Original papers

Med Ultrason 2026, Vol. 28, no. 3, 308-314
DOI: 10.11152/mu-4585

Ultrasonographic vascular indices in the post-evacuation assessment of complete hydatidiform mole and gestational trophoblastic neoplasia

Silvia Novaes Pinto[1], Gustavo Yano Callado[2], Edward Araujo Júnior[1], Alberto Borges Peixoto[3,4], Antonio Braga[5], Heron Werner[5], Marcio Bezerra Barcellos[6], Pedro Teixeira Castro[5], Gabriela Paiva[5], Sue Yazaki Sun[1]

[1]Department of Obstetrics, Paulista School of Medicine – Federal University of São Paulo (EPM-UNIFESP), São Paulo, [2]Albert Einstein Israelite College of Health Sciences, Albert Einstein Israelite Hospital, São Paulo, [3]Department of Obstetrics and Gynecology, Federal University of Triângulo Mineiro (UFTM), Uberaba-MG, [4]Gynecology and Obstetrics Service, Mário Palmério University Hospital, University of Uberaba (UNIUBE), Uberaba-MG, [5]Department of Obstetrics and Gynecology, Federal University of Rio de Janeiro (UFRJ), Rio de Janeiro, [6]Department of Obstetrics and Gynecology, Petrópolis School of Medicine (UFRJ), Petrópolis, Brazil

Abstract

Aim: To identify clinical, biochemical, and ultrasonographic parameters that may serve as early predictors of gestational trophoblastic neoplasia (GTN) in patients initially diagnosed with complete hydatidiform mole (CHM). **Material and methods**: This retrospective study included 47 patients with trophoblastic gestational disease, of whom 28 had CHM and 19 developed GTN. Clinical data, serum human chorionic gonadotropin (hCG) levels, and ultrasonographic parameters – including vascular index (VI) (MV-Flow®) and uterine artery pulsatility index (PI) – were collected and analyzed. Logistic regression and receiver operating characteristic (ROC) curve analyses were used to assess predictive value. **Results**: GTN patients had significantly higher rates of second uterine evacuation (47.4% vs. 7.1%, p=0.001), prolonged time to hCG normalization (92.0 vs. 40.0 days, p<0.001), and increased frequency of focal lesions (68.4% vs. 14.3%, p<0.001). VI values in the longitudinal, transverse, and mean uterine planes were significantly higher in GTN, while mean PI was significantly lower (1.61 vs. 3.13, p=0.001). ROC curves demonstrated good diagnostic performance for the mean VI (AUC=0.823) and mean PI (AUC=0.777). **Conclusion**: The VI and uterine artery PI, in combination with serum hCG dynamics and focal lesion detection, may serve as useful parameters in the early identification of patients at increased risk for neoplastic progression following molar pregnancy.

Keywords: Prediction; Complete hydatidiform mole; Gestational trophoblastic neoplasia; Doppler ultrasound

Introduction

The main clinical and biochemical challenges in predicting the progression from complete hydatidiform mole (CHM) to gestational trophoblastic neoplasia (GTN) lie in the absence of highly specific early markers and the variable regression kinetics of human chorionic gonadotropin (hCG) [1]. Although serial quantitative hCG monitoring remains the cornerstone of post-molar surveillance, hCG levels alone do not reliably differentiate between benign and malignant outcomes. Moreover, no universally accepted threshold or timeline for hCG decline accurately predicts neoplastic transformation across all patients. Clinical parameters such as uterine size, theca lutein cysts, and maternal age offer limited prognostic value, and molecular biomarkers, while promising, are

Received 27.08.2025 Accepted 10.01.2026
Early Access publication date 25.01.2026
Med Ultrason
2026, Vol. 28, No 3, 308-314
Corresponding author: Prof. Edward Araujo Júnior, PhD
Rua Belchior de Azevedo, 156 apto. 111
Torre Vitoria
CEP 05089-030, São Paulo – SP, Brazil
E-mail: araujojred@terra.com.br

still under investigation and not yet incorporated into routine practice [1-3].

In recent years, ultrasonographic parameters reflecting tissue vascularization – such as the vascular index (VI), focal lesion vascularity, and uterine artery pulsatility index (PI) – have been investigated as potential early predictors of GTN. These measurements, obtained through advanced imaging technologies such as MV-Flow® and three-dimensional power Doppler, provide a non-invasive assessment of neovascularization and uterine perfusion. Some studies suggest that patients who develop GTN present with lower PI values and increased endometrial vascularity, reflecting the angiogenic potential of malignant trophoblastic tissue [4,5]. Reflecting its clinical utility, it is recommended to perform a Doppler ultrasound as an adjunct to hCG surveillance in the early detection of post-molar GTN [6,7].

The present study aims to identify clinical, biochemical, and ultrasonographic parameters that may serve as early predictors of GTN among patients initially diagnosed with gestational trophoblastic disease (GTD). By comparing cases of CHM that progressed to GTN with those that did not, the study seeks to determine whether variables such as serum hCG levels, uterine vascular indices, and pulsatility indices of the uterine arteries can contribute to risk stratification and guide follow-up strategies.

Material and method

Study design and setting

This was a prospective cross-sectional study (March 2022 to August 2024) conducted to evaluate uterine microvascular flow using Doppler MV-Flow® imaging (Samsung, Seoul, South Korea) in women with GTD. The study was conducted in two GTD outpatient clinics, Federal University of São Paulo (UNIFESP) and Federal University of Rio de Janeiro (UFRJ), Brazil. This study was approval by the Ethics Committee of UNIFESP and all participants signed the consent form.

Eligible criteria

All patients attending the participating GTD outpatient clinics during the study period were screened for eligibility following institutional ethics approval. Those who met the inclusion criteria and provided written informed consent were enrolled in the study.

Eligible participants included patients with a histopathological diagnosis of complete hydatidiform mole, undergoing post-molar follow-up with regressing but not yet normalized hCG levels at the time of enrollment, as well as patients diagnosed with low-risk post-molar GTN, according to the 2000 FIGO criteria, prior to the initiation of chemotherapy. Patients were excluded if they were under 14 years of age, had a twin pregnancy with a coexisting fetus and mole, or had a previous diagnosis of GTN prior to the current pregnancy.

Ultrasonographic assessment

All participants underwent a single transvaginal ultrasound using Samsung HERA W9 or RS85 equipment (Samsung, Seoul, South Korea), each equipped with a 5 MHz endocavitary transducer. Examinations were conducted in the lithotomy position after bladder emptying and were performed by two experienced gynecologic sonographers (SNP and HW). For patients in Group I, the ultrasound was performed at their first post-evacuation visit, before hCG normalization and during the regression phase. For Group II, the ultrasound was conducted between 3 and 10 days prior to initiating single-agent chemotherapy for low-risk GTN. Uterine dimensions (longitudinal, transverse, and anteroposterior) were measured to calculate uterine volume. Bilateral uterine artery Doppler assessments were conducted to determine the PI, resistance index (RI), and systolic-to-diastolic ratio (S/D), based on the insonation of the ascending branches of the uterine arteries at the level of the internal cervical os. The MV-Flow® mode was applied to a mid-sagittal view and a transverse plane at the uterine cornua to calculate VI within manually defined regions of interest (ROIs) encompassing the respective uterine areas. When focal lesions were present, they were measured in three planes and evaluated using color Doppler imaging, spectral Doppler, and MV-Flow®, with VI calculated from a manually defined ROI aligned with the lesion's longest axis. Ovarian dimensions were also measured in three planes to determine ovarian volume, and the morphology was assessed to identify theca lutein cysts. The ROI was kept stable throughout image acquisition, particularly during VI capture. MV-Flow® settings were standardized across both centers, including a frame average of 7, dynamic range of 25, tissue suppression of 4, smoothness at 1, filter at 0, sensitivity of 32, color map 2, balance of 31, alpha blend of 70%, and power set to 90% (fig 1).

It is important to emphasize that the Doppler and biochemical parameters in this study were assessed during the post-evacuation period, allowing a cross-sectional comparison between patients with CHM and those already diagnosed with GTN, rather than a longitudinal prediction of disease progression.

Outcome measures

The primary outcome of interest was the development of GTN, defined according to FIGO 2000 criteria as either a plateau or increase in serum hCG levels over serial measurements. Patients were monitored for spontaneous

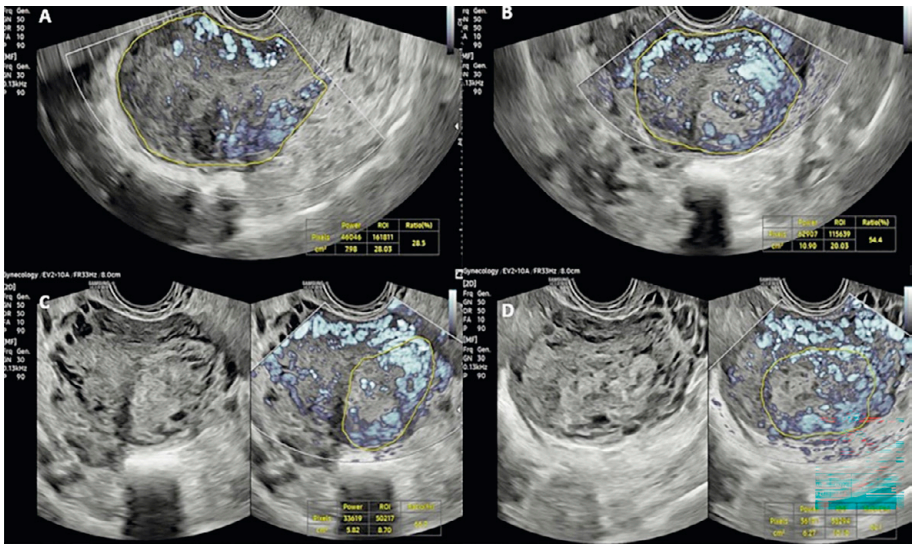

Fig 1. MVFlow® imaging. (A) Vascular index calculates of uterus in the longitudinal plane. (B) Vascular index calculates of uterus in the transverse plane. (C) Vascular index calculates of ovarian in the longitudinal plane. (D) Vascular index calculates of ovarian in the transverse plane.

remission, characterized by sustained hCG normalization without chemotherapy, or for progression to GTN requiring therapeutic intervention.

For those diagnosed with GTN, secondary outcomes included the occurrence of chemoresistance, defined as an increase in hCG levels during first-line single-agent chemotherapy, and the need for additional therapeutic strategies. Additional outcome variables included the time from molar evacuation to hCG normalization, presence of focal uterine lesions, ultrasonographic vascular indices, and uterine artery pulsatility measurements. These clinical and imaging parameters were analyzed to identify potential predictors of neoplastic progression and chemoresistance.

Statistical Analysis

Data were collected using Microsoft Excel 2007 (Microsoft Corp., Redmond, WA, USA) and analyzed with SPSS software version 20.0 (SPSS Inc., Chicago, IL, USA) and GraphPad Prism version 7.0 (GraphPad Software, San Diego, CA, USA). The Shapiro-Wilk test was applied to assess the normality of continuous variables. Variables with non-parametric distributions were expressed as medians and ranges (minimum–maximum), while those with parametric distributions were presented as means and standard deviations. Categorical variables were described using absolute frequencies and percentages.

The Mann–Whitney test was used to compare continuous variables with non-parametric distribution between groups. For parametric continuous variables, Student's t-test was applied. Associations between categorical variables and groups were assessed using the Chi-square test. Binary logistic regression was used to estimate the odds ratios (OR) for outcomes such as chemoresistance and GTN. Receiver operating characteristic (ROC) curve analysis was employed to determine the optimal cutoff values of vascular indices and mean uterine artery PI for predicting GTN. The significance level adopted for all tests was $\alpha<0.05$.

Results

During the study period, 55 patients with a diagnosis of GTD were evaluated. Of these, eight were excluded from the final analysis due to the following reasons: four had a diagnosis of partial mole, one had retained products of conception confirmed by histopathological examination, two presented with recurrent GTN, and one patient was lost to follow-up. Thus, the final sample comprised 47 patients, including 28 diagnosed with CHM and 19 with GTN (Table I).

A statistically significant association was observed between diagnosis group and the need for a second uterine evacuation (p=0.001), as well as with the performance of total abdominal hysterectomy (p=0.030). Patients diagnosed with GTN had a markedly higher frequency of requiring a second evacuation procedure compared to those with CHM (47.4% vs. 7.1%, respectively), and hysterectomy was performed in 15.8% of GTN cases, while no cases required this procedure in the CHM group.

Among patients with GTN, clinical staging according to FIGO/WHO criteria revealed that 15.8% (3/19) were classified as stage I:0, 10.5% (2/19) as stage I:1, 36.8% (7/19) as stage I:2, 26.3% (5/19) as stage I:3, and 5.3% (1/19) each in stages I:5 and I:7. Among 15 patients un-

dergoing first-line chemotherapy, 4 (26.7%) developed chemoresistance, while the remaining 11 (73.3%) responded to initial treatment. Among the chemoresistant cases, one patient was staged as I:2, one as I:3, one as I:5, and one as I:7.

Regarding ultrasonographic findings, GTN patients presented significantly higher values in several parameters. These included the number of MVFlow® images (median 9.0 vs. 6.0, p=0.008), VI in the longitudinal uterine plane (28.9 vs. 12.9, p<0.001), in the transverse plane (32.0 vs. 16.1, p<0.001), and the mean VI from both planes (31.7 vs. 15.2, p<0.001). Additionally, GTN patients exhibited higher serum hCG levels at the time of ultrasound (9585.0 vs. 285.0, p<0.001), and a longer time to normalization of serum hCG levels (92.0 vs. 40.0 days, p<0.001). The mean PI of the uterine arteries was significantly lower in the GTN group compared to the CHM group (1.61 vs. 3.13, p=0.001). Focal lesions were also more frequently detected in GTN patients (68.4% vs. 14.3%, p<0.001) (Table II).

No significant correlation was found between pre-evacuation hCG levels and the VI in the longitudinal (r=0.13, p=0.599), transverse (r=0.00, p=0.998), or mean uterine planes (r=0.05, p=0.715), when analyzing the entire sample (Supplementary figures S1 to S3). Similar non-significant correlations were observed when stratified by group. Likewise, there was no significant association between pre-evacuation hCG levels and uterine volume (r=0.06, p=0.682) or mean uterine artery PI (r=0.06, p=0.683), regardless of group (Supplementary figures S4 and S5).

In contrast, serum hCG levels measured at the time of ultrasound demonstrated statistically significant moderate positive correlations with the VI in the longitudinal

Table I. Population characteristics.

	Complete Mole (N=28)	Gestational Trophoblastic Neoplasia (N=19)	p-value
Age (years)	28.0 (18.0–45.0)	25.5 (17.0–46.0)	0.422 ∂
Ethnicity			0.801 ƒ
White	53.6% (15/28)	63.2% (12/19)	
Black	21.4% (6/28)	15.8% (3/19)	
Mixed race	25.0% (7/28)	21.1% (4/19)	
Gravidity	1.0 (1.0–5.0)	1.0 (1.0–5.0)	0.915 ∂
Parity	0.0 (0.0–3.0)	0.0 (0.0–2.0)	0.639 ∂
Miscarriage	0.0 (0.0–1.0)	0.0 (0.0–2.0)	0.667 ∂
Pre-evacuation hCG (IU)	58,383.0 (15.0–703,794)	60,468.0 (15.0–1,000,000)	0.836 ∂
Second uterine evacuation required	7.1% (2/28)	47.4% (9/19)	0.001 ƒ
Underwent TAH	0.0% (0/28)	15.8% (3/19)	0.030 ƒ

hCG: human chorionic gonadotropin; TAH: total abdominal hysterectomy. Statistical tests: Chi-square test ƒ: % (n/N); Mann–Whitney test ∂: median (minimum–maximum). p<0.05.

Table II. Effect of complete hydatidiform mole and gestational trophoblastic neoplasia on ultrasonographic characteristics.

	Complete Mole (N=28)	Gestational Trophoblastic Neoplasia (N=19)	p-value
Number of MV-flow® images	6.0 (4.0–9.0)	9.0 (2.0–11.0)	0.008 ∂
Focal lesion	14.3% (4/28)	68.4% (13/19)	<0.001 ƒ
VI – longitudinal uterine plane	12.9 (4.10–36.4)	28.9 (12.3–50.3)	<0.001 ∂
VI – transverse uterine plane	16.1 (4.4–54.4)	32.0 (12.9–68.8)	<0.001 ∂
VI – mean uterine value (long. + trans.)	15.2 (4.4–41.5)	31.7 (13.4–59.5)	<0.001 ∂
VI – focal lesion	56.8 (13.3)	52.9 (14.5)	0.640 †
Uterine volume (mL)	115.0 (40.8–236.0)	139.0 (76.0–576.0)	0.477 ∂
Mean uterine artery pulsatility index (PI)	3.13 (0.82–6.76)	1.61 (0.56–3.77)	0.001 ∂
Interval between US and hCG normalization (days)	40.0 (5.0–145.0)	92.0 (22.0–383.0)	<0.001 ∂
hCG level at the time of ultrasound (IU/L)	285.0 (1.4–33,790.0)	9,585.0 (155.0–118,730.0)	<0.001 ∂

VI: vascular index; PI: pulsatility index; US: ultrasound; hCG: human chorionic gonadotropin. Statistical tests: Chi-square test ƒ: % (n/N); Student's t test †: mean (standard deviation); Mann–Whitney test ∂: median (minimum–maximum). p<0.05.

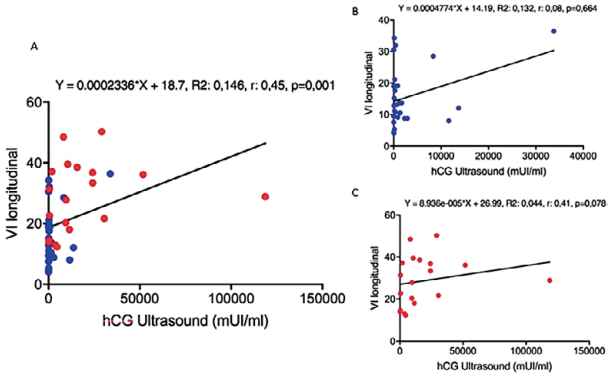

Fig 2. Correlation between serum human chorionic gonadotropin (hCG) levels at the time of ultrasound and the vascular index (VI) in the longitudinal uterine plane among patients with complete hydatidiform mole (blue) and gestational trophoblastic neoplasia (red). Spearman correlation test. p<0.05.

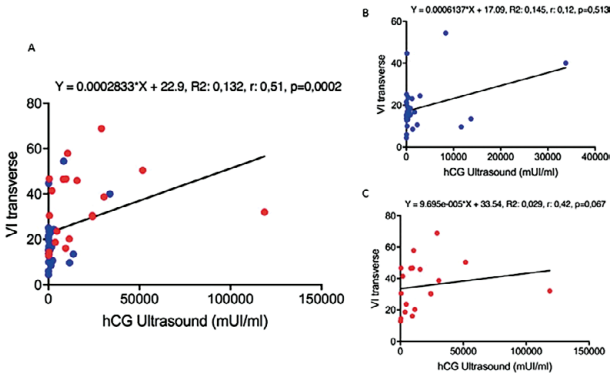

Fig 3. Correlation between serum human chorionic gonadotropin (hCG) levels at the time of ultrasound and the vascular index (VI) in the transverse uterine plane among patients with complete hydatidiform mole (blue) and gestational trophoblastic neoplasia (red). Spearman correlation test. p<0.05.

(r=0.45, p=0.001; fig 2), transverse (r=0.51, p=0.0002; fig 3), and mean uterine planes (r=0.50, p=0.0003), as well as with uterine volume (r=0.54, p<0.0001) (Supplementary figures S6 and S7). A moderate negative correlation was found between hCG at ultrasound and mean uterine artery PI (r=–0.56, p<0.0001) (Supplementary figure S8). In the GTN subgroup, this negative correlation remained statistically significant (r=–0.48, p=0.035), while in the CHM group the correlation was not significant (r=–0.32, p=0.092).

A strong negative correlation was also observed between the mean VI and the mean uterine artery PI when considering all patients (r=–0.71, p<0.0001) (fig 4). This correlation was weaker but still significant in the CHM group (r=–0.39, p=0.041), and very strong in the GTN group (r=–0.88, p<0.0001), suggesting an inverse hemodynamic pattern in cases progressing to neoplasia.

There was no significant correlation between the interval from first uterine evacuation to ultrasound and mean VI (r=0.26, p=0.078) (Supplementary figure S9), neither in the CHM group (r=–0.03, p=0.869) nor in the GTN group (r=0.39, p=0.094). However, a weak yet statistically significant negative correlation was observed between this interval and the mean PI of uterine arteries when considering all patients (r=–0.33, p=0.021) (Supplementary figure S10), though this association was not observed in group-specific analyses.

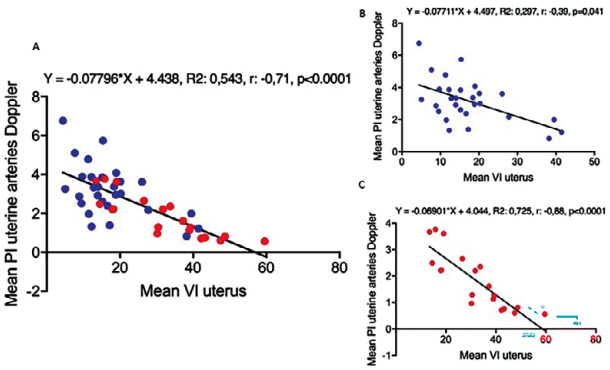

Fig 4. Correlation between mean vascular index (VI) and mean uterine artery pulsatility index (PI) among patients with complete hydatidiform mole (blue) and gestational trophoblastic neoplasia (red). Spearman correlation test. p<0.05.

Binary logistic regression analysis identified the VI in the longitudinal (OR: 1.12, 95% CI: 1.04–1.19, p<0.001), transverse (OR: 1.09, 95% CI: 1.03–1.15, p=0.002), and mean uterine planes (OR: 1.11, 95% CI: 1.04–1.18, p=0.001), as well as the mean PI of uterine arteries (OR: 0.38, 95% CI: 0.21–0.73, p=0.004), as statistically significant predictors of GTN development (Supplementary Table SI).

ROC curve analysis demonstrated that the longitudinal VI value of 19.7 was a moderately accurate predictor of GTN, with an area under the curve (AUC) of 0.829, sensitivity of 73.0%, and a false-positive rate of 21.4% (fig 5A). A VI of 23.5 in the transverse plane yielded an AUC of 0.816, with 74.0% sensitivity and 17.9% false-positive rate (fig 5B). The mean VI threshold of 26.3 had an AUC of 0.823, correctly identifying 68.0% of GTN cases with a false-positive rate of 14.3% (fig 5C). The mean PI of uterine arteries at or below 2.63 predicted GTN with an AUC of 0.777, sensitivity of 79.0%, and false-positive rate of 35.7% (fig 5D) (Supplementary Table SII).

In a secondary logistic regression model incorporating the same ultrasound parameters and pre-evacuation hCG, none reached statistical significance, although borderline p-values were observed for longitudinal VI (p=0.056), transverse VI (p=0.074), and mean VI (p=0.063) (Supplementary Table SIII).

Discussion

Compared to patients with non-neoplastic evolution, those who progressed to GTN showed higher rates of second uterine evacuation and hysterectomy, elevated hCG levels at the time of ultrasound, longer time to hCG normalization, and a higher prevalence of focal uterine lesions. Importantly, VI measurements in the longitudinal, transverse, and mean uterine planes, as well as lower mean PI of the uterine arteries, were significantly associated with GTN. These variables were also found to be independent predictors of neoplastic transformation, with ROC curve analysis demonstrating good diagnostic performance for the VI and PI parameters. However, these findings should be interpreted in the context of the study's cross-sectional design, which identifies differences between CHM and GTN in the post-evacuation period rather than establishing a prospective predictive model.

Previous studies have reported moderate predictive value of uterine vascularization indices, such as VI and PI, in differentiating CHM from GTN [5,8,9]. In line with our findings, lower PI values are consistently associated with malignant progression, likely reflecting increased angiogenesis and reduced vascular resistance in neoplastic tissue. Although our study did not include serial PI measurements, we observed that lower mean PI was independently associated with GTN and had moderate discriminative accuracy. These results are consistent with previous reports proposing PI thresholds of ≤1.38 pre-evacuation and ≤1.77 post-evacuation, with sensitivity around 77–79% and specificity ranging from 82–86% [5]. These findings support the integration of PI assessment into post-molar risk stratification.

Our study also contributes novel evidence regarding the diagnostic potential of VI, which remains less explored in the literature. Higher VI values in all assessed planes were independently associated with GTN, suggesting that volumetric assessment of vascularity may enhance early identification of malignant transformation. While spectral Doppler measures have been more frequently studied [6], VI may provide a more comprehensive evaluation of endometrial perfusion and neovascularization. Despite the absence of established VI thresholds in clinical guidelines, our findings indicate that this parameter holds promise as a complementary imaging marker.

Nonetheless, it is essential to contextualize these results. hCG regression patterns remain the most reliable and widely validated predictor of post-molar GTN. High pre-evacuation hCG levels (≥100,000 IU/L) and abnormal regression dynamics – such as serum hCG ≥1400 IU/L at two weeks – have demonstrated superior predictive accuracy, with AUCs approaching 0.92 in some studies [10,11]. Compared to these biochemical markers, imaging-based parameters such as VI and PI provide supportive but less discriminative value and are best interpreted within a multimodal framework. This approach is consistent with current recommendations from the American College of Radiology, which endorses Doppler indices as ancillary tools alongside clinical and biochemical surveillance [6].

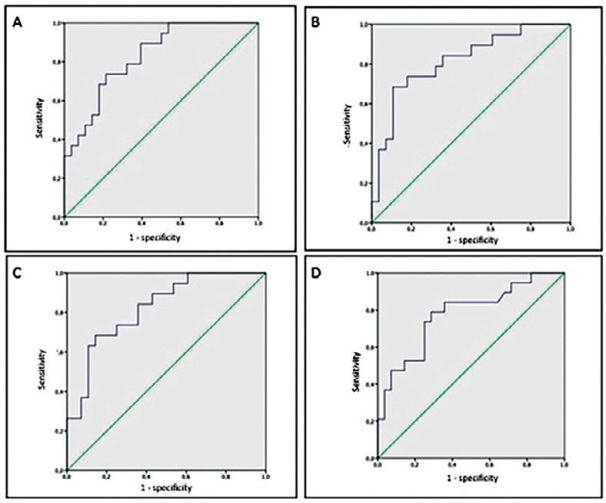

Fig 5. Receiver operating characteristic (ROC) curves for the prediction of gestational trophoblastic neoplasia in patients with gestational trophoblastic disease. (A) Vascular index (VI) in the transverse uterine plane (AUC=0.816; p<0.0001; 95% CI: 0.69–0.94); (B) Mean uterine vascular index (AUC=0.823; p=0.001; 95% CI: 0.70–0.84); (C) Mean uterine artery pulsatility index (AUC=0.777; p=0.001; 95% CI: 0.63–0.91); (D) Mean uterine artery pulsatility index (AUC=0.777; p=0.001; 95% CI: 0.63–0.91).

In this context, our findings support the utility of combining biochemical and imaging parameters for early GTN risk stratification. Although hCG monitoring remains the foundation of post-molar follow-up, vascular imaging – particularly through indices such as VI and PI – may refine individual risk assessment and guide early therapeutic decisions, especially in patients with suggestive ultrasonographic findings. Further prospective studies with larger sample sizes and standardized imaging protocols are needed to validate the clinical utility of these measures.

An additional clinical consideration in the management of patients with GTN involves fertility preservation, given that many affected women are of reproductive age. In cases where malignant transformation requires chemotherapy or may necessitate hysterectomy, oocyte vitrification through antagonist ovarian stimulation protocols can be offered prior to treatment to safeguard

reproductive potential. Fertility-sparing strategies are increasingly integrated into oncologic care, aiming to preserve the uterus when feasible and maintain the possibility of future conception [12,13]. Future studies integrating vascular imaging markers with reproductive counseling and fertility preservation outcomes may further enhance patient-centered management.

One of the main strengths of this study lies in its combined assessment of clinical, biochemical, and ultrasonographic variables, which allowed for a more comprehensive evaluation of potential early predictors of GTN. The incorporation of advanced vascular imaging indices, such as the VI, represents a novel approach that goes beyond traditional reliance on serial hCG measurements alone. By including Doppler-based uterine artery PI as well as VI data, the study provides insight into the perfusion characteristics of trophoblastic tissue and supports the concept that increased vascularization is associated with malignant progression. Additionally, the analysis of both correlation and predictive value through logistic regression and ROC curves strengthens the clinical relevance of these findings.

Nevertheless, this study has several limitations. The sample size was relatively small, particularly within the GTN subgroup, which may affect the generalizability of the findings. Furthermore, despite the statistically significant associations observed, some variables – such as the pre-evacuation hCG level and uterine volume – did not independently predict GTN, and the borderline significance in the secondary regression model underscores the need for cautious interpretation. The observational and retrospective nature of the study also limits causal inference, and the results should be confirmed in larger, prospective cohorts with standardized ultrasonographic protocols. Lastly, although VI and PI offer promising prognostic information, their widespread implementation in clinical practice may be limited by equipment variability and operator dependency.

Conclusion

In conclusion, this study suggests that the VI and uterine artery PI, along with focal lesion detection and hCG dynamics, may serve as useful parameters in identifying patients at increased risk of post-molar neoplastic transformation. These findings contribute to the growing body of evidence supporting the role of quantitative ultrasonographic markers in the early stratification of GTD and may help optimize follow-up protocols and clinical decision-making. Future research is warranted to validate these findings in larger populations and to explore their utility in prospective risk prediction models.

References

1. Soper JT. Gestational Trophoblastic Disease: Current Evaluation and Management. Obstet Gynecol 2021;137:355-370.
2. McMahon LM, Stewart WW, Cuthill L. Human chorionic gonadotrophin assays to monitor GTD. Best Pract Res Clin Obstet Gynaecol 2021;74:109-121.
3. Hoeijmakers YM, Eysbouts YK, Massuger LFAG, et al. Early prediction of post-molar gestational trophoblastic neoplasia and resistance to methotrexate, based on a single serum human chorionic gonadotropin measurement. Gynecol Oncol 2021;163:531-537.
4. Laban M, El-Swaify ST, Refaat MA, Ibrahim EA, Abdelrahman RM. Prediction of Neoplastic Transformation of Hydatidiform Mole: Current Evidence. Reprod Sci 2021;28:3010-3012.
5. Asmar FTC, Braga-Neto AR, de Rezende-Filho J, Villas-Boas JMS, Charry RC, Maesta I. Uterine artery Doppler flow velocimetry parameters for predicting gestational trophoblastic neoplasia after complete hydatidiform mole, a prospective cohort study. Clinics (Sao Paulo) 2017;72:284-288.
6. Dudiak KM, Maturen KE, Akin EA, et al. ACR Appropriateness Criteria® Gestational Trophoblastic Disease. J Am Coll Radiol 2019;16(11S):S348-S363.
7. Cioffi R, Cavoretto PI, Sabetta G, et al. Additional value of uterine artery Doppler pulsatility index for ultrasound diagnosis of placental site trophoblastic tumor: prospective cohort study. Ultrasound Obstet Gynecol 2025; doi:10.1002/uog.29235
8. Gungor T, Ekin M, Dumanli H, Gokmen O. Color Doppler ultrasonography in the earlier differentiation of benign molehydatidiforms from malignant gestational trophoblastic disease. Acta Obstet Gynecol Scand 1998;77:860-86.
9. Lin LH, Bernardes LS, Hase EA, Fushida K, Francisco RP. Is Doppler ultrasound useful for evaluating gestational trophoblastic disease? Clinics (Sao Paulo) 2015;70:810-815.
10. Braga A, Canelas AC, Torres B, et al. Neutrophil/lymphocyte ratio and other blood cell component counts are not associated with the development of postmolar gestational trophoblastic neoplasia. PLoS One 2022;17:e0277892.
11. Rakprasit C, Ruengkhachorn I, Therasakvichya S, et al. Combined analysis of clinical features, human chorionic gonadotropin (hCG) value, and hCG ratios for early prediction of postmolar gestational trophoblastic neoplasia. Arch Gynecol Obstet 2023;307:1145-1154.
12. Gullo G, Satullo M, Conti E, et al. Gestational Trophoblastic Disease: Diagnostic and Therapeutic Updates in Light of Recent Evidence: A Literature Review. Medicina (Kaunas) 2025;61:1642.
13. De Paola L, Napoletano G, Gullo G, Circosta F, Montanari Vergallo G, Marinelli S. The era of increasing cancer survivorship: Trends in fertility preservation, medico-legal implications, and ethical challenges. Open Med (Wars) 2025;20:20251144.