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Sonographic Diagnosis of Ovarian Torsion

Accuracy and Predictive Factors

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Article includes CME test

Objectives—The purpose of this study was to determine the accuracy of sonographic diagnosis of ovarian torsion and the predictive value of typical sonographic signs.

Methods—The study included 63 women attending an ultrasound unit of a tertiary obstetrics and gynecology department in 2002 through 2008 who had suspected ovarian torsion on sonography and subsequently underwent laparoscopy.

Results—Sonography had diagnostic accuracy of 74.6% for ovarian torsion. Abnormal ovarian blood flow and the presence of free fluid were the most diagnostically accurate isolated sonographic signs (positive predictive values, 80.0% and 89.2%, respectively; negative predictive values, 46.2% and 46.2%). Using combinations of sonographic signs yielded higher specificity and positive predictive values and lower sensitivity and negative predictive values for ovarian torsion. The diagnostic accuracy was largely affected by the ultrasound operator (mean ± SD, 78.8% ± 16.0%; range, 60.0%–100%).

Conclusions—In the setting of a specialized ultrasound unit, sonographic diagnosis of ovarian torsion had high (74.6%) accuracy compared with previous reports. The absence of typical sonographic signs does not rule out ovarian torsion, especially when the clinical presentation is suggestive. Basing assessments on multiple sonographic signs, including Doppler evaluation, increases the diagnostic specificity.

Key Words—accuracy; diagnosis; ovarian torsion

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Abbreviations

NPV, negative predictive value; PPV, positive predictive value

Ovarian torsion is the fifth most common gynecologic surgical emergency, with prevalence rates of 2.7% to 3%.[1–4] It may signal either a necrotic adnexa or an unimpaired vascularly twisted ovary. Early diagnosis is important to prevent loss of the adnexa or ovary and, more rarely, potentially fatal thrombophlebitis or peritonitis.[5] However, diagnosis poses a difficult challenge because the clinical presentation of ovarian torsion is variable and often misleading, and physical examination is often unhelpful. The only consistent symptom cited in most studies is abdominal pain,[5–7] usually localized to a lower quadrant.[7]

Sonography has advanced tremendously in recent years. Conventional sonographic findings with the addition of Doppler flow studies might assist clinicians in reaching the diagnosis of ovarian torsion.[8] The accuracy of this modality, however, remains controversial, with studies reporting a correct diagnosis before surgery in only 23% to 66% of cases.[3,9–12] This problem may be at least partly explained by the professional heterogeneity of ultrasound opera-

tors, who range from senior physicians who are ultrasound specialists to medical residents and sonographers, and differences in the extent of the sonographic evaluation, eg, inclusion of Doppler ovarian blood flow assessment.

The aim of this study was to determine the accuracy of sonographic diagnosis of ovarian torsion and the predictive value of the various sonographic signs.

Materials and Methods

The study population was identified from the comprehensive database of the ultrasound unit of the department of obstetrics and gynecology at a university-affiliated tertiary medical center. The database was searched for all women attending the unit in 2002 through 2008 in whom sonographic findings raised a suspicion of ovarian torsion. The medical records of the women identified were reviewed, and those who underwent diagnostic laparoscopy after the sonographic examination were included in the study group. The study was approved by the Institutional Review Board of Rabin Medical Center.

During the years covered by the study, sonographic examinations were performed by 5 senior physicians who are ultrasound specialists. The data collected at each examination were directly saved to the database, according to departmental procedures, including the uterine and ovarian size and the presence of free fluid in the Douglas pouch. We also carefully read the free-text fields provided in the database for comments regarding the uterus, each of the ovaries, the Douglas pouch, and concluding remarks. Data on the following torsion-related sonographic parameters were obtained from the medical records in the ultrasound unit database: (1) ovarian edema, usually manifesting as hypoechoic or heterogeneous central stroma with several small peripherally located follicles; (2) ovarian enlargement relative to the contralateral unaffected ovary; (3) an ovarian cyst or mass; (4) an abnormal ovarian location, in the midline, anterior to, or above the uterus or in the Douglas pouch; (5) abnormal ovarian blood flow, defined as the lack of venous and arterial flow or detection of only arterial flow on Doppler evaluation; (6) the presence of free fluid in the Douglas pouch or around the affected ovary; (7) evidence of a distended fallopian tube; and (8) sites of bleeding within the affected ovary. The results of diagnostic laparoscopy were obtained from the surgical reports, including intraoperative findings of ovarian torsion, an ovarian mass or cyst, free fluid in the Douglas pouch, peritoneal adhesions, and signs of inflammation.

Data were analyzed with SPSS version 15.0 software (SPSS Inc, Chicago, IL). χ^2 and Fisher exact tests were used to compare the frequency of the sonographic signs by the presence or absence of laparoscopic evidence of ovarian torsion. χ^2 and Fisher exact tests were also used to compare the proportion of cases of proved torsion associated with isolated or combined sonographic signs. The sensitivity, specificity, positive predictive value (PPV), and negative predictive values (NPV) were calculated for the sonographic signs, alone or in selected combinations.

Initially, all possible combinations of the 8 sonographic signs were evaluated. However, because of space limitations and to simplify the presentation of the results, only the combinations that provided the highest diagnostic accuracy in each of the categories are included in this article. The rate of torsion associated with each of the combinations was calculated as the rate of torsion in the subgroup of women in whom all of the signs included in the combination were present and none of the signs not included in the combination were present. If 1 or more of the signs included in a given combination was absent, than the result of the dichotomous test based on this combination was negative.

Multivariate stepwise (forward likelihood ratio) logistic regression analysis was used to determine which of the sonographic factors best predicted ovarian torsion as well as to assess the effect of other factors (ie, sonographic approach, side of torsion, and operator) on the accuracy of the diagnosis of ovarian torsion. All of the statistical tests were 2 tailed, and differences were considered significant at $P < .05$.

Table 1. Laparoscopic Findings in Women With a Sonographic Diagnosis of Ovarian Torsion

Laparoscopic Finding	n (%)
Total cases	63 (100.0)
Ovarian torsion	47 (74.6)
Left	23 (36.5)
Right	24 (38.1)
Hemorrhagic corpus luteum	7 (11.1)
Ovarian cyst	3 (4.8)
Pelvic inflammatory disease	1 (1.6)
Appendicitis	1 (1.6)
No pathologic findings	4 (6.3)

Results

Overall Accuracy of Sonographic Diagnosis of Ovarian Torsion

Sixty-three women met the study criteria. Their laparoscopic findings are presented in Table 1. Ovarian torsion was identified in 47 cases (74.6%). In the remainder, in whom there was no evidence of ovarian torsion on laparoscopy, the most common finding was a hemorrhagic corpus luteum. Four women (6.3%) had no abnormal findings on laparoscopy.

Frequency of Typical Sonographic Signs by the Presence or Absence of Laparoscopic Evidence of Ovarian Torsion

Table 2 presents the frequency of the various sonographic signs associated with ovarian torsion in women with and without evidence of ovarian torsion on laparoscopy. In those with ovarian torsion, the most frequent sonographic signs were ovarian edema, abnormal ovarian blood flow, relative enlargement of the affected ovary, and the presence of free fluid around the ovary or in the Douglas pouch (Table 2). Seven women with laparoscopy-proven ovarian torsion (13%) had normal ovarian blood flow on Doppler imaging; 7 (13%) had no evidence of ipsilateral ovarian enlargement; and 28 (60%) had no evidence of an ovarian cyst or mass. Figures 1 and 2 show examples of typical sonographic signs.

The only sonographic signs that showed a statistically significant difference were abnormal ovarian blood flow and the presence of free fluid around the affected ovary or in the Douglas pouch. There was no significant difference between women with and without laparoscopic evidence of torsion for the frequency of edematous ovarian tissue, an abnormal location of the ovary, bleeding within the ovarian tissue, ovarian enlargement, the presence of an adjacent distended tube, and an ovarian cyst or mass on sonography.

Accuracy of Isolated and Combined Sonographic Signs for Diagnosis of Ovarian Torsion

Table 3 shows the accuracy of the various sonographic signs for diagnosis of ovarian torsion. The sensitivity of the individual signs ranged from 36.2% to 85.1%, and the specificity ranged from 18.8% to 87.5%. Some signs were associated with relatively high sensitivity (ovarian edema, abnormal ovarian blood flow, and ipsilateral ovarian enlargement), whereas others were characterized by relatively high specificity (free fluid around the ovary or in the Douglas pouch, an ovarian cyst or mass, and an abnormal location of the ovary; Table 3). The PPVs for the isolated signs ranged from 75.5% to 89.5%, and the NPVs ranged from 30% to 46.2%. A combination of 2 or more sonographic signs was associated with a higher specificity and PPV for ovarian torsion (up to 100% for most combinations of ≥3) but a lower sensitivity (10.6%–55.3% for combinations of ≥3) and NPV (27.6%–40.0%).

Additional Factors Affecting the Accuracy of Sonographic Diagnosis of Ovarian Torsion

To determine which of the sonographic factors best predicted ovarian torsion, as well as to assess the effect of other factors (ie, sonographic approach, side of torsion, and operator), on the accuracy of the diagnosis of ovarian torsion, we performed a multivariate logistic regression analysis with ovarian torsion on laparoscopy as the dependent variable and the ultrasound operator (5 physicians in the ul-

Table 2. Frequency of Sonographic Signs of Ovarian Torsion in Women With and Without Evidence of Ovarian Torsion on Laparoscopy

Sonographic Sign	Torsion (n = 47)	No Torsion (n = 16)	*P*
Ovarian edema, n (%)	40 (85.1)	13 (81.3)	.72
Abnormal ovarian blood flow, n (%)	40 (85.1)	10 (62.5)	.05
Absence of arterial and venous flow	37 (78.7)	10 (62.5)	.20
Only arterial flow detected	3 (6.4)	0 (0.0)	.56
Relative enlargement of ipsilateral ovary, n (%)	40 (85.1)	13 (81.3)	.73
Free fluid around ovary or in Douglas pouch, n (%)	33 (70.2)	4 (25.0)	.003
Ovarian cyst, n (%)	19 (40.4)	4 (25.0)	.37
Clear	8 (17.0)	3 (18.8)	>.99
Turbid	11 (23.4)	1 (6.3)	.27
Abnormal ovarian location, n (%)	17 (36.2)	2 (12.5)	.11
Anterior to and/or above the uterus	9 (19.1)	2 (12.5)	.71
Douglas pouch	8 (17.0)	0 (0.0)	.10
Distended fallopian tube, n (%)	4 (8.5)	0 (0.0)	.30
Sites of bleeding within the ovary, n (%)	3 (6.4)	0 (0.0)	.55

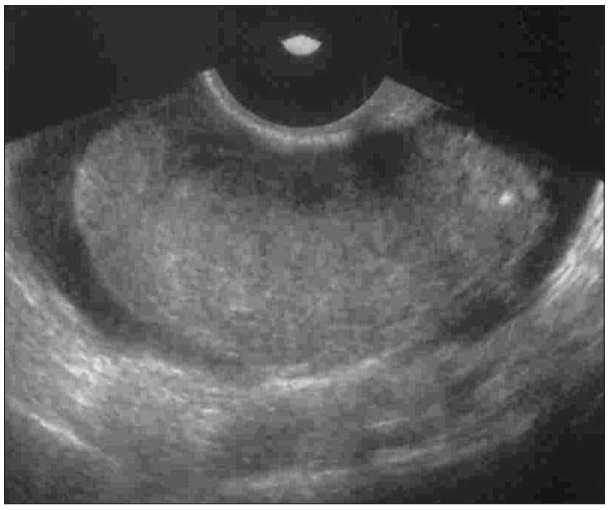

Figure 1. Transvaginal sonogram showing a large edematous homogeneous circumscribed mass surrounded by free fluid.

trasound unit), side of suspected torsion (left versus right), and sonographic approach (transabdominal versus transvaginal) as the independent variables, in addition to the different sonographic signs (Table 4). There was considerable variation in the accuracy of the sonographic diagnosis among the operators (mean ± SD, 78.8% ± 16.0%; range, 60.0%–100%), although the differences did not reach statistical significance (odds ratio, 0.9; 95% confidence interval, 0.2–4.7; Table 4). The diagnostic accuracy of ovarian torsion was unrelated to the side of torsion or the sonographic approach (Table 4).

Figure 2. Longitudinal sonogram showing an enlarged ovary with several small peripherally located follicles.

Discussion

This study sought to determine the accuracy of sonographic diagnosis of ovarian torsion and the predictive value of different sonographic signs associated with ovarian torsion. Our main findings were as follows: (1) sonographic diagnosis of ovarian torsion had overall accuracy of 74.6%; (2) the most frequent laparoscopic finding in cases of an erroneous sonographic diagnosis of ovarian torsion was a hemorrhagic corpus luteum; (3) abnormal ovarian blood flow and free fluid were the most accurate isolated sonographic signs of ovarian torsion; (4) a substantial proportion of women had ovarian torsion despite the presence of normal ovarian blood flow, lack of ovarian enlargement, and lack of an ovarian cyst or mass on sonography; and (5) combinations of sonographic signs had higher specificity values and PPVs for ovarian torsion.

Diagnosis of ovarian torsion requires clinician awareness and a high degree of suspicion. It is presently based on clinical symptoms and physical examination. However, the clinical findings of ovarian torsion frequently overlap with other causes of pelvic pain and adnexal masses, including hemorrhagic cysts and abscesses.

Sonography is usually the first imaging modality used in the evaluation of a patient with pelvic pain. The sonographic appearance of a torsed adnexa may be solid, cystic, or complex. The ovary shows one or more cystic follicles with marked thickening of the cyst wall; it is usually diffusely enlarged.[13,14] The most consistent finding is a unilateral enlarged ovary. Comparison with the asymptomatic contralateral side is typically very helpful. However, the presence of normal-appearing ovaries does not rule out the diagnosis of adnexal torsion.[15]

Findings on color Doppler imaging are not consistent because of the variable degree of torsion; however, ovarian torsion rarely manifests with completely normal venous waveforms.[16,17] The presence of central venous flow and flow in the vascular pedicle may indicate ovarian viability.[18] Other telltale findings on both gray scale and color Doppler sonography are a twisted vascular pedicle and the whirlpool sign,[19,20] although information regarding these signs was not available in this study.

This study was limited by a fairly small sample size and retrospective design, in addition to the use of data obtained from various ultrasound operators. Moreover, because not all women with pelvic pain undergo laparoscopy, we did not have data regarding false-negative diagnoses. Nevertheless, our departmental policy indicates a high index of suspicion for ovarian torsion, and almost all women who present with severe pelvic pain (which accompanies most

Table 3. Accuracy of Sonographic Findings, Alone and in Combination, for the Diagnosis of Ovarian Torsion

Sonographic Signs	Rate of Torsion,%			Measure of Accuracy, %			
	Signs Present	Signs Absent	*P*	Sensitivity	Specificity	PPV	NPV
Isolated signs							
Ovarian edema	75.5	70.0	.7	85.1	18.8	75.5	30.0
Abnormal ovarian blood flow	80.0	53.8	.04	85.1	37.5	80.0	46.2
Relative enlargement of ipsilateral ovary	75.5	70.0	.7	85.1	18.8	75.5	30.0
Free fluid around ovary or in Douglas pouch	89.2	53.8	.002	70.2	75.0	89.2	46.2
Ovarian cyst/mass	82.6	70.0	.2	40.4	75.0	82.6	30.0
Abnormal ovarian location	89.5	68.2	.05	36.2	87.5	89.5	31.8
Combinations of 2 signs							
Edema + abnormal flow	81.4	60.0	.07	74.5	50.0	81.4	40.0
Abnormal flow + free fluid	90.6	58.1	.003	61.7	81.3	90.6	41.9
Abnormal flow + abnormal location	100.0	68.6	.02	25.5	100.0	100.0	31.4
Combinations of 3 signs							
Edema + abnormal flow + abnormal location	100.0	69.8	.04	17.0	100.0	100.0	29.1
Abnormal flow + enlargement + free fluid	92.9	60.0	.003	55.3	87.5	92.9	40.0
Abnormal flow + free fluid + ovarian cyst/mass	100.0	67.3	.01	29.8	100.0	100.0	32.7
Combinations of 4 signs							
Edema + abnormal flow + enlargement + free fluid	91.3	65.0	.02	44.7	87.5	91.3	35.0
Edema + abnormal flow + free fluid + ovarian cyst/mass	100.0	68.6	.02	25.5	100.0	100.0	31.4
Abnormal flow + enlargement + free fluid + ovarian cyst/mass	100.0	68.6	.02	25.5	100.0	100.0	31.4
Abnormal flow + enlargement + free fluid + abnormal location	100.0	70.4	.06	19.1	100.0	100.0	29.6
Combinations of 5 signs							
Edema + abnormal flow + enlargement + free fluid + ovarian cyst/mass	100.0	69.8	.04	21.3	100.0	100.0	30.2
Edema + abnormal flow + free fluid + ovarian cyst/mass + abnormal location	100.0	71.9	.1	12.8	100.0	100.0	28.1
Combination of 6 signs							
Edema + abnormal flow + enlargement + free fluid + ovarian cyst/mass + abnormal location	100.0	72.4	.2	10.6	100.0	100.0	27.6

P values were calculated with χ^2 and Fisher exact tests. NPV indicates negative predictive value; and PPV, positive predictive value.

cases of ovarian torsion) undergo laparoscopic evaluation; therefore, the false-negative rate was expected to be low.

In conclusion, the diagnosis of ovarian torsion remains a clinical and occasionally an imaging enigma. We recommend that sonographic evaluation retain its place as the first-line imaging study for female patients with lower quadrant pain. According to our data, in the setting of an ultrasound unit and a team of ultrasound specialists, the sonographic diagnosis of ovarian torsion had high accuracy compared with previous reports. However, given the low NPV of some of the sonographic signs, ovarian torsion should be considered even when the typical sonographic signs are absent, especially if the clinical presentation is suggestive. In cases in which the clinical presentation is inconclusive, using combinations of sonographic signs, including Doppler evaluation, in the assessment can increase the specificity of the sonographic diagnosis.

Table 4. Factors Affecting the Accuracy of Sonographic Diagnosis of Ovarian Torsion

Factor	OR (95% CI)
Sonographic sign	
Abnormal ovarian location	51.0 (1.3–123.7)[a]
Abnormal ovarian blood flow	20.8 (1.3–35.3)[a]
Free fluid around ovary or in Douglas pouch	8.1 (1.4–46.4)[a]
Ovarian edema	3.7 (0.7–10.2)
Relative enlargement of ipsilateral ovary	2.0 (0.1–29.8)
Ovarian cyst/mass	0.8 (0.2–8.0)
Other	
Approach (transvaginal vs transabdominal)	1.6 (0.3–8.0)
Side (left vs right)	0.7 (0.1–3.0)
Operator[b]	0.9 (0.2–4.7)

Values reflect the results of multivariate logistic regression analysis using laparoscopic evidence of ovarian torsion as the dependent variable ($R^2 = 0.49$). CI indicates confidence interval; and OR, odds ratio.

[a] $P < .05$.

[b] Five different physicians from the ultrasound unit performed the sonographic examinations.

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