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Systematic review

Clinical predictors of ovarian torsion in female patients presenting to the emergency department: A Systematic Review

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Abstract

Background: Ovarian torsion is a gynecologic emergency in which nonspecific symptoms and imperfect imaging complicate early recognition in emergency care. In this study we aimed to analyze original articles on clinical, laboratory, and ultrasound predictors associated with surgically confirmed ovarian or adnexal torsion in females presenting with acute symptoms. **Methods:** A PRISMA-aligned systematic review framework was constructed for PubMed, Scopus, Web of Science Core Collection, and the Cochrane Library from inception through August 2026. Eligible studies evaluated preoperative predictors of ovarian or adnexal torsion in females assessed in emergency settings and used operative findings as the reference standard. Prediction-model and diagnostic-factor studies

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were analyzed qualitatively because predictor definitions, thresholds, age groups, and modeling strategies were heterogeneous. **Results:** Eighteen original studies were included. Recurrent predictors include unilateral or localized pain, nausea or vomiting, shorter symptom duration, leukocytosis or elevated neutrophil-to-lymphocyte ratio, ovarian enlargement or increased ovarian volume ratio, ovarian stromal edema, free pelvic fluid, abnormal ovarian position, and the whirlpool sign. Multivariable and composite models performed better than isolated symptoms, laboratory values, or Doppler findings. Pediatric models integrating age, inflammatory indices, and sonographic morphology reported discrimination in internal validation. **Conclusions:** Ovarian torsion prediction is strongest when history, examination, inflammatory markers, and ultrasound morphology are integrated.

Keywords: Ovarian torsion; Adnexal torsion; emergency department; acute pelvic pain; clinical prediction; ultrasound; neutrophil-to-lymphocyte ratio; diagnostic model

Introduction

Ovarian or adnexal torsion results from rotation of the adnexa around its vascular pedicle, which result in venous and lymphatic obstruction followed by arterial compromise, ischemia, and tissue injury when torsion persists. The condition represents a gynecologic surgical emergency and diagnostic delay increases the likelihood of ovarian necrosis and loss of ovarian function (1). Clinical recognition is difficult because abdominal or pelvic pain, nausea, vomiting, and adnexal tenderness overlap with appendicitis, ruptured cysts, renal colic, pelvic inflammatory disease, and other acute abdominal conditions. The intermittent nature of torsion and spontaneous partial detorsion create variability in pain severity and examination findings (2).

Published syntheses in pediatric populations describe sudden abdominal pain accompanied by nausea or vomiting as a common presentation (3). Adolescents deserve attention because torsion often occurs without a malignant mass, and preservation of the ovary is a central treatment objective (4). Ultrasound is the principal first-line imaging test, with ovarian enlargement, stromal edema, peripheral follicles, free fluid, abnormal position, altered Doppler flow, and a twisted vascular pedicle among reported findings (4). A meta-analysis of imaging studies found useful diagnostic performance for ultrasound, although heterogeneity across technique, operator experience, and diagnostic criteria limits reliance on a single imaging feature (5).

Emergency clinicians face a risk-stratification problem not a simple binary imaging question because preserved arterial or venous flow does not remove torsion from consideration. Previous studies directed at emergency practice found integration of symptom pattern, physical findings, ovarian morphology, vascular findings, and consultation when clinical suspicion remains substantial (6). Emergency literature highlights ovarian asymmetry, increased ovarian volume, vomiting, and inflammatory laboratory indices as candidate predictors that complement sonographic assessment. This shift toward combined prediction is important because several primary studies have developed composite scores, regression models, and machine-learning approaches that outperform individual features (7).

The available prediction literature include children, adolescents, and reproductive-age women, with considerable variation in study design, case selection, predictor thresholds, and reference populations (3). A focused synthesis of these studies

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is needed to identify findings that recur in cohorts and to distinguish repeatedly supported predictors from features reported only in single models. This systematic review evaluates clinical, laboratory, and emergency ultrasound predictors associated with surgically confirmed ovarian or adnexal torsion in female patients presenting with acute abdominal or pelvic symptoms, with emphasis on predictors relevant to emergency decision-making.

Methods

This review was structured according to PRISMA 2020 principles for systematic reviews and was conducted in female patients assessed for acute abdominal or pelvic symptoms in emergency or urgent-care settings. PubMed, Scopus, Web of Science Core Collection, and the Cochrane Library were designated as the primary databases, with a search period from inception through August 2026. Search concepts combined controlled vocabulary and free-text terms for “ovarian torsion,” “adnexal torsion,” “emergency department,” “acute pelvic pain,” “predictor,” “prediction model,” “clinical features,” “laboratory,” “neutrophil lymphocyte ratio,” “ultrasound,” “Doppler,” “ovarian volume,” and related variants. Reference lists of eligible studies and relevant reviews were examined for additional primary reports.

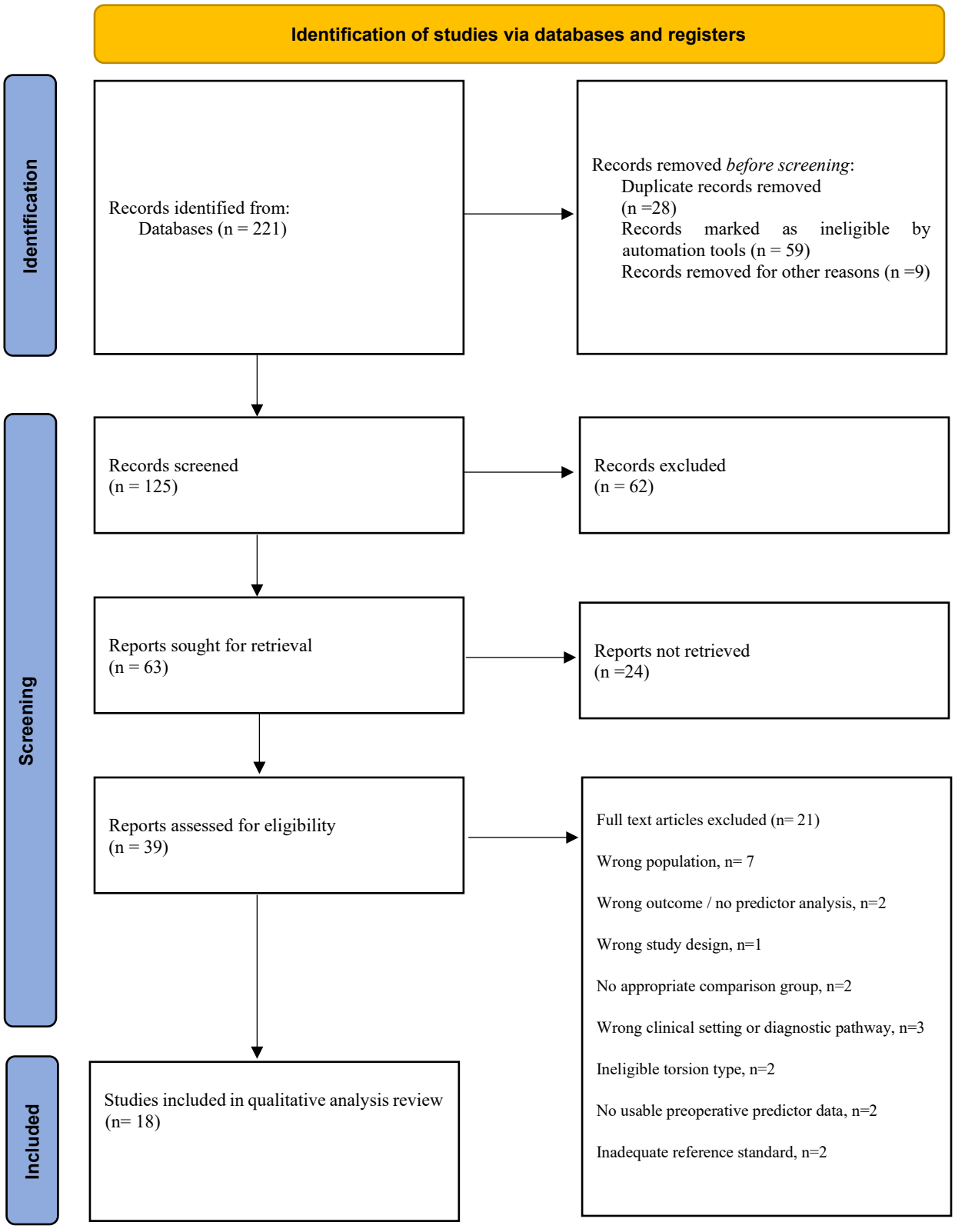
Eligible reports were original human studies evaluating one or more preoperative clinical, laboratory, or ultrasound predictors in females with suspected ovarian or adnexal torsion. Emergency-department cohorts, acute gynecology cohorts, urgent surgical cohorts, and pediatric acute-care cohorts were eligible when the diagnostic pathway reflected emergency assessment. Operative visualization of torsion was the preferred reference standard; studies with a clearly defined alternative reference standard were considered only when torsion status was adequately verified. Case reports, small uncontrolled case series without predictor analysis, narrative reviews, systematic reviews, editorials, letters without original data, animal studies, isolated tubal torsion without separable ovarian or adnexal data, and studies focused only on postoperative outcomes were excluded.

Titles and abstracts were assessed against eligibility criteria, followed by full-text assessment of potentially relevant reports (Fig 1). Data extraction fields included country, setting, design, age group, sample size, torsion prevalence, reference standard, candidate predictors, multivariable predictors, thresholds, odds ratios, discrimination measures, sensitivity, specificity, and validation approach. When study populations appeared related, cohort dates, centers, age criteria, and model purpose were compared to reduce inappropriate duplication of findings. Prediction-model studies were appraised conceptually with PROBAST domains, while diagnostic-factor studies were assessed using QUADAS-2 domains, focusing on participant selection, predictor measurement, reference standard, and flow.

Because predictor definitions, thresholds, populations, and analytic methods differed, a quantitative pooled meta-analysis was not performed. Findings were synthesized qualitatively by predictor domain: symptoms and examination, inflammatory laboratory markers, ovarian size and morphology, vascular or pedicle signs, and multivariable models. Recurrent predictors were given greater interpretive weight when replicated

across independent cohorts or supported by internal or external validation.

Fig 1: PRISMA flow chart



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Results

The included studies assembled for qualitative synthesis spanning adult, reproductive-age, adolescent, and pediatric populations, with most using operative findings as the definitive diagnosis. The earliest multivariable score identified unilateral pain, symptom duration under eight hours, vomiting, absence of leucorrhoea or metrorrhagia, and an ovarian cyst larger than 5 cm as independent diagnostic features (8). In menarchal pediatric patients, King et al. combined ovarian volume ratio, absolute ovarian volume, nausea, and pain duration; a composite score of at least 3 produced 100% sensitivity and 65.3% specificity (9). A later prospective pediatric emergency-department study of 324 females found vomiting, adnexal volume, and adnexal volume ratio to be independent components of its composite score (10).

Adult acute-care evidence also supported combined symptom, laboratory, and ultrasound assessment. In reproductive-age women undergoing urgent laparoscopy, nausea or vomiting, peritoneal irritation, leukocytosis, free pelvic fluid, ovarian edema, benign cystic teratoma, and right-sided pathology were associated with torsion (11). A pediatric and adolescent surgical cohort likewise reported higher frequencies of nausea or vomiting, peritoneal irritation, ovarian edema, and free fluid among torsion cases (12). An emergency-department case-control study evaluated maximum ovarian diameter and identified 5 cm as a useful screening threshold in postmenarchal females with pelvic pain (13).

More recent pediatric study emphasized multidimensional prediction. Otjen et al. analyzed sonographic features in 99 torsion cases older than one year plus a non-torsion control cohort; a decision tree incorporating intra-ovarian flow, peripheral follicles, bilateral ovarian volumes, and cyst or mass status reached an AUC near 0.96 (14). In premenarchal girls without an adnexal mass, an ovarian volume ratio above 2.5 demonstrated 100% sensitivity and 94% specificity in one retrospective study (15). External application of a prior pediatric composite tool in a heterogeneous cohort again identified nausea or vomiting, leukocytosis, ovarian volume, and ovarian volume ratio as informative features (16).

Clinical and hematologic predictors also entered regression models. A pediatric model identified absence of right-lower-quadrant tenderness, platelet count above 240,000/µL, and neutrophil count above 5.4×10^3/µL as independent predictors (17). A larger model using 669 clinical episodes identified vomiting, neutrophil-to-lymphocyte ratio above 3.5, and an enlarged ovary as independent factors, with increasing positive predictive values as factors accumulated in the derivation cohort (18). In 125 women with adnexal masses, neutrophil-to-lymphocyte ratio above 3 was the only hematologic variable retained in logistic regression and yielded an AUC of 0.835 (19). A machine-learning-derived adult score subsequently combined clinical and imaging variables, with ovarian edema and reduced vascular flow contributing positive diagnostic information and a simplified score achieving an AUC of 0.72 (20).

A study published in 2024 strengthened the recurring pattern of vomiting, inflammatory indices, and ovarian morphology. Chen et al. reported improved pediatric prediction when vomiting, neutrophil-to-lymphocyte ratio above 3, and ultrasound findings were integrated (21). A seven-center pediatric study found the neutrophil-to-

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lymphocyte ratio to have an AUC of 0.918, with a reported optimal threshold of 2.57 in children undergoing surgical evaluation for suspected torsion (22). In adults, localized pain, vomiting, and ovarian edema remained independent predictors in a 221-patient case-control study (23). A pediatric machine-learning study of 143 patients identified nausea or vomiting, inflammatory indices, ovarian size ratio, medialization, follicular ring sign, and free pelvic fluid as significant features (24). The most recent 201-patient pediatric nomogram retained younger age, higher neutrophil-to-lymphocyte ratio, the whirlpool sign, and increasing maximum ovarian diameter, reaching AUCs of 0.915 in training and 0.853 in internal validation (25).

Risk-of-bias appraisal identified recurring concerns related to retrospective sampling, case-control construction, and restriction to surgically evaluated patients (11,14,18,23). Predictor measurement was generally available before the operative reference standard, reducing concern for incorporation bias in most studies, although retrospective chart abstraction increased susceptibility to missing or inconsistently documented symptoms (8,12,17). Model studies frequently relied on internal validation or cross-validation rather than independent external cohorts (18,20,24,25). The prospective emergency-department design used by Schwartz et al. and the separate validation approaches used in selected models strengthened confidence in those specific estimates (10,16,18).

Table 1. Characteristics and principal findings of selected original studies included in the synthesis

Study	Population	Sample	Principal predictors
Huchon et al. (2010) (8)	Women with acute pelvic pain; derivation plus prospective validation	142 derivation; 35 validation	Unilateral pain, pain <8 h, vomiting, absence of leucorrhoea/metrorrhagia, cyst >5 cm
King et al. (2014) (9)	Menarchal pediatric surgical cohort	54	Ovarian volume ratio, ovarian volume, nausea, pain duration; score ≥3: sensitivity 100%, specificity 65.3%
Schwartz et al. (2018) (10)	Adolescent ED cohort	324	Vomiting, adnexal volume, adnexal volume ratio; no torsion with composite score <2
Melcer et al. (2018) (11)	Reproductive-age women undergoing urgent laparoscopy	199	Nausea/vomiting, peritoneal irritation, leukocytosis, free fluid, ovarian edema, right-sided pathology
Melcer et al. (2018) (12)	Adolescent acute pelvic pain with surgery	87	Nausea/vomiting, peritoneal irritation, ovarian edema, free pelvic fluid
Budhram et al. (2019) (13)	ED case-control study	92 torsion; 92 controls	Maximum ovarian diameter 5 cm: sensitivity 91%, specificity 92% in postmenarchal patients
Otjen et al. (2020) (14)	Pediatric imaging/ML cohort	99 torsion cases >1 year plus controls	Flow, peripheral follicles, bilateral volumes, cyst/mass status; decision-tree AUC ≈0.96

Study	Population	Sample	Principal predictors
Hartman et al. (2021) (15)	Premenarchal girls without adnexal mass	Retrospective cohort	Ovarian volume ratio >2.5: sensitivity 100%, specificity 94%
Umasankar et al. (2021) (16)	Heterogeneous pediatric validation cohort	57	Nausea/vomiting, leukocytosis, ovarian volume and ratio; composite tool detected >90% of torsions
Meller et al. (2022) (18)	Derivation and validation prediction study	669 episodes	Vomiting, NLR >3.5, enlarged ovary
Ghimire et al. (2023) (19)	Torsion versus untwisted ovarian cysts	125	NLR >3 retained in regression; AUC 0.835
Aiob et al. (2025) (23)	Adult retrospective case-control study	221	Localized pain, vomiting, ovarian edema independently associated with torsion
Boztas et al. (2025) (24)	Pediatric ED/control ML cohort	143	Vomiting, WBC/NLR-related inflammation, ovarian size ratio, medialization, follicular ring, free fluid
Meng et al. (2026) (25)	Pediatric emergency-surgery cohort with internal validation	201	Younger age, NLR, whirlpool sign, maximum ovarian diameter; validation AUC 0.853

Abbreviations: AUC, area under the receiver operating characteristic curve; ED, emergency department; ML, machine learning; NLR, neutrophil-to-lymphocyte ratio; WBC, white blood cell count.

Table 2. Recurrent predictor domains in included studies

Predictor domain	Supporting studies	Overall pattern
Localized/unilateral pain	(8), (23)	Focal pain increased the probability of torsion, especially when combined with other findings
Nausea/vomiting	(8)–(12), (16), (18), (20), (21), (23), (24)	One of the most repeatedly identified clinical predictors across pediatric and adult cohorts
Short symptom duration	(8), (9)	Entered early composite scores; intermittent symptoms limit rigid threshold interpretation
Leukocytosis/neutrophilia	(11), (16), (17), (24)	Supports an acute inflammatory response, with limited standalone specificity
Elevated NLR	(18), (19), (21), (22), (25)	Recurrent laboratory predictor; reported thresholds varied between cohorts
Ovarian enlargement/diameter	(10), (13), (18), (25)	Repeated structural predictor with stronger value when interpreted relative to age and contralateral ovary

Predictor domain	Supporting studies	Overall pattern
Increased ovarian volume ratio	(9), (10), (15), (16), (24)	Particularly informative in pediatric and premenarchal populations
Ovarian stromal edema	(11), (12), (20), (23)	Repeated morphologic feature strongly associated with torsion
Free pelvic fluid	(11), (12), (24)	Supportive feature, especially within combined models
Whirlpool/pedicle twisting	(24), (25)	Direct structural evidence of torsion; in the strongest sonographic predictors
Abnormal or absent Doppler flow	(14), (20)	Supportive when abnormal; preserved flow does not reliably exclude torsion
Composite/multivariable prediction	(8)–(10), (16), (18), (20), (24), (25)	Combined clinical, laboratory, and sonographic models consistently outperform isolated findings

Discussion

The present study found that the most reproducible predictors arise from four linked domains: focal symptom pattern, gastrointestinal symptoms, systemic inflammatory response, and ovarian morphologic change on ultrasound. Unilateral or localized pain and vomiting recur in adult and pediatric datasets (8,10,23). Short symptom duration appears in early composite models, although intermittent torsion and partial detorsion weaken rigid time thresholds for individual patients (8,9). Emergency risk assessment therefore gains strength from accumulation of concordant findings rather than dependence on a single classic presentation (10,18).

Vomiting is independently associated with torsion in several multivariable models in age groups (8,11,18,23). Its persistence in models containing ultrasound and laboratory variables indicate information beyond nonspecific abdominal distress (11,20). Examination findings are less uniform: peritoneal irritation was associated with torsion in one adult cohort, whereas a pediatric model associated torsion with absence of right-lower-quadrant tenderness (11,17). Isolated examination predictors therefore require cautious interpretation outside their derivation population (17,23).

Inflammatory blood-count markers form the most consistent laboratory theme. Leukocyte or neutrophil measures were associated with torsion in several cohorts (11,18,19,22). A systematic review and meta-analysis dedicated to NLR found higher values in adnexal torsion than in comparison groups, reinforcing NLR as an adjunctive marker of ischemia-associated inflammation rather than a standalone test (26). Variation in thresholds reflects age, disease duration, comparator conditions, and analytic optimization (19,22,26). Recent models pair NLR with ovarian size or direct torsion signs, matching the multicomponent nature of the disorder (21,25).

Ultrasound morphology provides the strongest structural complement to clinical assessment. Ovarian enlargement, increased ovarian volume ratio, stromal edema, free fluid, peripheral follicles, abnormal position, and mass characteristics recur across pediatric and adult studies (23-25). Ovarian volume ratio is useful in children because comparison with the contralateral ovary partly accounts for age-related size differences, and a ratio above 2.5 performed strongly in a selected premenarchal cohort without adnexal masses (15). The whirlpool sign depicts twisting of the vascular pedicle, and a systematic review and meta-analysis reported high diagnostic value for this sign (27). Earlier studies associated abnormal flow and free fluid with torsion while documenting imperfect overall ultrasound accuracy (28,29).

Doppler flow deserves caution because preserved flow occurs in confirmed torsion and arterial or venous flow failed to discriminate cases in some pediatric studies (9,14). Dual ovarian blood supply, incomplete twisting, and intermittent torsion explain preserved signals despite clinically important torsion (6,28). A normal-flow report therefore has less value for exclusion than a coherent combination of symptoms, ovarian asymmetry or edema, and direct pedicle findings has for raising suspicion (14,25). This distinction matters in emergency care, where false reassurance from one negative feature risks diagnostic delay (6,7).

Prediction models have progressed from additive scores toward regression, nomograms, and

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machine-learning algorithms (8-10). The latest pediatric nomogram integrated age, NLR, whirlpool sign, and ovarian diameter and retained good discrimination in internal validation, illustrating the value of routinely available emergency data (25). Machine-learning performance is promising, although small datasets, retrospective sampling, high torsion prevalence, and internal cross-validation increase optimism in reported estimates (14,24). External validation in consecutive emergency populations remains necessary before any score directs discharge decisions or replaces specialist judgment (16,24,25).

The evidence base has important limitations. Many studies were retrospective, single-center, and restricted to surgically selected patients, creating spectrum and verification bias through underrepresentation of lower-risk patients managed without surgery. Predictor definitions and thresholds varied substantially. Despite these constraints, repeated convergence of vomiting, localized pain, inflammatory indices, ovarian enlargement or edema, and direct torsion signs supports multimodal emergency risk stratification.

Conclusion

Clinical prediction of ovarian torsion is most reliable when emergency assessment integrates symptom pattern, physical findings, inflammatory blood-count indices, and ultrasound morphology. Localized or unilateral pain, vomiting, elevated NLR, ovarian enlargement or asymmetry, stromal edema, free pelvic fluid, and the whirlpool sign recur in independent cohorts. Composite models outperform isolated findings, while preserved Doppler flow does not reliably exclude torsion. The findings are limited by retrospective designs, surgical-selection bias, variable thresholds, and insufficient external validation. Future prospective multicenter validation is essential before routine score-based disposition is adopted.

List of Abbreviations

ACOG — American College of Obstetricians and Gynecologists
AT — Adnexal torsion
AUC — Area under the receiver operating characteristic curve
CI — Confidence interval
ED — Emergency department
ML — Machine learning
MOD — Maximum ovarian diameter
NLR — Neutrophil-to-lymphocyte ratio
OR — Odds ratio
OT — Ovarian torsion
OVR — Ovarian volume ratio
PRISMA — Preferred Reporting Items for Systematic Reviews and Meta-Analyses
PROBAST — Prediction model Risk Of Bias ASsessment Tool
QUADAS-2 — Quality Assessment of Diagnostic Accuracy Studies 2
ROC — Receiver operating characteristic
WBC — White blood cell count

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