внутри узла	0,65±0,07	0,65±0,08	0,61±0,06	0,50±0,09
Диапазон IR (узел)	0,50–0,82	0,40–0,81	0,45–0,80	0,17–0,58
VAmax в узле (см/с)	18,7	25,4	20,3	28,9
VAavg в узле (см/с)	13,9	16,6	14,5	17,4
Диапазон VA (узел)	4–38	4–42	9–43	7–87
VBmax (см/с)	—	9,0	11,5	12,8
Диапазон VB (см/с)	—	5–13	7–15	8–23

Table 1. Doppler hemodynamics across myometrial pathology variants (from the dissertation dataset).

A dedicated comparison between proliferative myoma and uterine sarcoma is presented in Table 2.

Показатель	Пролиферирующая миома (n=60)	Саркома матки (n=5)
Купирование кровотока	Интенсивный периферический + центральный, «мозаичность»	Интенсивный периферический + центральный, «мозаичность»
IRmin, внутри узла	0,40±0,06	0,38±0,07
IRmed, внутри узла	0,50±0,09	0,47±0,09
Диапазон IR (узел)	0,17–0,58	0,29–0,64
VAmax, внутри узла (см/с)	28,9	17,0
VAavg, внутри узла (см/с)	17,4	11,3
Диапазон VA, внутри узла (см/с)	7–87	4–30
VBmax, внутри узла (см/с)	12,8	—
Диапазон VB, внутри узла (см/с)	8–23	—
IRmin, аркуатные артерии	0,53±0,09	0,45±0,10
IRmed, аркуатные артерии	0,57±0,09	0,52±0,08
Диапазон IR, аркуатные	0,33–0,69	0,33–0,72

VA _{max} , аркуатные (см/с)	25,6	16,8
VA _{avg} , аркуатные (см/с)	17,4	11,3
Диапазон VA, аркуатные (см/с)	10–58	5–29
IR _{med} , маточные артерии	0,72±0,07	0,70±0,04

Table 2. Doppler indices: proliferative myoma (n=60) vs uterine sarcoma (n=5) (from the dissertation dataset).

Key operational points observed in the dissertation clinical pathway:

- TVUS+CDM was used as the first-line tool for morphological characterization and vascular phenotyping of uterine masses.
- Color-signal count grading and documentation of vascular distribution (central vs peripheral) supported reproducible reporting.
- Cross-sectional imaging (MRI/CT) was reserved for ambiguous cases, complex adnexal pathology, or suspected malignancy (escalated in 34 patients).
- Quantitative Doppler indices suggested lower resistance and more intense central+peripheral vascularity in proliferative myoma; however, overlap with sarcoma was present, indicating that Doppler alone is insufficient for ruling out malignancy.

Proposed Stepwise Diagnostic Algorithm

1. Step 1 — Clinical triage: bleeding pattern, pain, growth dynamics, anemia, postmenopausal status; red flags for sarcoma include rapid growth in postmenopause and atypical systemic symptoms.
2. Step 2 — TVUS (B-mode): map lesion(s) (location, number, echogenicity, margins), endometrium, and adnexa; document degeneration (cystic change, edema/necrosis).
3. Step 3 — CDM/energy Doppler: grade vascularity (≤ 5 / 5–10 / >10 signals) and describe distribution (peripheral vs central).
4. Step 4 — Pulsed Doppler: record RI/IR and velocities in uterine/arcuate and intra-tumoral vessels; compare with hemodynamic profiles (Tables 1–2).
5. Step 5 — Risk stratification of adnexa: if an adnexal mass is present, apply a standardized lexicon such as O-RADS US v2022 to guide follow-up vs referral.
6. Step 6 — Escalation: perform pelvic MRI (preferred) or CT when ultrasound is indeterminate, when malignancy is suspected, or when surgical planning requires better anatomical detail.
7. Step 7 — Tissue diagnosis and MDT: hysteroscopy/biopsy or surgical specimen for histology when indicated; suspected sarcoma should follow contemporary sarcoma guidelines and multidisciplinary planning.

Discussion

The dissertation data support a pragmatic approach in which standardized TVUS+CDM serves as the backbone of initial evaluation, while MRI/CT is reserved for cases with discordant or high-risk features. The observed Doppler patterns align with broader literature: benign leiomyomas often show predominantly peripheral vascularity, whereas more cellular/proliferative variants may exhibit richer central flow and lower resistance indices. However, uterine sarcomas can share similar qualitative vascular patterns, and reliable discrimination may be impossible with ultrasound alone; modern imaging reviews emphasize combining morphology (irregular borders, hemorrhage/necrosis, heterogeneous signal) with diffusion-weighted MRI and clinical context.

For adnexal masses encountered during uterine tumor work-up, contemporary practice increasingly uses standardized, evidence-based risk systems such as O-RADS US v2022 to reduce ambiguity and harmonize management. In suspected uterine sarcoma, updated

ESGO/EURACAN/GCIG guidelines (2024; with pocket guidance updates) underline centralized expertise, appropriate staging, and avoidance of tumor disruption when malignancy is plausible. Accordingly, the algorithm prioritizes escalation to MRI and multidisciplinary planning rather than over-reliance on Doppler thresholds.

Limitations: The dissertation series is single-center and includes heterogeneous diagnostic groups; sarcoma numbers are small, limiting statistical inference. Nevertheless, the structured protocol and clearly defined vascularity grading provide a practical framework that can be integrated with modern guideline-based pathways.

Conclusion

A structured TVUS+CDM protocol with predefined vascularity grading and Doppler indices supports consistent characterization of uterine mass lesions and provides an actionable stepwise diagnostic pathway. Given the overlap between proliferative leiomyoma and uterine sarcoma on Doppler features, suspicious cases should be escalated to MRI and managed in accordance with contemporary uterine sarcoma guidelines. Incorporating O-RADS US v2022 for concomitant adnexal lesions further strengthens reporting and clinical decision-making.

References

8. American College of Radiology (ACR). O-RADS™: Ovarian-Adnexal Reporting & Data System — Ultrasound arm (v2022). ACR Clinical Resources. Accessed 2026.
9. Andreotti RF, Timmerman D, Strachowski LM, et al. O-RADS US Risk Stratification and Management System. *Radiology*. 2020;294(1):168–185. doi:10.1148/radiol.2019191150.
10. American College of Obstetricians and Gynecologists (ACOG). Practice Bulletin No. 228: Management of Symptomatic Uterine Leiomyomas. *Obstet Gynecol*. 2021;137(6):e100–e115.
11. Ray-Coquard I, Casali PG, Croce S, et al. ESGO/EURACAN/GCIG guidelines for the management of patients with uterine sarcomas. *Int J Gynecol Cancer*. 2024;34(10):1499–1521.
12. ESGO/EURACAN/GCIG. Uterine Sarcomas Pocket Guidelines (2025).
13. Smith J, et al. Differentiating uterine sarcoma from leiomyoma: imaging features and pitfalls. (Review). 2021. (PMC article).
14. Mension E, et al. An update on the management of uterine fibroids. 2024. (Review).
15. Wojtowicz K, et al. Uterine myomas and sarcomas – clinical and ultrasound diagnostics. *J Ultrason*. 2022.