Preoperative Sonographic and Clinical Characteristics as Predictors of Ovarian Torsion

Libby L. Shadinger, MD, Rochelle F. Andreotti, MD, Rachel L. Kurian, MD

**Objective.** The purpose of this study was to determine the most closely associated sonographic and clinical characteristics of ovarian torsion. **Methods.** The medical records and sonographic studies of 39 patients with pathologically proven ovarian torsion diagnosed at our institution from July 1, 2000, through December 31, 2005, were retrospectively reviewed. The volumes of the affected ovaries and ovary/mass complexes were compared with an age-appropriate standard. Statistical significance of the data was assessed by a likelihood ratio \( \chi^2 \) analysis. **Results.** All patients (100%) had a chief symptom of abdominal pain. Thirty-three (85%) reported vomiting; 22 (56%) had leukocytosis; and 7 (18%) had a documented elevated temperature. All affected ovaries and ovary/mass complexes were enlarged. Twenty-one (54%) had arterial flow on Doppler interrogation, and 18 (46%) had no arterial flow. Thirteen (33%) had venous flow, and 26 (67%) had no venous flow. Differences in the arterial and venous flow patterns between the premenarchal and reproductive age groups were not statistically significant. **Conclusions.** Abdominal pain, vomiting, ovarian enlargement, and absence of ovarian venous Doppler flow are the most frequently shown clinical and sonographic indicators of ovarian torsion. However, ovarian enlargement, even in the presence of arterial and venous Doppler flow, is the most commonly associated sonographic finding. Suspicion of ovarian torsion should be high in the setting of clinical symptoms and ovarian enlargement regardless of the presence or absence of an ovarian Doppler signal. **Key words:** color Doppler sonography; ovarian masses; ovarian torsion.

Adnexal torsion is the fifth most common gynecologic emergency, with a reported prevalence of 3% in some series, primarily affecting women of reproductive age or younger. The diagnosis is complicated by its vague clinical presentation. The ovaries are frequently difficult to palpate, so physical examination findings often do not suggest the diagnosis. The only consistent symptom cited in most studies is abdominal pain, usually localized to a lower quadrant. Unfortunately, the differential considerations for abdominal pain in female patients include a myriad of causes such as appendicitis, cholecystitis, pelvic inflammatory disease, urinary collecting system calculi, and ruptured benign adnexal cysts. Other nonspecific signs and symptoms that are more variably present include fever, nausea, vomiting, and leukocytosis.

Because it is noninvasive, radiation free, cost-effective, and widely available and offers high-resolution anatomic detail of the uterus and adnexa, sonography is often the...
method of choice for imaging evaluation of lower abdominal and pelvic pain in female patients. The most common sonographic finding in torsion is ovarian enlargement, the presence of which has been documented in all patients in several studies. Other frequently described sonographic findings include free fluid in the cul-de-sac, a complex mass with septations and debris, homogeneous low-level echoes (“ground glass”) within the affected ovary, and small peripheral cystic structures within the torsed ovary.

Color and spectral Doppler analysis of the ovarian arterial and vascular waveforms is lauded as an accurate tool for the evaluation of ovarian torsion. In actuality, however, studies of Doppler flow patterns in torsion are conflicting. Ben-Ami and colleagues reported that the positive predictive value for torsion in the absence of venous flow was 94%, and torsion was very unlikely when Doppler interrogation revealed venous flow. Fleischer et al and Lee et al asserted that the presence of arterial and venous flow within ovaries that were found to be torsed on subsequent surgical exploration was predictive of the ultimate viability of the organs. In a study by Albayram and Hamper, all 15 patients with ovarian torsion had venous flow abnormalities. Contrarily, several case reports and retrospective studies of adnexal torsion diagnosed at the time of surgical intervention also described an abnormal appearance of the ovary in the presence of arterial and venous Doppler signals.

Early intervention has been shown to improve ovarian salvage rates and therefore some aspect of reproductive capacity. Women who undergo oophorectomy do not necessarily have reduced fertility potential. However, they have no compensatory measures in the event of loss or damage to the second ovary and may actually have a shortened reproductive life span because their predetermined number of primordial follicles is decreased. Anders and Powell reported that pediatric patients taken to surgery within 8 hours of the onset of symptoms had an ovarian salvage rate of 40%, but patients going to surgery more than 24 hours later had a salvage rate of 0%. Nonetheless, gynecologists often delay surgery because of misleading sonographic findings only to discover nonviable tissue on exploration.

To date, we have found no large-scale studies in the English literature evaluating the preoperative predictive value of Doppler flow in cases of ovarian torsion. We found no investigations of the correlation between the duration of pain and Doppler signal characteristics. The purpose of this study was to evaluate preoperative sonographic and clinical characteristics predictive of ovarian torsion in an effort to expedite diagnosis and therefore improve clinical outcomes in both pediatric and adult female patients.

Materials and Methods

This study was a retrospective evaluation of 39 patients with pathologically proven ovarian torsion and reviewable sonographic studies conducted at Vanderbilt University Medical Center and Vanderbilt Children’s Hospital. The medical records of all 93 female patients discharged from Vanderbilt University Medical Center and Vanderbilt Children’s Hospital with the diagnosis of ovarian torsion from July 1, 2000, through December 31, 2005, were reviewed. One patient with fallopian tube torsion, 3 patients without Doppler interrogation of the ovaries, and 30 patients without sonographic studies available for review or whose studies were deemed unacceptable for retrospective interpretation were excluded. Seventeen patients for whom the surgical pathologic findings were not consistent with torsion were excluded, as were 3 patients who underwent oophoropexy or surgical detorsion with ovarian conservation.

The medical records were examined for clinical findings of the duration of abdominal pain and the presence or absence of nausea and vomiting, fever, and leukocytosis. The patient’s age, pregnancy status, and onset of menarche or menopause as appropriate for the patient’s age were noted. The pathologic diagnosis of the surgical specimen was evaluated for definitive ovarian torsion. When documented in the surgical reports, the numbers of pedicle twists of the torsed ovaries were recorded. The sonograms were reviewed by an independent radiologist for the imaging characteristics of ovarian vascularity, the morphologic appearance, associated masses or cysts, the presence or absence of intraperitoneal free fluid, and the right or left lower quad-
rant location of the abnormality. Statistical significance was assessed by a likelihood ratio \( \chi^2 \) analysis computed with SPSS software (SPSS Inc, Chicago, IL).

The patients were categorized by the duration of pain at presentation, the presence or absence of color Doppler arterial and venous signals, and reproductive stage (premenarchal, reproductive age, or peri/postmenopausal). Pregnant and virginal patients and those immediately postpartum were examined transabdominally only. Standard transabdominal or transvaginal 2-dimensional color Doppler sonography of the patients was conducted with HDI 4000, HDI 5000, and iU22 scanners (Philips Medical Systems, Bothell, WA), PowerVision 8000 and Aplio scanners (Toshiba America Medical Systems, Inc, Tustin, CA), and Acuson Sequoia and Aspen scanners (Siemens Medical Solutions USA, Inc, Mountain View, CA). Examinations were conducted with 2- to 5-MHz curved array probes, 4- to 8-MHz vector probes, 6-MHz linear probes, and 4- to 8-MHz curved transvaginal probes. Images were stored on a picture archiving and communications system (Agfa Corp, Ridgefield Park, NJ). Histopathologic findings were obtained via standard hematoxylin-eosin staining techniques.

Results

Clinical Data
On surgical exploration, the affected ovaries of all patients in this study were visually judged to be torsed and nonviable. The patients underwent oophorectomy or salpingo-oophorectomy. The anatomic pathologic findings of all specimens were consistent with torsion. The average age of the patients was 21.5 years (range, 3–61 years). Twenty-two patients underwent only transabdominal sonography secondary to their virginal, pregnant, or immediate postpartum status. The remaining 17 were scanned both transabdominally and transvaginally.

The number of pedicle twists was documented in the surgical reports in 10 cases and ranged from 1 to 4.5 rotations. Twenty-two (56%) of the 39 cases were associated with a cyst or benign mass. Specifically, torsion was precipitated by simple cysts or corpus lutei in 10 cases. The other 12 masses consisted of 7 dermoids, 2 cystadenomas, a fibroma, a benign spindle lesion, and a Brenner tumor. Seventeen (46%) of all 39 cases occurred in the absence of a pathologically proven cyst or mass.

The patients were divided into 3 categories for the duration of pain: those with pain for 24 hours or less, those with pain for 2 days, and those with pain for 3 or more days. The numbers of patients within the categories were fairly similar, ranging from 12 (31%) to 14 (36%). The most common clinical signs and symptoms in addition to abdominal pain were analyzed and ranged from 7 (18%) for fever to 33 (85%) for nausea and vomiting (Table 1).

Imaging Data
The gray scale sonographic studies in 8 (21%) of 39 patients showed free fluid within the abdomen. Ten patients (26%) had a ground glass appearance of the ovary. Two patients had an enlarged ovary with multiple small peripheral cysts. In many instances, the ovarian characteristics were obscured by the accompanying mass or cyst. When masses or cysts were in close association with the ovary and caused enlargement of the total ovarian complex, accurate measurement of the ovary and mass as separate entities was often difficult or impossible (Figure 1). The ovaries or, when the ovary and mass could not be differentiated, the ovary/mass complexes, were uniformly enlarged, ranging from 24 cm\(^3\) in a 3-year-old patient to 957 cm\(^3\) in an adult. The ovarian volume was assessed by the formula for the volume of an ellipse: volume = \( \frac{1}{2} \) length \( \times \) width \( \times \) height. The upper limit of normal for ovarian volume in adults is generally accepted as

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>n (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Leukocytosis (WBC ≥11,000)*</td>
<td>22 (56)</td>
</tr>
<tr>
<td>Nausea and vomiting</td>
<td>33 (85)</td>
</tr>
<tr>
<td>Fever (temperature ≥100.5°F)</td>
<td>7 (18)</td>
</tr>
<tr>
<td>Duration of pain</td>
<td></td>
</tr>
<tr>
<td>≤24 h</td>
<td>13 (33)</td>
</tr>
<tr>
<td>2 d</td>
<td>12 (31)</td>
</tr>
<tr>
<td>≥3 d</td>
<td>14 (36)</td>
</tr>
</tbody>
</table>

*White blood cell count (WBC) was not documented for 2 patients.
15 cm³. Previously established pediatric ovarian size guidelines state that the mean volumes are 1 cm³ or less in girls of 6 years and younger, 1.2 to 2.3 cm³ in girls of 6 to 10 years, and 2 to 4 cm³ in girls of 11 to 12 years; the mean volume in post-menopausal women is 8 cm³.¹⁹ 

The differences in both arterial and venous Doppler flow patterns between the premenarchal, reproductive age, and peri/postmenopausal groups were not statistically significant (Table 2). Interestingly, 9 (64%) of 14 patients with relatively long durations of pain (≥3 days) had arterial flow, and 8 (57%) of 14 had venous flow. Although the duration of pain did not show a statistically significant relationship with the presence or absence of arterial flow, the relationship between the duration of pain and the absence of venous flow was significant and unexpectedly inverse (Table 3). In most cases, patients who had arterial flow also had venous flow (Figure 2). Conversely, most patients with no arterial flow had no venous flow (Figure 3). In 8 cases, the presence of arterial and venous Doppler flow was discordant with an arterial signal present in the setting of no venous signal.

Of the 10 patients for whom the numbers of pedicle twists were recorded in the surgical reports, 5 had both arterial and venous signals, with 2 to 4.5 (average, 2.7) pedicle rotations. Three of these 10 patients had no arterial or venous flow. Pedicle twists ranged from 2 to more than 3 rotations (average, 2.6). Two of the 10 patients had arterial flow but no venous signal, with 2 and 3 pedicle twists, respectively (average, 2.5).

Discussion

The clinical presentations of the patients in our study were similar to those described in multiple prior studies. The consistent clinical symptom in this series was abdominal pain localized to a lower quadrant, which was the chief symptom in 100% at the time of presentation. Vomiting, at 85%, was the second most reliable finding. Fever and leukocytosis were more variable, at 18% and 56%, respectively. Therefore, whereas the presence of lower quadrant pain plus 1 or more of those symptoms should raise clinical suspicion for torsion, the absence of these additional symptoms does not preclude the diagnosis.

The affected ovaries or ovary/mass complexes were uniformly enlarged. Although the ovaries and ovary/mass complexes usually had an abnormal appearance, the gray scale findings were nonspecific. Abnormal sonographic appearances of the ovaries, such as the ground glass and cystic enlargement descriptors that previously have been attributed to the appearance of torsed ovaries, were nonspecific findings. Entities such

---

**Table 2.** Color and Spectral Doppler Characteristics as a Function of Reproductive Age Category

<table>
<thead>
<tr>
<th>Reproductive Age Category</th>
<th>Arterial Flow</th>
<th>Arterial Flow</th>
<th>Venous Flow</th>
<th>Venous Flow</th>
</tr>
</thead>
<tbody>
<tr>
<td>Premenarchal (n = 9)</td>
<td>5</td>
<td>4</td>
<td>2</td>
<td>7</td>
</tr>
<tr>
<td>Reproductive (n = 28)</td>
<td>14</td>
<td>14</td>
<td>11</td>
<td>17</td>
</tr>
<tr>
<td>Peri/postmenopausal (n = 2)</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>Total</td>
<td>21</td>
<td>18</td>
<td>13</td>
<td>26</td>
</tr>
</tbody>
</table>

Values are numbers of patients.

**Table 3.** Color and Spectral Doppler Characteristics as a Function of the Duration of Pain at the Time of Presentation

<table>
<thead>
<tr>
<th>Duration of Pain at Time of Presentation, d</th>
<th>Arterial Flow</th>
<th>Arterial Flow</th>
<th>Venous Flow</th>
<th>Venous Flow</th>
</tr>
</thead>
<tbody>
<tr>
<td>≤1 (n = 13)</td>
<td>6</td>
<td>7</td>
<td>2</td>
<td>11</td>
</tr>
<tr>
<td>2 (n = 12)</td>
<td>6</td>
<td>6</td>
<td>3</td>
<td>9</td>
</tr>
<tr>
<td>≥3 (n = 14)</td>
<td>9</td>
<td>5</td>
<td>8</td>
<td>6</td>
</tr>
<tr>
<td>Total</td>
<td>21</td>
<td>18</td>
<td>13</td>
<td>26</td>
</tr>
</tbody>
</table>

Values are numbers of patients.
as endometriomas, hemorrhagic cysts, and tubo-ovarian complexes are often similarly described.

In contrast to the 54% of patients with arterial flow on sonography, 33% of all patients had normal venous Doppler flow. This finding supports the supposition that venous flow is more readily affected because of the compressibility of the venous plexus, and the phenomenon of arterial flow to an ovary with pathologically proven torsion could be at least partially explained by a dual ovarian arterial supply from the aorta and uterine arteries. The observation that 8 patients with arterial and venous flow discordance had arterial flow in the absence of venous flow further supports this hypothesis. We had tentatively hypothesized that the smaller pelvic structure of the premenarchal patient population allowed earlier compression of the venous outflow compared with the older girls and women and that the dual arterial supply might be less developed in the essentially nonfunctioning pelvic organs in these young girls. However, we did not find a statistically significant difference in the presence or absence of arterial or venous flow among the premenarchal, reproductive age, and peri/post-menopausal groups.

The relationship between the duration of pain and vascular flow characteristics was unexpectedly inverse. Several studies have cited the importance of early intervention in the possibility of ovarian salvage.3,18,20 However, more patients in this study had no venous or arterial flow when they had abdominal pain of 1 day or less compared with those who had longer dura-

**Figure 2.** Intraovarian arterial and venous Doppler signals in a pathologically proven infarcted hemorrhagic ovary from a 31-year-old postpartum patient with worsening abdominal pain. **A**, Transvaginal sonogram of the right ovary in the sagittal plane shows enlargement with heterogeneous hypoechoic parenchyma centrally. A focus of calcification is seen peripherally, although there was no evidence of a tumor in the pathologic specimen. **B**, Power Doppler sonogram shows an abundance of color Doppler signals within the ovary. **C** and **D**, Duplex Doppler sonograms show arterial (**C**) and venous (**D**) signals.
tions of pain. One possibility is that the patients waiting a longer period may have had less severe pain than the patients who sought care earlier, thereby raising the possibility that this subset of patients had intermittent torsion. Therefore, whereas expedient surgical intervention is optimal, ovarian salvage may not be as time dependent as previously thought. We found that the trend toward an inverse relationship between the duration of pain and arterial and venous flow characteristics was statistically significant only for venous flow. The statistical significance for venous flow was unexpected because venous flow is widely considered to be affected earlier than the arterial supply, as discussed previously.

A reasonable suspicion is that the number of pedicle twists of a torsed ovary may play a role in the presence or absence of arterial and venous Doppler signals. The average number of pedicle twists in the patients in our study for whom the number of pedicle twists was documented ranged from 2.5 to 2.7 within the subgroups with the presence of arterial and absence of venous Doppler signals, the absence of arterial and venous signals, and the presence of arterial and venous signals, respectively. At 10 patients, the number of patients for whom the number of pedicle rotations could be correlated with the imaging characteristics was too small to be statistically significant. However, our research suggests that the average number of twists is no different among patients with the presence or absence of Doppler signal characteristics.

Limitations of this study included its fairly small sample size and low power, particularly for the premenarchal patient subset, and the exclusion of patients with similar symptoms for which the pathologic studies did not show torsion. An additional subset of patients treated surgically by ovarian conservation who did not undergo oophorectomy but had a clinical and radiographic diagnosis of torsion exists as well. Further investigations might include these patients.

The lack of documentation of the number of pedicle twists in most of the surgical reports prevented statistically significant correlation between the number of twists and the presence or absence of Doppler signals. The inability to retrospectively quantify the patients’ pain at presentation also prevented correlation between severity of pain and the presence or absence of Doppler signals. Another confounding variable

Figure 3. Absence of color Doppler signals secondary to ovarian torsion in a 19-year-old patient. A, A large paratubal cyst is shown adjacent to the ovary, likely the fulcrum for torsion. B, Enlarged ovary containing homogeneous echoes centrally. This pattern has been described as associated with edema. C, Power Doppler sonogram fails to show color signals within the ovary.
was that the Doppler velocity scale may have been too high to detect slow flow in some patients. Finally, the presence of arterial or venous flow may have caused the pursuit of other diagnoses and a delay in surgical exploration. Therefore, ovaries that may have been viable at the time of sonographic evaluation could have progressed to irreversible ischemia in the interval between presentation and surgery. Although the diagnosis of ovarian torsion remains a clinical and occasionally even an imaging enigma, we recommend that sonographic evaluation continue in its role as the first-line imaging study in female patients with lower quadrant pain. Our data indicate that abdominal pain, vomiting, ovarian enlargement, and the absence of ovarian venous Doppler flow are the most frequently shown clinical and sonographic indicators of ovarian torsion. However, ovarian enlargement, even in the presence of arterial and venous Doppler flow, is the most commonly associated sonographic finding. Suspicion of ovarian torsion should be high in the setting of clinical symptoms and ovarian enlargement regardless of the presence or absence of ovarian Doppler signals, and surgical exploration should not be delayed. Further research is necessary to develop methods of determining the viability of the ovary because the presence or absence of spectral Doppler signals does not appear to be a reliable tool for viability assessment.

References