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Original Article

Comparitive Efficacy of Transabdominal and Transvaginal Sonography Augmented With Color Doppler and Biomarkers in Diagnosis of Retained Products of Conception

Noor Fatima[1], Javeria Ijaz[1], Rushmail Aftab[1], Zoya Younas[1], Gulzaib Khan[1], Maryam Arshad[1], Tehreem Zahra[2]

[1] BS in Medical Imaging and Ultrasonography, University of Management and Technology, Lahore, Pakistan
[2] Lecturer, Department of Medical Imaging, University of Management and Technology, Lahore, Pakistan

*** Corresponding author: Tehreem Zahra, tehreem.zahra@umt.edu.pk**

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ABSTRACT

Background: Retained products of conception are an important cause of abnormal post-pregnancy bleeding and may lead to infection, hemorrhage, intrauterine adhesions, and future reproductive complications if not accurately diagnosed. Ultrasonography is the main imaging modality for evaluation, but the relative diagnostic performance of transabdominal sonography and transvaginal sonography may differ, particularly when supplemented by color Doppler and serum β-hCG. Objective: To compare the diagnostic performance of transabdominal and transvaginal sonography, with adjunctive color Doppler and serum β-hCG assessment, in women clinically suspected of having retained products of conception. Methods: This prospective comparative cross-sectional diagnostic accuracy study included 116 women aged 18–45 years with clinical suspicion of retained products of conception after miscarriage, abortion, termination, or pregnancy-related uterine intervention. All participants underwent TAS followed by TVS with color Doppler assessment, and serum β-hCG was measured using quantitative immunoassay. Imaging impressions were compared with the final diagnostic classification. Results: Final RPOC positivity was 44.8% (52/116). TAS identified suspected RPOC in 22.4% of participants, whereas TVS identified suspected RPOC in 44.8%. Against the final diagnostic classification, TAS showed sensitivity of 50.0%, specificity of 100.0%, positive predictive value of 100.0%, negative predictive value of 71.1%, and overall accuracy of 77.6%. TVS showed complete agreement with the final diagnostic classification in the supplied dataset, although this should be interpreted cautiously if TVS contributed to final diagnosis. Mean serum β-hCG was higher in RPOC-positive cases than RPOC-negative cases (2128.88 ± 922.53 IU/L vs 121.95 ± 73.76 IU/L; $p < 0.001$). Conclusion: TVS identified more suspected RPOC cases than TAS and showed stronger agreement with final diagnostic classification. Serum β-hCG and color Doppler vascularity provided useful adjunctive diagnostic information. A multimodal approach using clinical assessment, TVS, Doppler, and β-hCG may improve diagnostic confidence in suspected RPOC. Keywords: retained products of conception; transabdominal sonography; transvaginal sonography; color Doppler; serum β-hCG; diagnostic accuracy.

INTRODUCTION

Retained products of conception are residual placental, trophoblastic, or decidual tissues that remain within the uterine cavity after miscarriage, induced abortion, termination of pregnancy, or delivery (1-4). Although some cases may resolve spontaneously, persistent retained tissue can delay endometrial

healing and uterine involution, leading to abnormal uterine bleeding, pelvic pain, infection, secondary postpartum hemorrhage, intrauterine adhesions, subfertility, and adverse reproductive outcomes. Because the clinical presentation overlaps with normal post-pregnancy uterine changes, blood clots, endometrial thickening, and post-procedural bleeding, accurate diagnosis remains clinically important but challenging. A missed diagnosis may expose patients to hemorrhagic or infective complications, whereas overdiagnosis may lead to unnecessary uterine evacuation and avoidable procedural morbidity (1, 5-8).

Ultrasonography is the first-line imaging modality for evaluating suspected retained products of conception because it is accessible, non-invasive, repeatable, and capable of assessing both intrauterine morphology and vascularity. Grayscale sonography can identify endometrial thickening, echogenic intrauterine material, intracavitary fluid, and focal endometrial masses, while color Doppler helps differentiate vascular trophoblastic tissue from avascular blood clot or inactive debris. However, no single sonographic parameter has universal diagnostic reliability. Endometrial thickness thresholds vary across studies, and Doppler vascularity may overlap with benign post-pregnancy vascular changes. Therefore, contemporary diagnostic reasoning increasingly favors a multimodal approach combining clinical symptoms, grayscale imaging, Doppler vascularity, and biochemical markers rather than relying on an isolated ultrasound feature (2-13).

Transvaginal sonography generally provides better spatial resolution for intracavitary assessment than transabdominal sonography, particularly for small retained fragments, early post-abortion changes, and subtle endometrial lesions. Its proximity to the uterus allows clearer visualization of the endometrial cavity and improved assessment of vascularity when color Doppler is used. Nevertheless, transvaginal examination may not always be feasible because of patient discomfort, cultural considerations, limited availability, active bleeding, refusal of internal examination, or resource constraints. Transabdominal sonography, although less invasive and more widely acceptable, may be limited by body habitus, bladder status, uterine position, bowel gas, and lower resolution for small intrauterine lesions. This creates an important practical question: whether transabdominal sonography, when supplemented with Doppler and clinical-biochemical correlation, can provide clinically useful diagnostic information, and how its performance compares with transvaginal sonography in suspected retained products of conception (3-19).

Serum beta-human chorionic gonadotropin is a biologically plausible adjunctive biomarker because persistent trophoblastic activity may be reflected by delayed decline or persistently elevated β-hCG levels after pregnancy termination or delivery. However, β-hCG should not be interpreted as a definitive standalone test because levels vary according to gestational age, timing after pregnancy event, completeness of evacuation, individual clearance, and the viability of residual trophoblastic tissue. Its strongest clinical role is supportive: when combined with clinical symptoms and imaging findings, β-hCG may help distinguish active retained trophoblastic tissue from inactive intracavitary material, particularly in sonographically equivocal cases (18-23).

Previous research has emphasized that retained products of conception are best evaluated through integrated clinical and imaging criteria. Studies have shown that echogenic intracavitary tissue, Doppler vascularity, and endometrial thickness may contribute to diagnosis, but diagnostic accuracy varies according to population, timing of assessment, and reference standard. More recent evidence suggests that transvaginal ultrasound and structured sonographic classification systems may improve diagnostic confidence, while systematic reviews continue to highlight heterogeneity in ultrasound thresholds and reporting standards. These inconsistencies are particularly relevant in clinical settings where transvaginal sonography may not be routinely accepted or available, and where clinicians often begin evaluation with transabdominal sonography (24-29).

The present study was therefore designed as a prospective comparative diagnostic accuracy study to evaluate the performance of transabdominal and transvaginal sonography in women clinically

suspected of having retained products of conception, with additional assessment of color Doppler vascularity and serum β-hCG levels. Rather than assuming equivalence between modalities, the study specifically aimed to compare how often TAS and TVS identified suspected RPOC and how each modality agreed with the final diagnostic classification. The primary research objective was to determine whether TVS demonstrates superior diagnostic agreement compared with TAS in suspected RPOC and whether serum β-hCG provides useful supportive diagnostic information when interpreted alongside sonographic findings.

MATERIAL AND METHODS

This prospective, comparative, cross-sectional diagnostic accuracy study was conducted in the Department of Radiology in collaboration with the Departments of Obstetrics and Gynecology and Pathology at Kishwar Sultana Hospital over a two-month study period. The study population comprised women of reproductive age, 18–45 years, who presented after recent spontaneous miscarriage, induced abortion, termination of pregnancy, or vaginal delivery and were clinically suspected of having retained products of conception. Clinical suspicion was based on post-pregnancy vaginal bleeding, pelvic symptoms, obstetric history, and the treating clinician's assessment. Eligible participants were recruited at the time of presentation, and written informed consent was obtained before enrolment and diagnostic evaluation.

All enrolled participants underwent standardized clinical assessment before imaging. Demographic and obstetric variables included age, body mass index, gestational age at termination or delivery, number of previous miscarriages, type of pregnancy-related event or procedure, bleeding severity, and relevant uterine findings. Bleeding severity was categorized clinically as spotting, moderate bleeding, or heavy bleeding. Sonographic variables included endometrial thickness, presence or absence of intracavitary fluid, uterine fibroid status, intrauterine vascularity on color Doppler, transabdominal sonography impression, transvaginal sonography impression, and final diagnostic classification. Serum β-hCG level was measured as a quantitative biochemical marker and interpreted as an adjunct to imaging rather than as a standalone diagnostic test.

Sonographic assessment was performed in a fixed sequence to reduce procedural variability. Transabdominal sonography was performed first, followed by transvaginal sonography with grayscale evaluation and color Doppler assessment. Intrauterine vascularity was categorized as absent, increased, or marked according to Doppler findings. The transabdominal and transvaginal impressions were recorded as negative or suspicious for retained products of conception based on the presence of sonographic features suggestive of residual intrauterine tissue, including echogenic or heterogeneous intracavitary material, endometrial abnormality, intracavitary fluid, and Doppler vascularity when present. To reduce diagnostic review bias, modality-specific interpretations were recorded separately, and the interpreting radiologist was blinded to the alternate modality findings at the time of interpretation.

Venous blood sampling was performed for serum β-hCG assessment. Samples were processed after centrifugation, and quantitative β-hCG levels were measured using an automated electrochemiluminescence immunoassay platform. Additional hematological and coagulation parameters were assessed for clinical correlation and to identify alternative contributors to abnormal uterine bleeding. The final diagnostic classification of retained products of conception was determined using histopathological confirmation when uterine evacuation was performed and/or structured clinical follow-up when conservative management was selected. Final diagnosis was categorized as absent or present RPOC. To avoid overinterpretation, ultrasound findings were treated as index-test results, and diagnostic performance was interpreted in relation to the final diagnostic classification.

The primary index tests were transabdominal sonography and transvaginal sonography. The primary outcome was the presence of retained products of conception on final diagnostic classification. Secondary variables included color Doppler vascularity category and serum β-hCG level. The diagnostic

performance of TAS and TVS was planned to be evaluated using 2 × 2 diagnostic tables against the final diagnostic classification. Sensitivity, specificity, positive predictive value, negative predictive value, overall diagnostic accuracy, and likelihood ratios were considered the most clinically relevant diagnostic measures. Agreement between imaging impressions and final diagnosis was assessed using appropriate agreement statistics, with correlation coefficients interpreted cautiously because the diagnostic variables were binary. Group-wise comparison of serum β-hCG levels between participants with and without confirmed RPOC was performed using independent-samples testing, with unequal-variance interpretation applied when variance assumptions were not met. Categorical variables were summarized as frequencies and percentages, while continuous variables were summarized as mean ± standard deviation when distributional reporting supported parametric description. Statistical significance was assessed at a two-sided alpha level of 0.05.

Bias control measures included prospective recruitment, use of the same imaging sequence for all participants, separate documentation of TAS and TVS impressions, blinding of modality-specific interpretations where feasible, and standardized recording of clinical, sonographic, Doppler, and biochemical variables. Confounding was addressed by collecting clinically relevant variables such as gestational age at pregnancy event, procedure type, bleeding severity, uterine fibroid status, endometrial thickness, and β-hCG level, allowing interpretation of imaging findings within the broader clinical context. Data were checked for completeness, internal consistency, coding accuracy, and denominator agreement before analysis. The study protocol was approved by the Institutional Ethics Committee of the University of Management and Technology, and all participants provided written informed consent after being informed about the study purpose, procedures, and potential risks.

RESULTS

A total of 116 women clinically suspected of having retained products of conception were included in the analysis. The mean age was 30.81 ± 6.99 years, and the mean gestational age at termination was 13.78 ± 4.47 weeks. The mean endometrial thickness was 13.87 ± 6.83 mm, while the mean serum β-hCG level was 1022.76 ± 1182.05 IU/L.

Table 1. Baseline Clinical and Sonographic Characteristics of the Study Participants

Variable	n	Mean ± SD	Minimum	Maximum
Age, years	116	30.81 ± 6.99	18	42
Gestational age at termination, weeks	116	13.78 ± 4.47	6	20
Endometrial thickness, mm	116	13.87 ± 6.83	5	28
Serum β-hCG, IU/L	115	1022.76 ± 1182.05	10	3474

SD, standard deviation; β-hCG, beta-human chorionic gonadotropin.

The study population consisted of reproductive-age women with a broad range of gestational ages at pregnancy termination. Mean endometrial thickness was 13.87 mm, indicating that many participants had sonographically measurable endometrial abnormality, although thickness alone was not treated as a definitive diagnostic criterion. Serum β-hCG showed wide dispersion, ranging from 10 to 3474 IU/L, supporting the need for group-wise interpretation rather than reliance on a single unstratified mean.

Table 2. Obstetric History, Presenting Features, and Doppler Findings

Variable	Category	n (%)
Previous miscarriages	0	30 (25.9)
	1	25 (21.6)
	2	37 (31.9)
	3	24 (20.7)
Pregnancy-related event/procedure	Abortion	27 (23.3)
	Dilatation and curettage	53 (45.7)
	Miscarriage	36 (31.0)
Bleeding severity	Spotting	32 (27.6)
	Moderate	37 (31.9)

Variable	Category	n (%)
	Heavy	47 (40.5)
Uterine fibroid	No	43 (37.1)
	Yes	73 (62.9)
Fluid in uterine cavity	No	64 (55.2)
	Yes	52 (44.8)
Intrauterine vascularity on color Doppler	Absent	64 (55.2)
	Increased	29 (25.0)
	Marked	23 (19.8)

The most frequent pregnancy-related event was dilatation and curettage, reported in 53 participants. Heavy vaginal bleeding was the most common presenting feature and was reported by 47 participants. Color Doppler showed increased or marked intrauterine vascularity in 52 participants, matching the number of final RPOC-positive cases, while 64 participants showed absent vascularity. These findings indicate that Doppler vascularity was clinically relevant in the diagnostic profile of suspected RPOC.

Table 3. Distribution of TAS, TVS, and Final Diagnostic Classification

Diagnostic variable	Negative, n (%)	Positive, n (%)	Total
TAS impression	90 (77.6)	26 (22.4)	116
TVS impression	64 (55.2)	52 (44.8)	116
Final diagnosis	64 (55.2)	52 (44.8)	116

TAS, transabdominal sonography; TVS, transvaginal sonography.

Transabdominal sonography identified 26 participants as positive for suspected RPOC, whereas transvaginal sonography identified 52 participants as positive. The final diagnostic classification also identified 52 positive cases. The higher positivity rate on TVS indicates that TVS detected additional suspected cases that were not identified by TAS.

Table 4. Cross-Classification of TAS and TVS Impressions

TAS impression	TVS negative	TVS positive	Total
Negative	64	26	90
Positive	0	26	26
Total	64	52	116

TAS, transabdominal sonography; TVS, transvaginal sonography.

Among 90 participants classified as negative by TAS, 26 were classified as positive by TVS. All 26 participants classified as positive by TAS were also classified as positive by TVS. This pattern shows that TVS identified a larger number of suspected RPOC cases than TAS, while TAS-positive findings were concordant with TVS-positive findings.

Table 5. Diagnostic Cross-Tabulation of TAS and TVS Against Final Diagnosis

Index test	Test result	Final diagnosis negative	Final diagnosis positive	Total
TAS	Negative	64	26	90
TAS	Positive	0	26	26
TVS	Negative	64	0	64
TVS	Positive	0	52	52

TAS, transabdominal sonography; TVS, transvaginal sonography.

Against the final diagnostic classification, TAS produced 26 true-positive, 64 true-negative, 0 false-positive, and 26 false-negative results. TVS produced 52 true-positive and 64 true-negative results, with no false-positive or false-negative cases in the supplied diagnostic classification. The TAS pattern indicates that a negative TAS did not exclude RPOC in this cohort, whereas positive TAS findings were highly concordant with final RPOC classification.

Table 6. Diagnostic Performance of TAS and TVS Against Final Diagnosis

Diagnostic measure	TAS, %	95% CI	TVS, %	95% CI
Sensitivity	50.0	35.8–64.2	100.0	93.2–100.0
Specificity	100.0	94.4–100.0	100.0	94.4–100.0
Positive predictive value	100.0	86.8–100.0	100.0	93.2–100.0
Negative predictive value	71.1	60.6–80.2	100.0	94.4–100.0
Overall accuracy	77.6	68.9–84.8	100.0	96.9–100.0

TAS, transabdominal sonography; TVS, transvaginal sonography; CI, confidence interval. Confidence intervals were calculated from the supplied 2 × 2 diagnostic tables. Likelihood ratios were not reported because both modalities had zero false-positive results, producing undefined or infinite positive likelihood ratios.

TAS showed limited sensitivity, identifying only 26 of 52 final RPOC-positive cases, but it showed complete specificity in the supplied classification because no TAS-positive case was finally classified as negative. TVS showed 100.0% sensitivity and 100.0% specificity against the final diagnostic classification. This finding should be interpreted cautiously because the final diagnosis must be independent of TVS findings to avoid incorporation bias.

Table 7. Serum β-hCG Levels According to Final Diagnosis

Final diagnosis	n	Mean ± SD, IU/L	Median, IU/L	Minimum	Maximum	Mean difference, IU/L	95% CI	t	df	p-value
Negative	64	121.95 ± 73.76	129.50	10	249					
Positive	52	2128.88 ± 922.53	2327.00	500	3474	2006.93	1749.50–2264.37	15.647	51.53	<0.001

β-hCG, beta-human chorionic gonadotropin; SD, standard deviation; CI, confidence interval. Test statistics are based on unequal-variance independent-samples testing as reported in the supplied output.

Serum β-hCG levels were markedly higher among participants with confirmed RPOC than among those without RPOC. The mean difference was 2006.93 IU/L, with a 95% confidence interval from 1749.50 to 2264.37 IU/L. The wide separation between diagnostic groups supports the role of β-hCG as a supportive biomarker, although it should be interpreted alongside sonographic and clinical findings rather than as an isolated diagnostic test.

Table 8. Summary of Statistically Relevant Comparative Findings

Comparison	Test statistic	df	p-value	Interpretation
TAS impression versus TVS impression	$\chi^2 = 41.244$	1	<0.001	TVS identified additional positive cases compared with TAS
TAS impression versus final diagnosis	$\chi^2 = 41.244$	1	<0.001	TAS was significantly associated with final diagnosis but missed half of final positive cases
TVS impression versus final diagnosis	$\chi^2 = 116.000$	1	<0.001	TVS showed complete agreement with final diagnosis in the supplied classification
Serum β-hCG by final diagnosis	t = 15.647	51.53	<0.001	β-hCG was substantially higher in final RPOC-positive cases

χ^2, chi-square statistic; β-hCG, beta-human chorionic gonadotropin; TAS, transabdominal sonography; TVS, transvaginal sonography.

The comparative analyses showed statistically significant associations between TAS and TVS impressions, between TAS and final diagnosis, and between TVS and final diagnosis. However, the clinical interpretation differed by modality. TAS was statistically associated with final diagnosis but had a substantial false-negative burden, while TVS showed complete agreement with final diagnosis in the supplied dataset. Serum β-hCG also differed significantly between final diagnostic groups, supporting its use as an adjunctive diagnostic marker.

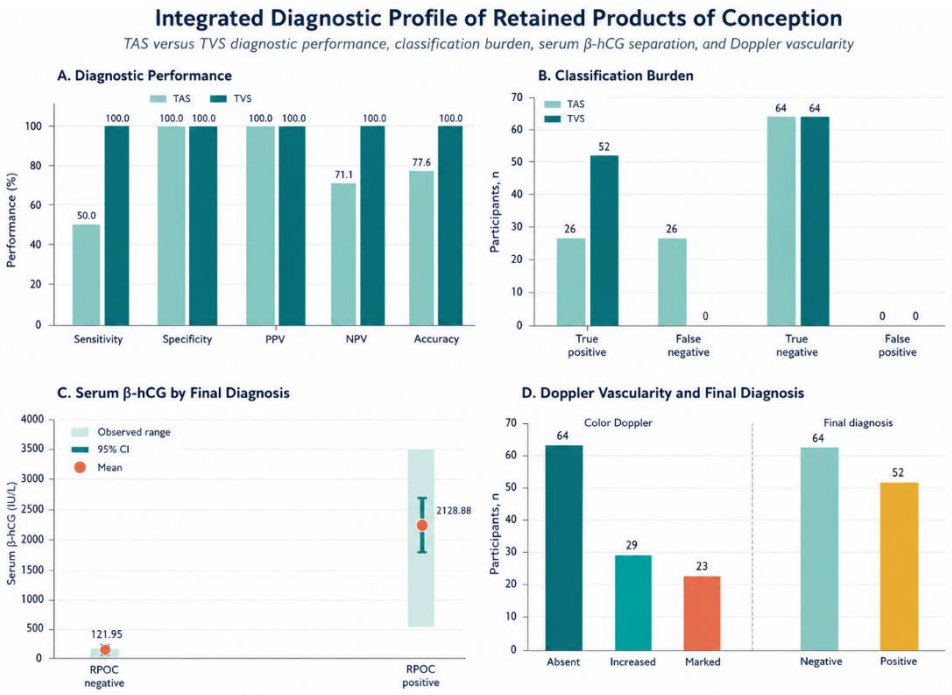

Figure 1 Integrated diagnostic profile of retained products of conception. Panel A compares the diagnostic performance of transabdominal sonography and transvaginal sonography against the final diagnostic classification, showing lower sensitivity for TAS than TVS while specificity remained 100.0% for both modalities. Panel B demonstrates the classification burden, where TAS produced 26 false-negative cases compared with none for TVS. Panel C shows marked separation of serum β-hCG between final diagnosis groups, with mean levels of 121.95 IU/L in RPOC-negative cases and 2128.88 IU/L in RPOC-positive cases. Panel D summarizes color Doppler vascularity and final diagnosis distribution, showing absent vascularity in 64 participants and increased or marked vascularity in 52 participants, corresponding to the number of final RPOC-positive cases.

DISCUSSION

This prospective comparative diagnostic accuracy study evaluated transabdominal sonography, transvaginal sonography, color Doppler vascularity, and serum β-hCG in women clinically suspected of having retained products of conception. The study found that 44.8% of participants were finally classified as RPOC-positive, indicating a substantial diagnostic yield among symptomatic women presenting after miscarriage, abortion, or pregnancy-related uterine intervention. Heavy vaginal bleeding was the most frequent presenting symptom, which is clinically consistent with RPOC being an important cause of abnormal post-pregnancy bleeding. Because bleeding may also occur with normal post-abortion or post-miscarriage involution, blood clot, endometritis, or non-retained intrauterine material, imaging and biochemical correlation remain central to diagnostic decision-making rather than clinical symptoms alone (10,11).

The principal finding was that transvaginal sonography identified a larger number of suspected RPOC cases than transabdominal sonography. TAS was positive in 22.4% of participants, whereas TVS was positive in 44.8%, matching the final RPOC-positive classification in the supplied diagnostic dataset. When compared with the final diagnostic classification, TAS showed limited sensitivity because it missed 26 of 52 final RPOC-positive cases, while its positive findings were concordant with the final diagnosis. This pattern suggests that TAS may be useful when positive but may be insufficient for excluding RPOC when negative, particularly in symptomatic women. The lower detection rate of TAS is clinically plausible because transabdominal imaging is more vulnerable to reduced spatial resolution, body habitus, bowel gas, bladder status, and suboptimal visualization of small intracavitary lesions. By contrast, TVS provides closer proximity to the endometrial cavity and superior visualization of focal retained tissue, which explains its stronger diagnostic agreement in the present cohort (12,13).

The finding that TVS showed complete agreement with the final diagnostic classification should be interpreted cautiously. In diagnostic accuracy research, the validity of sensitivity, specificity, and

agreement estimates depends on the independence and reliability of the reference standard. If TVS findings contributed to the final diagnostic classification, the apparent perfect agreement may reflect incorporation bias rather than true independent diagnostic accuracy. Therefore, the present findings support the clinical superiority of TVS over TAS in detecting suspected RPOC, but they should not be interpreted as proof that TVS has perfect diagnostic accuracy unless confirmed against an independent reference standard such as histopathology or standardized follow-up assessed without knowledge of the index-test result. Future studies should clearly define whether all positive cases undergo histopathological confirmation or whether conservatively managed cases are classified through prespecified follow-up criteria (19-29).

Color Doppler findings added clinically meaningful information to grayscale ultrasound interpretation. Increased or marked intrauterine vascularity was observed in 44.8% of participants, corresponding numerically to the final RPOC-positive group. Doppler vascularity is useful because vascular retained trophoblastic tissue is more likely to represent active RPOC than avascular clot or inactive debris. However, Doppler should not be considered definitive in isolation because vascularity may overlap with normal post-pregnancy uterine vascular changes, subinvolution, arteriovenous malformation, or inflammatory changes. The clinical value of Doppler is therefore greatest when interpreted with the echogenic appearance of intrauterine material, endometrial thickness, bleeding severity, and biochemical findings rather than as a standalone diagnostic sign (15,16).

Serum β-hCG differed markedly between diagnostic groups. Participants with final RPOC-positive classification had substantially higher mean β-hCG levels than those without RPOC, with a large mean difference. This supports the biological plausibility that persistent trophoblastic tissue may continue to produce β-hCG after pregnancy termination or miscarriage. Nevertheless, β-hCG values are influenced by gestational age at pregnancy event, timing of measurement, baseline pregnancy hormone level, completeness of evacuation, individual clearance rate, and viability of retained tissue. A single β-hCG value should therefore be interpreted as an adjunct rather than a definitive diagnostic marker. Serial β-hCG kinetics, when available, may provide stronger diagnostic information than a single measurement because delayed decline or plateauing values may better indicate persistent trophoblastic activity (27-31).

The clinical implication of these findings is that TVS should be preferred when RPOC is suspected and the patient accepts internal examination, especially when TAS is negative despite persistent bleeding or clinical concern. TAS may remain valuable as an initial or alternative modality in patients who decline TVS, in resource-limited settings, or when transvaginal examination is temporarily unsuitable. However, a negative TAS should not be used alone to rule out RPOC in symptomatic patients. Combining TVS with color Doppler and serum β-hCG provides a more robust diagnostic framework, especially for distinguishing active retained tissue from blood clot or nonspecific endometrial thickening. This multimodal strategy may help reduce both underdiagnosis and unnecessary uterine evacuation (32-35).

The study has several limitations. First, it was conducted at a single center with 116 participants, which may limit external validity. Second, the study population included women already clinically suspected of RPOC, which increases disease prevalence and may affect predictive values. Third, the final diagnostic classification requires clearer operational definition, particularly regarding which cases were confirmed histopathologically and which were classified through clinical follow-up. Fourth, if TVS contributed to the final diagnostic classification, incorporation bias may have inflated TVS performance estimates. Fifth, the study did not report receiver operating characteristic analysis for β-hCG, an optimal diagnostic cutoff, likelihood ratios with confidence intervals, or adjusted models incorporating Doppler vascularity and clinical factors. Finally, interobserver reliability was not reported, although diagnostic ultrasound is operator-dependent. Larger multicenter studies using independent reference standards, standardized sonographic criteria, and prespecified β-hCG timing are needed to validate these findings (36).

CONCLUSION

In women clinically suspected of having retained products of conception, transvaginal sonography identified more suspected cases than transabdominal sonography and showed stronger agreement with the final diagnostic classification. Transabdominal sonography demonstrated high specificity but limited sensitivity in the supplied diagnostic dataset, indicating that a negative TAS should not be used alone to exclude RPOC in symptomatic patients. Increased or marked color Doppler vascularity and substantially elevated serum β-hCG levels were more frequent among final RPOC-positive cases, supporting their role as adjunctive diagnostic indicators. A multimodal approach combining clinical presentation, TVS, Doppler vascularity, and serum β-hCG appears to provide the most clinically useful diagnostic framework, although future studies should confirm these findings using independent reference standards and standardized diagnostic criteria.

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