

Characteristics and Management of Ovarian Torsion in Premenarchal Compared With Postmenarchal Patients

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OBJECTIVE: To compare the clinical, ultrasonographic, and operative characteristics of premenarchal and postmenarchal patients with surgically verified ovarian torsion.

METHODS: A retrospective cohort study of all patients with surgically verified ovarian torsion operated on at a single university-affiliated tertiary medical center during 1997–2013. Age at presentation, presenting symptoms, diagnostic studies, surgical procedure, and pathologic findings were analyzed.

RESULTS: A total of 41 premenarchal and 208 postmenarchal patients were diagnosed with ovarian torsion during the study period. Median ages were 9 and 27 years, respectively. Median duration of symptoms before first presentation was longer among the premenarchal patients (24.0 compared with 8.0 hours, $P<.001$) as was the median interval from hospital admission to surgery (9.5 compared with 4.6 hours, $P<.001$). Premenarchal girls had a higher rate of restlessness, fever, and evidence of pelvic mass at presentation and a similar rate of ultrasonographic signs for torsion (78.5% compared with 73.1% $P=.53$). During surgery, a finding of a black–bluish ovary was more common in premenarchal girls (61.0% compared with 41.3%, $P=.02$).

CONCLUSION: Ovarian torsion in premenarchal girls is associated with a longer interval from onset of symptoms and an increased rate of fever and pelvic mass at

presentation compared with postmenarchal patients. These data may aid the physician in the evaluation of abdominal pain in premenarchal girls.

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LEVEL OF EVIDENCE: II

Ovarian torsion is the fifth most common gynecologic emergency and is caused by the twisting of an ovary on its pedicle with subsequent lymphatic and venous stasis, leading to ischemia, potential necrosis, and loss of function.^{1,2} Although ovarian torsion is most common in women of childbearing age, nearly 30% of cases are in females younger than 20 years.¹

As a result of the rare occurrence of ovarian torsion in the pediatric population, most studies addressing this issue have comprised relatively small sample sizes.^{3–7} In addition, although some studies have addressed mainly radiologic findings,^{8–12} others have focused on intraoperative findings and management^{13–15} without addressing a wider spectrum of characteristics (clinical symptoms, preoperative laboratory and radiologic findings, time interval to surgery, and intraoperative characteristics). Finally, only a few reports have focused on premenarchal girls with their unique features such as lower communication skills. Additionally, as a result of the absence of functional ovarian cysts, the etiologies of torsion in premenarchal girls might be different from those in postmenarchal patients. The aim of the current study was to compare the clinical, ultrasonographic, and operative characteristics of premenarchal and postmenarchal patients with adnexal torsion.

MATERIALS AND METHODS

The study cohort comprised all premenarchal and postmenarchal patients with surgically verified ovarian torsion who were diagnosed and treated in one university-affiliated tertiary medical center from 1997

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to 2013. Patients diagnosed on discharge or on surgery records with an International Classification of Diseases, 9th Revision, Clinical Modification code for torsion of the ovary, ovarian pedicle, or fallopian tube (620.5) were selected for our analysis.

The emergency department in our medical center as well as in many others in Israel is comprised of different emergency departments according to subspecialties. Therefore, it is not uncommon for a teenage girl experiencing a stomach ache to be examined by several different emergency department physicians (such as a pediatrician, gynecologist, and general surgeon). Each caregiver in an emergency department is entitled to send the patient for consultation and examination as he or she considers necessary.

According to our gynecologic departmental protocol, all females admitted to the emergency department with abdominal pain undergo medical interviews, physical examinations, and laboratory tests, including complete blood count, electrolytes, liver and kidney function tests, and urinalysis including testing for β -human chorionic gonadotropin. The extent of laboratory tests is performed at the discretion of the physician. All premenarchal patients undergo multidisciplinary evaluation, which includes pediatric, surgical, and gynecologic evaluation. Generally, all minors (younger than age 18 years) are first admitted to the pediatric emergency department; from there, they are referred to other professional disciplines according to physicians' decisions.

Transabdominal ultrasonography is performed with a full bladder. When indicated and acceptable to the patient, transvaginal ultrasonography with Doppler flow imaging is performed. When adnexal torsion is suspected, surgery is performed. Suspicion for ovarian or adnexal torsion was assumed if any of the following were demonstrated on ultrasonographic assessment before surgery: ovarian enlargement (defined as 4 cm or larger diameter in at least one of three dimensions), unilateral ovarian displacement, unilateral enhanced ovarian echogenicity, unilateral ovarian edema (defined as ultrasonographic appearance of swollen ovarian parenchyma), pathologic Doppler studies in ovarian vessels, or evidence of a whirlpool sign (see Video, available online at <http://links.lww.com/AOG/A674>).¹⁶ In patients in whom the ovarian vessels were wrapped around a central axis in a clockwise or counterclockwise direction, a whirlpool sign on Doppler ultrasonography was considered.

Data obtained from our departmental electronic medical records included patient age, medical and gynecologic history, presenting symptoms and signs, findings on physical examination, complete blood count, and imaging studies. We also calculated the median time that elapsed from stated symptom onset to



Video. Whirlpool sign in a case of ovarian torsion. Real-time ultrasound images of the whirlpool sign in a case of ovarian torsion. The study demonstrates blood flow in a clockwise direction around a central axis. Video courtesy of Dr. Yoav Peled. Used with permission.

the first emergency department admission, stated symptom onset to the gynecologic emergency department admission (as noted by the gynecologist), and from emergency department admission (unless specified otherwise, the first admission to the emergency department was referred to) to first incision made in the operating room. Surgery duration and surgical findings, surgical treatment of ovarian torsion, and post-operative complications were also noted. In addition, we documented whether the index ovarian torsion was a primary event or a recurrence. The study protocol was approved by the local institutional review board, Helsinki Committee of Rabin Medical Center.

Data analysis was performed with SPSS 21.0. Student's *t* test and Mann-Whitney *U* test were used to compare continuous variables with and without normal distribution between the groups. χ^2 and Fisher's exact tests were used for categorical variables, as appropriate. The Shapiro-Wilk test was used to test distributions for normality. Differences were considered statistically significant when the *P* value was $<.05$.

RESULTS

A total of 249 patients were surgically diagnosed with ovarian torsion during the study period; of them, 41



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Table 1. Signs and Symptoms of Ovarian Torsion in the Premenarchal and Postmenarchal Patients

Characteristic	Premenarchal Group (n=41)	Postmenarchal Group (n=208)	P
Age (y)*	9.0 (5.0–10.0)	27.0 (20.0–31.0)	<.001
Previous torsion [†]	9 (22.0)	34 (16.3)	.37
1	8 (19.5)	28 (13.5)	.33
2 or more	1 (2.4)	6 (2.9)	1.0
Concurrent pregnancy	0 (0)	66 (31.7)	<.001
Duration of symptoms before 1st presentation (h)*	24.0 (9.5–126.0)	8.0 (4.0–25.5)	<.001
1st triage [†]			<.001
Gynecologist	0 (0)	111 (53.4)	
Pediatrician	34 (82.9)	29 (13.9)	
General surgeon	0 (0)	22 (10.6)	
Internal medicine specialist	0 (0)	35 (16.8)	
Not specified	7 (17.1)	11 (5.3)	
Not seen by gynecologist before surgery [†]	5 (12.2)	1 (0.5)	.001
Abdominal pain [†]	37 (90.2)	206 (99.0)	.008
Lower abdomen	25 (61.0)	191 (91.8)	<.001
Diffuse	12 (29.3)	15 (7.2)	<.001
Nausea and vomiting [†]	27 (65.9)	132 (63.5)	.86
Diarrhea [†]	4 (9.8)	6 (2.9)	.06
Restlessness [†]	6 (14.6)	0 (0)	<.001
Urinary symptoms [†]	3 (7.3)	11 (5.3)	.70
Chills [†]	0 (0)	3 (1.4)	1.0
Fever higher than 38°C [†]	4 (9.8)	2 (1.0)	.02
Abdominal tenderness [†]	25 (61.0)	175 (84.1)	.002
Pelvic mass [†]	4 (9.8)	0 (0)	<.001
WBC count higher than 12×10 ³ /microliter [†]	15 (36.6)	76 (36.5)	1.0
Time from symptom onset to gynecologic ED admission (h)*	28.5 (15.7–77.0)	7.0 (3.0–24.0)	.01
Suspected adnexal torsion before surgery [†]	26 (63.4)	173 (83.2)	.009

Data are median (interquartile range) or n (%) unless otherwise specified.

WBC, white blood cell; ED, emergency department.

* Not normally distributed; Mann-Whitney *U* test.

[†] Not normally distributed; Fisher's exact test.

(16.5%) were premenarchal and 208 postmenarchal. Median ages were 9 and 27 years, respectively. The index case was a recurrent event in nine of the premenarchal (22.0%) and 34 of the postmenarchal patients (16.3%) (Table 1). Among premenarchal patients, 82.9% were admitted initially to the pediatric emergency department, whereas 53.4% of the postmenarchal patients were admitted initially to the gynecologic emergency department. Overall, a higher proportion of premenarchal patients were not evaluated by a gynecologist before surgery (12.2% compared with 0.5%, *P*<.001) (Table 1).

The median duration from symptom onset to gynecologic emergency department admission was greater among the premenarchal than postmenarchal patients (28.5 compared with 7.0 hours, *P*=.01). For both groups, the most common presenting symptom was abdominal pain (90.2% and 99.0%, respectively). Premenarchal patients were more likely to report diffuse abdominal pain rather than low abdominal pain (29.3% compared with 7.2%, *P*<.001). Other gastro-

intestinal and urinary complaint rates were similar between the groups.

On physical examination, premenarchal patients were characterized by higher rates of restlessness (14.6% compared with 0%, *P*<.001), fever (higher than 38°C) (9.8% compared with 1.0%, *P*=.02), and a palpable pelvic mass (9.8% compared with 0%, *P*<.001) compared with postmenarchal patients (Table 1).

Among 208 postmenarchal patients, transabdominal and transvaginal ultrasound examinations were performed in 100 (48.1%) and 135 (64.9%) patients, respectively, including 27 patients who underwent both transabdominal and transvaginal ultrasound evaluations. Transabdominal ultrasonography was performed in 68.3% of the premenarchal and in 48.1% of the postmenarchal patients (*P*=.02). Transvaginal ultrasonography was done in 64.9% of the postmenarchal patients, whereas it was not performed in the premenarchal patients. Premenarchal and postmenarchal patients had similar rates of



Table 2. Type of Abdominal Investigation and Findings Associated With Ovarian Torsion in Premenarchal and Postmenarchal Patients

	Premenarchal Group (n=41)	Postmenarchal Group (n=208)	P
Abdominal ultrasonogram*	28 (68.3)	100 (48.1)	.02
Transvaginal ultrasonogram*	0 (0)	135 (64.9)	<.001
Computed tomography*	2 (4.9)	5 (2.4)	.32
Signs for torsion in ultrasonogram*†	22/28 (78.5)	152 (73.1)	.53
Ultrasound findings*			
Mean ovary or adnexa size (cm)‡	4.7 (3.8–5.5)	6.8 (5.5–8.4)	.002
Edema of the ovary	9/28 (32.1)	98 (47.1)	.13
Enhanced echogenicity	1/28 (3.5)	5 (2.4)	.71
Free pelvic fluid	3/28 (10.7)	10 (4.8)	.19
Doppler flow*	15/28 (53.5)	97 (46.6)	.49
Absence of venous flow	1/28 (3.5)	5 (2.4)	.71
Absence of arterial blood flow	14/28 (50.0)	81 (38.9)	.26
Whirlpool sign	2/28 (7.1)	13 (6.3)	.85
Additional findings*	15/28 (53.5)	121 (58.2)	.64
Simple ovarian or paraovarian cyst	10/28 (35.7)	72 (34.6)	.49
Complex ovarian or paraovarian cyst	5/28 (17.8)	31 (14.9)	.68
Dermoid cyst	0 (0)	5 (2.4)	.59
Hemorrhagic cyst	0 (0)	13 (6.3)	.13

Data are n (%), n/N (%), or median (interquartile range) unless otherwise specified.

* Not normally distributed; Fisher's exact test.

† Presence of any of the followings: ovarian enlargement, enhanced ovarian echogenicity, additional ovarian or paraovarian findings (ie, cyst), ovarian edema, or pathologic Doppler studies in ovarian vessels.

‡ Not normally distributed; Mann-Whitney U test.

ultrasonographic signs for ovarian torsion (73.1% compared with 78.5%, $P=.53$). Any additional ultrasonographic findings (such as unilateral enhanced echogenicity or presence of free pelvic fluid) and Doppler flow studies (such as absence of venous or arterial flow) were similar between the premenarchal and postmenarchal groups (Table 2).

The median duration from emergency department admission to the first incision in the operating room was greater in the premenarchal group (9.5 compared with 4.6 hours, $P<.001$). The majority of torsions in the postmenarchal patients occurred on the right side (58.7%). No predilection of sides could be drawn in the premenarchal patients. More laparoscopies were performed in postmenarchal patients (91.3% compared with 63.4%, $P<.001$) (Table 3).

Premenarchal patients had a higher number of adnexal twists (median of three compared with two, $P=.02$) and a higher rate of bluish black ovary appearance (61.0% compared with 41.3%, $P=.02$). Rates of additional pathologic findings such as adnexal enlargement, adnexal edema, or ovarian or paraovarian cysts were similar between the groups. Inguinal hernia repair and appendectomy were performed more often in premenarchal patients (7.3% compared with 0%, $P=.004$ and 9.8% compared with 1.0%, $P=.008$, respectively) (Table 3).

Conservative management, mainly detorsion with additional cyst drainage or cystectomy, was the standard of care in both groups (95.1% and 98.6% for premenarchal and postmenarchal patients, respectively, $P=.25$). Rates of oophoropexy (consisting of plication of the ovarian ligament) and oophorectomy were similar between the groups (Table 3). Resection of the affected adnexa was necessary in two premenarchal girls (4.9%)—in one case because of ovarian tissue necrosis and in the other as a result of an atretic and undeveloped ovary. Among postmenarchal patients, oophorectomy occurred in three patients (1.4%)—ovarian tissue necrosis in one and fibrothecoma in two. No evidence of malignancy was documented in any of the patients (Table 3).

We further compared data regarding the nine premenarchal girls with recurrent ovarian torsion with data of the 32 who presented with first episodes. The median duration from symptom onset to initial emergency department admission and from symptom onset to gynecologic emergency department admission was greater for those with initial presentation than for those with subsequent presentation (27 compared with 12 hours, $P=.35$ and 48.5 compared with 10.7 hours, $P=.02$, respectively). Likewise, the median duration from emergency department admission to the first incision in the operating room was greater for those with initial presentation (11 compared with 5.5 hours, $P=.17$).



Table 3. Additional Pathologic Findings at Surgery and Surgical Treatment in Premenarchal and Postmenarchal Patients

	Premenarchal Group (n=41)	Postmenarchal Group (n=208)	P
Time from admission to surgery (h)*	9.5 (5.5–19.5)	4.6 (2.6–9.0)	<.001
Time from gynecologic evaluation to surgery (h)*	7.0 (4.0–14.5)	3.5 (2.5–8.0)	.05
Operating time (min)*	53.0 (35.0–66.0)	28.0 (21.0–40.0)	<.001
Surgery type [†]			
Laparoscopy	26 (63.4)	190 (91.3)	<.001
Open	10 (24.4)	13 (6.3)	.001
Conversion (laparoscopy to open)	3 (7.3)	4 (1.9)	.09
Unknown	1 (4.8)	1 (0.5)	
Affected side [‡]			
Right	20 (48.8)	122 (58.7)	.30
Left	21 (51.2)	82 (39.4)	.16
Bilateral	0 (0)	4 (1.9)	1.0
No. of twists*	3 (2–4)	2 (1–3)	.02
Additional pathologic findings [†]	13 (31.7)	85 (40.9)	.29
Black–bluish ovary	25 (61.0)	86 (41.3)	.02
Edematous ovary	15 (36.6)	58 (27.9)	.26
Enlarged ovary (larger than 4 cm)	15 (36.6)	80 (38.5)	.86
Simple ovarian or paraovarian cyst	4 (9.8)	47 (22.6)	.08
Complex ovarian or paraovarian cyst	5 (12.2)	22 (10.6)	.78
Dermoid	0 (0)	3 (1.4)	1.0
Hemorrhagic corpus luteum	1 (2.4)	8 (4.3)	1.0
Hydrosalpinx	1 (2.4)	3 (1.4)	.51
Inguinal hernia	3 (7.3)	0 (0)	.004
Appendicitis	4 (9.8)	2 (1.0)	.008
Surgical procedure [†]			
Detorsion	25 (60.9)	139 (66.8)	.29
Detorsion and drainage	12 (29.3)	37 (17.8)	.13
Detorsion and cystectomy	1 (2.4)	25 (12.0)	.09
Detorsion and fixation	1 (2.4)	3 (1.4)	.51
Ovarian or adnexal resection	2 (4.9)	3 (1.4)	.25
Histopathologic results [†]	3 (7.3)	27 (65.8)	.10
Simple cyst	1 (33.3)	17 (58.6)	1.0
Mature cystic teratoma	0 (0)	5 (17.2)	NA
Endometrioma	0 (0)	1 (3.4)	NA
Fibroma or fibrothecoma	0 (0)	2 (6.9)	NA
Necrosis of ovary	2 (66.7)	2 (6.9)	.04

NA, not applicable.

Data are n (%) or median (interquartile range) unless otherwise specified.

* Not normally distributed; Mann-Whitney *U* test.

[†] Not normally distributed; Fisher's exact test.

[‡] Normally distributed; χ^2 .

DISCUSSION

Overall, 16.5% of our study population was premenarchal. This compares with previous reports,^{9,17} yet most studies addressing ovarian torsion in the pediatric population do not stratify by menarchal status.^{3,5,6,9}

We found that although abdominal pain, accompanied by nausea and vomiting, was the leading symptom in both groups, other symptoms or signs such as fever, restlessness, and a palpable pelvic mass were more prevalent among premenarchal girls. This concurs with others who noted a fever incidence of 9–22%.^{2–4,18,19}

In the current study, the intervals from symptom presentation to gynecologic examination and from hospital admission to surgery were longer in the premenarchal group. For the pediatric population, the reported interval from admission to surgery ranged between 4.8¹⁸ and 35.7¹⁹ hours. Plausible explanations for the longer admission to surgery interval among premenarchal patients are omission of ovarian torsion from differential diagnosis because only approximately two-thirds of premenarchal patients underwent pelvic ultrasonography and 12% were not seen by gynecologists. Thus, it would seem that



this diagnosis might not even have been considered. Other possibilities are the reluctance to operate on premenarchal patients. As a result of the retrospective design of this study, the definite reasons for the delays are not known.

We report a higher rate of recurrent torsion in premenarchal patients. Whereas the mechanism of adnexal rotation in cases of ovarian pathology such as a cyst or tumor is comprehensible, the cause of torsion of apparently normal adnexa is less clear. Possible explanations include excess adnexal mobility, adnexal venous congestion, and jarring bodily movements.⁴ Because the majority of premenarchal patients underwent detorsion without fixation, the causal pathologic mechanism remained as well as the risk of subsequent torsion.

A similar rate of suspicion for preoperative adnexal torsion was observed in the premenarchal and postmenarchal groups. Although only transabdominal ultrasonography was performed in the former, pathologic Doppler flow characterizing ovarian torsion was similar in both groups. These results do not differ from previous reports.^{9,20,21} A novel ultrasonographic marker of a follicular ring sign was recently documented in 80% of those with ovarian torsion.²⁰ This marker was not addressed by our ultrasonographers because most of the ultrasonograms were performed before that report. Another explanation for the delay of care among premenarchal patients could be the higher rate of fever in this group, which could have raised suspicion for an infectious etiology rather than ovarian torsion. The delay in operative management probably explains the higher rate of a black–bluish-colored ovary observed among premenarchal girls, which represents a longer duration of ischemia.²² Although statistically significant, our study population included very few cases of ovary necrosis, requiring further study before reaching conclusions.

Data have recently accumulated regarding the misleading appearance of black–bluish ovaries and the potential for restoration of normal function, making conservative surgical therapy in these situations preferable.^{8,13,23–27} In our cohort, no evidence of malignancy was found in premenarchal girls who underwent oophorectomy, although this procedure was performed in only 4.5% of patients. This concurs with other reports that documented the rarity of malignant ovarian tumors in the premenarchal population^{19,28} and in 0–4% of those presenting with ovarian torsion.^{5,7,13,19,29} Thus, oophorectomy as a clinical practice in this scenario is generally unnecessary, yet the malignant potential does exist and must be considered during surgery.

The management of ovarian torsion has evolved from the “traditional” removal of the torsed ovary to successful conservative management with detorsion despite a necrotic appearance.³⁰ Although delays in both presentation and diagnosis were thought to irreversibly jeopardize ovary viability, there was no clear association between symptom duration and successful detorsion. The small sample size of the current study did not enable consideration in the analysis of any changes in technology and knowledge that may have occurred during the study period.

There is no consensus about oophorectomy in the treatment of premenarchal patients. Some authors suggested performing oophorectomy in specific cases as bilateral ovarian torsion, recurrent ovarian torsion, and previous resection of single ovary or adnexa,^{4,26,31} whereas others have suggested performing oophorectomy in cases of a normally appearing torsed ovary as a result of a high recurrence rate.²⁶ Ovarian function does not seem to be adversely affected by oophorectomy,^{32,33} although concerns have been raised that anatomic alterations may decrease future fertility.³⁴ In our series, one premenarchal patient who had two previous adnexal torsions underwent oophorectomy.

The retrospective design poses limitations. The inclusion of only patients who were surgically diagnosed with ovarian torsion may result in a selection bias, which would underestimate a delay in diagnosis in premenarchal patients. Similarly, the reliance on documentation of patient symptoms by the charting physician resulted in discrepancy of information, which yielded an information bias. In addition, the particular effects on final decisions, of the different disciplines of the physicians involved, were not clear. Nevertheless, the study represents a relatively large cohort with specific reference to the premenarchal population.

In summary, ovarian torsion constitutes a surgical emergency, whose diagnosis is not always clear from clinical imaging and presentation. Premenarchal girls presenting with ovarian torsion display symptoms that are common to the postmenarchal population, but also some that are more distinct such as fever and restlessness. Ultrasound findings may be reliable even in the premenarchal population; nevertheless, clinicians should trust physical findings. Because diagnosis delay is associated with increased risk for ovarian ischemia, a higher index of suspicion is needed for premenarchal patients and a thorough gynecologic evaluation for adnexal torsion must be considered for this population.

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