Clinical Characteristics of Women with Isolated Fallopian Tube Torsion Compared with Adnexal Torsion

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ABSTRACT:

Background: Isolated fallopian tube torsion (IFTT) is a rare gynecological entity and its diagnosis is challenging.

Objectives: To compare clinical characteristics, sonographic findings, surgical management, and outcomes of women with surgically verified IFTT compared to those diagnosed with adnexal torsion.

Methods: A retrospective case-control study in a university hospital was conducted. Thirty-four women with surgically verified IFTT between March 1991 and June 2017 were compared to 333 women diagnosed with adnexal torsion within the same time period.

Results: Both groups presented primarily with abdominal pain, which lasted longer prior to admission among the IFTT group (46.8 ± 39.0 vs. 30.0 ± 39.4 hours, $P < 0.001$). Higher rates of abdominal tenderness with or without peritoneal signs were found in the adnexal torsion group (90.3% vs. 70.6%, $P < 0.001$). Sonographic findings were similar; however, an increased rate of hydrosalpinx was found among the IFTT group (5.9% vs. 0.0%, $P = 0.008$). Suspected adnexal torsion was the main surgical indication in only 61.8% of IFTT cases compared with 79.0% in the adnexal torsion group ($P = 0.02$). Salpingectomy with or without cystectomy was more commonly performed in the IFTT group (35.3% vs. 1.5%, $P < 0.001$). The leading pathological findings among the IFTT group were hydrosalpinx and paraovarian cysts.

Conclusions: The clinical signs and symptoms of IFTT and adnexal torsion are similar. Although sonographic imaging demonstrating a paraovarian cyst or hydrosalpinx may be helpful in diagnosing IFTT, it is rarely done preoperatively.

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KEY WORDS: adnexal torsion, fallopian tube torsion, hydrosalpinx, isolated fallopian tube torsion (IFTT), paraovarian cyst

Adnexal torsion is one of the most common gynecological emergencies and is demonstrated in approximately 3% of patients with acute abdominal pain undergoing surgery [1]. Adnexal torsion refers to the rotation, complete or partial, of the ovary and the tube around its own ligamentous support, which can result in interruption of circulation, ischemia, and even-

tually adnexal necrosis. Isolated fallopian tube torsion (IFTT) is considered a subgroup of adnexal torsion. IFTT is defined as a tubal rotation without ipsilateral ovarian involvement. Compared to adnexal torsion, IFTT is a rare gynecological diagnosis with an estimated incidence of 1 in 1.5 million women, mainly of reproductive age, and even rarer in pre-menarchal girls [2]. Several case reports and a few small case-series have been published regarding IFTT since it was first described by Bland-Sutton in 1890. However, the clinical presentation as well as ultrasound and laboratory characteristics among patients with IFTT and adnexal torsion have not been previously compared. The aim of this study was to investigate and compare the clinical manifestation, sonographic imaging, and surgical management of surgically proven adnexal torsion and IFTT.

PATIENTS AND METHODS

This retrospective case study evaluated women treated at the gynecology department at the Wolfson Medical Center between March 1991 and June 2017. Patient charts with an ICD-9 code for torsion of ovary, fallopian tube, or adnexa were extracted. Only surgically verified cases were further evaluated. Cases of torsion found during both emergent and elective surgeries were included. Data relating to demographic characteristics, menarcheal status, medical history, clinical and laboratory presentation, as well as sonographic imaging, surgical findings, and treatment and pathological diagnosis were retrieved from the medical records and reviewed. Patients were classified according to adnexal compartments involved in torsion. The first group included cases of isolated fallopian tube torsion, not involving the ovary (IFTT group). The second group included all other cases of adnexal torsion involving fallopian tube and ovary (adnexal torsion group). Adnexal torsion was defined as a rotation of the adnexa of at least 360 degrees, while IFTT was defined as tubal rotation either in its mid-portions or around its supporting ligaments, without ovarian involvement. Sonographic evaluations were performed using two-dimensional gray-scale imaging with trans-vaginal and/or trans-abdominal probe. Surgical procedures were performed by senior attending physicians and residents of the department of gynecology. All specimens obtained during surgery were sent for pathological evaluation.

Data were analyzed with Epi Info™, version 7.0 (public domain software package designed by the U.S. Centers for Disease Control and Prevention). Quantitative variables were calculated as mean ± standard deviation or median and range, as appropriate. Qualitative variables were calculated as frequency (percentage) and compared using the Chi-square test or Fisher's exact test, as appropriate. A P value of < 0.05 was considered statistically significant.

The study was approved by the Wolfson Medical Center institutional review board in agreement with the Helsinki Declaration.

RESULTS

A total of 367 cases of adnexal torsion during the study period were identified and included. Among them were 34 cases of IFTT and 333 cases of adnexal torsion, all of which were surgically confirmed. Similar demographic characteristics were found in both groups including age (32.3 ± 14.6 vs. 31.8 ± 15.4 years, $P = 0.85$), patients of reproductive age (88.2% vs. 83.8%, $P = 0.49$), and pregnancy rates (14.7% vs. 22.8%, $P = 0.28$). In cases of gravid patients, a younger gestational age was noted in the adnexal torsion group (20.4 vs. 10.2 weeks, $P < 0.001$). While there were no cases of IFTT in the pre-menarcheal period, 16 pre-menarcheal patients with adnexal torsion were identified in the control group.

Clinical manifestations of both study groups are presented in Table 1. Abdominal pain was the main presenting symptom in both groups, although significantly higher in patients with adnexal torsion compared with IFTT (96.7% vs. 88.2%, $P = 0.04$). Rates of gastrointestinal symptoms, such as nausea and vomiting, did not differ between the groups (50.3% vs. 43.8%, $P = 0.48$), as well as elevated white blood cell count (> 11,000 cells/ml) and febrile history (> 37.8°C). On physical examination, abdominal tenderness with or without peritoneal irritation signs (i.e.,

rebound tenderness and guarding) were elicited more frequently in the adnexal torsion group compared with IFTT group (90.3% and 70.6%, respectively, $P < 0.001$).

Right sided presentation was more common in both groups (64.6% and 67.7%, $P = 0.72$). Ovarian cyst or mass were the most common preoperative sonographic features, found in 73.5% of the IFTT group, and 81.1% of the adnexal torsion group ($P = 0.29$) with a similar average diameter of 5.6 and 7.2 centimeters, respectively ($P = 1.0$). Hydrosalpinx was demonstrated only in patients with IFTT (5.9% vs. 0.0%, $P = 0.008$). Similar rate of normal adnexa was found in both groups (20.6 vs. 18.9, $P = 0.81$). Doppler flow examination, performed in 29% of IFTT cases and in 39% of adnexal torsion patients, revealed absent arterial flow in the adnexal torsion group only ($P = 0.01$). Likewise, ovarian edema was observed exclusively in the adnexal torsion group ($P = 0.02$).

Table 2 refers to preoperative indications for surgery. Suspected adnexal torsion was the primary surgical indication in only 61.8% of IFTT cases, compared with 79.0% in the adnexal torsion group ($P = 0.02$). More patients with IFTT underwent elective surgery (11.8% vs. 3.3%, $P = 0.04$), emergent surgery due to suspected appendicitis (14.7% vs. 5.7%, $P = 0.04$), or diagnostic surgery due to acute abdomen (5.9% vs. 0.0%, $P < 0.01$). IFTT was not suspected in any of the study group cases preoperatively, based on clinical presentation or sonographic imaging. Laparoscopy was the main surgical procedure in both groups (82.4% vs. 78.7%, $P = 0.62$). Laparotomy was performed in patients who underwent surgery before 1995, third trimester pregnant women, and in cases of suspected ovarian malignancy.

A higher number of adnexal rotations and cyanotic appearance were found in the IFTT group [Table 3]. Rates of detorsion only, along with detorsion and cystectomy, were similar for both groups (11.8% vs. 19.8%, $P = 0.36$ and 38.2% vs. 34.2%, $P = 0.64$, respectively).

In addition, rate of bilateral salpingo-oophorectomy (BSO) did not differ statistically (15.0% and 14.7%, $P = 0.96$). Overall,

Table 1. Clinical manifestations of IFTT and adnexal torsion

	IFTT n=34	Adnexal torsion n=333	P value
Abdominal pain	30 (88.2)	322 (96.7)	0.04
Elective surgery*	4 (11.8)	11 (3.3)	0.04
Duration of pain (hours)	46.8 ± 39.0	30.0 ± 39.4	‹ 0.001
Nausea ± vomiting	14 (43.8)	165 (50.3)	0.48
Fever › 37.8°C	4 (11.8)	21 (6.3)	0.27
WBC › 11,000 cells/ml	10.5 ± 4.8	10.5 ± 3.3	0.93
Abdominal tenderness ± peritoneal signs	24 (70.6)	299 (90.3)	‹ 0.001
Right sided presentation	23 (67.7)	215 (64.6)	0.72

Data are presented as mean ± standard deviation or number (%) as appropriate
*Patients admitted for elective surgery due to persistent ovarian cyst or suspected pelvic mass and were found to have IFTT
IFTT = isolated fallopian tube torsion, WBC = white blood cell count

Table 2. Preoperative surgical indications

	IFTT n=34	Adnexal torsion n=333	P value
Suspected adnexal torsion	21 (61.8)	263 (79.0)	0.02
Suspected appendicitis	5 (14.7)	19 (5.7)	0.04
Elective surgery	4 (11.8)	11 (3.3)	0.04
Acute abdomen	2 (5.9)	0 (0.0)	‹ 0.01
Other*	2 (5.9)	40 (12.0)	0.4
Operative methods: Laparoscopy Laparotomy	28 (82.4) 6 (17.6)	262 (78.7) 71 (21.3)	0.62 0.62

Data presented as mean ± standard deviation or number (%) as appropriate
*Suspected tubo-varian abscess/hydrosalpinx, pelvic mass, or inguinal hernia
IFTT = isolated fallopian tube torsion

Table 3. Intra-operative findings and surgical procedures

	IFTT n=34	Adnexal torsion n=333	P value
Admission to operation interval, hours*	29.0 ± 35.7	30.2 ± 47.0	0.90
Number of rotations	3.0 ± 1.5	2.1 ± 0.92	‹ 0.001
Cyanotic appearance	15 (50.0)	31 (9.4)	‹ 0.001
Surgical procedure:			
Detorsion only	4 (11.8)	66 (19.8)	0.36
Detorsion + fenestration	0 (0.0)	62 (18.6)	0.002
Detorsion + cystectomy	13 (38.2)	114 (34.2)	0.64
Salpingectomy	7 (20.6)	5 (1.5)	‹ 0.001
Salpingectomy + cystectomy	5 (14.7)	0 (0.0)	‹ 0.001
USO	0 (0.0)	36 (10.8)	0.04
BSO	5 (14.7)	50 (15.0)	0.96
Hospital stay, days	4.4 ± 2.1	3.8 ± 3.3	0.27

Data presented as mean ± standard deviation or number (%) as appropriate
*Calculated for emergent surgeries only
BSO = bilateral salpingo-oophorectomy, USO = unilateral salpingo-oophorectomy, IFTT = isolated fallopian tube torsion

Table 4. Histopathological findings

	IFTT n=30	Adnexal torsion n=219	P value
Functional cyst (follicular, corpus lutheum)	0 (0.0)	52 (23.6)	0.001
Cyst adenoma (mucinous, serous)	1 (3.3)	48 (21.8)	0.01
Mature teratoma	0 (0.0)	45 (20.5)	0.004
Paraovarian cyst	14 (46.7)	20 (9.0)	‹ 0.001
Hydrosalpinx	6 (20.0)	3 (1.4)	‹ 0.001
Fibroma	0 (0.0)	15 (6.8)	0.22
Endometrioma	0 (0.0)	3 (1.4)	1.0
Necrosis	9 (30.0)	26 (11.8)	0.02
Ovarian carcinoma	0 (0.0)	7 (3.2)	1.0

Data presented as mean ± standard deviation or number (%) as appropriate
Adnexal pathology was assessed in 30 patients with IFTT and in 219 adenxal torsion patients
IFTT = isolated fallopian tube torsion

BSO was performed in five patients in the IFTT group: four menopause women and one peri-menopausal patient aged 47 who underwent surgery in 1995. In all cases, the reason for the ablative procedure was the presence of ovarian cyst/mass in addition to the IFTT. None of these patients were found to have ovarian malignancy. In contrast, unilateral salpingo-oophorectomy was performed only in the adnexal torsion group (10.8% vs. 0.0%, P = 0.04). Salpingectomy with or without cystectomy was more commonly performed in patients with IFTT (35.3% vs. 1.5%, P < 0.001) and more patients with adnexal torsion underwent detorsion with fenestration (18.6% vs. 0.0%, P = 0.002).

There were no differences between the groups concerning the time interval between admission to surgery (29.0 ± 35.7 vs. 30.2 ± 47.0 hours, P = 0.90) and overall hospital stay (4.4 ± 2.1 vs. 3.8 ± 3.3 days, P = 0.27).

Functional, adenoma and dermoid ovarian cysts were the most common histopathological findings among patients with adnexal torsion, as opposed to paraovarian cyst and hydrosalpinx, which were more commonly found among IFTT patients [Table 4]. Histological finding of necrosis only was significantly more common in the IFTT group (P = 0.02). Ovarian carcinoma was diagnosed in 3% of patients with adnexal torsion, compared to no cases of cancer in the IFTT group, but this difference did not reach statistical significance.

DISCUSSION

Preoperative diagnosis of IFTT is difficult and challenging since its symptoms are nonspecific and similar to other gynecologic diseases, such as adnexal torsion with ovarian involvement, and many non-gynecologic diseases [3,4]. Until now, the clinical presentation of IFTT and adnexal torsion have not been compared, and to the best of our knowledge, our study is the largest case series of IFTT and the first one to perform such a comparison. Similar to previous studies [5,6], we found abdominal pain to be the main presenting symptom in both groups, but significantly higher in patients with adnexal torsion compared to IFTT (96.7% vs. 88.2, P = 0.04). Rates of gastrointestinal symptoms, such as nausea and vomiting were common in both groups; however, it did not differ significantly (43.8% vs. 50.3%, P = 0.48). Furthermore, white blood cell count and temperature were unremarkable in the majority of cases in both groups. These data are compatible with the results of previous studies [5-8]. According to our study, clinical manifestations in the IFTT group were probably less substantial, and the majority of patients had no peritoneal signs at physical examination compared to the adnexal torsion group. This finding could explain the longer pain duration prior to admission in the IFTT group and higher rates of cyanosis and necrosis compared to the adnexal torsion group.

In our series, the majority of torsion cases in both the IFTT and adnexal torsion groups were right-sided (67.7% vs. 64.6%, P = 0.72) in concordance with other series [5,7,8]. This finding may be explained by the presence of the relatively fixed sigmoid colon, which prevent torsion of the left fallopian tube [9]. Another possibility is that surgeons are more likely to perform surgical exploration on right-sided abdominal pain to rule out acute appendicitis [10]. In contrast, Wong et al. [6] reported the opposite in his series, in which he found left-sided IFTT in five out of six patients.

In the present study, compared with other studies, ovarian torsion was the most common mistaken preoperative diagnosis of IFTT, followed by appendicitis [11].

Possible intrinsic and extrinsic predisposing factors for IFTT were first described by Yousef and colleagues [12] and further suggested by Provost [9] and Filtenborg and Hertz [13].

Intrinsic tubal factors include a long tube and mesosalpinx, cyst of Morgagni, hydrosalpinx or hematosalpinx, tubal neoplasm, and mesosalpingeal venous congestion. Extrinsic factors consisted of ovarian and paraovarian cysts, enlarged pregnant uterus, tumors, peritubal adhesions, and previous tubal ligation. In our study, paraovarian cysts were the most common intraoperative finding followed by hydrosalpinx. Therefore, it seems that paraovarian cysts and hydrosalpinx are predisposing factor for IFTT as described by additional studies [14,15]. In contrast to former studies reporting tubal surgery, such tubal ligation, as an IFTT risk factor [7,16], none of our patients had undergone prior tubal ligation. Although it is more common in post-menarcheal females, IFTT has been reported in the pediatric population by others, with the youngest patient being 4 years old [17,18].

In our series, both IFTT and adnexal torsion occurred more frequently among women of reproductive age and there were no cases of IFTT in the pre-menarche period.

Several imaging modalities for preoperative evaluation of IFTT have been described, including ultrasound with or without Doppler, computerized tomography (CT) and magnetic resonance imaging (MRI). Conventional transvaginal two-dimensional gray-scale ultrasound, typically the first line imaging modality for investigating abdominal pain in women with suspected adnexal torsion, occasionally may suggests IFTT diagnosis. The presence of the following sonographic triad should raise a strong suspicion for IFTT [19,20]: long tubular, convoluted cystic structure that tapers toward the uterine cornua; thin-walled cystic structure with variable septations and mixed internal echoes, suggestive of hydrohematosalpinx; and visualization of a normal ipsilateral ovary.

In our study, none of the IFTT cases demonstrated reduced or absent blood flow by color Doppler ultrasonography, while other studies did note unilateral absence of blood flow with color Doppler ultrasonography [6,20]. Nevertheless, the presence of normal flow does not necessarily rule out tubal torsion [21].

The value of CT and MRI imaging in diagnosing IFTT has been controversial. Some reports advocate its usefulness in detecting a twisted vascular pedicle, thickened fallopian tubes, and hemorrhagic infarction, as well as rarely associated congenital uterine anomalies [22,23]. Others regard the images as unnecessary intervention adding little, if any, detail to what is visualized on ultrasonography [24]. While being evaluated for surgical emergencies, four of our patients in the IFTT group underwent abdominal CT scans, which were interpreted by a radiologist specialist, and were still misdiagnosed.

The treatment of choice in cases of adnexal torsion, particularly in women of reproductive age, is conservative. This conservative surgery has been proven safe and adnexal function is usually restored, even when ischemic or necrotic lesions are present [10,25]. In our opinion, based on available evidence, cases of IFTT should also be treated conservatively by simple laparoscopic fallopian tube detorsion to restore blood flow and preserve fertility. Salpingectomy may be considered in cases of tissue gangrene, hydrosalpinxs, or tubal/ovarian neoplasm.

Our study is limited by its retrospective design, including the potential for underreporting and the limitation of lack of a unified diagnostic process (such as Doppler imaging for all patients). Despite its limitations, the present study is the largest series of women with IFTT from a single tertiary center treated over 25 years.

CONCLUSIONS

The clinical features of IFTT and adnexal torsion are similar and nonspecific. As a result, the diagnosis of IFTT is often not made preoperatively. IFTT should be considered within the differential diagnosis of lower abdominal pain in all women, especially when sonographic imaging demonstrates a paraovarian cyst or hydrosalpinx, which are the main risk factors for this condition. In our opinion, laparoscopy is the intervention of choice for definitive diagnosis and treatment. Furthermore, we believe that standard treatment should be conservative, to include detorsion and resection of concurrent findings as needed.

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Capsule

Potential roles of gut microbiome and metabolites in modulating ALS in mice

Amyotrophic lateral sclerosis (ALS) is a complex neuro-degenerative disorder in which the clinical manifestations may be influenced by genetic and unknown environmental factors. **Blacher** et al. showed that ALS-prone *Sod*1 transgenic (*Sod*1-Tg) mice have a pre-symptomatic, vivarium-dependent dysbiosis. The mice had altered metabolite configuration, coupled with an exacerbated disease under germ-free conditions or after treatment with broad-spectrum antibiotics. The authors correlated 11 distinct commensal bacteria at the vivarium with the severity of ALS in mice, and by their individual supplementation into antibiotic-treated *Sod*1-Tg mice they demonstrate that *Akkermansia muciniphila (AM)* ameliorates, whereas *Ruminococcus torques* and *Parabacteroides distasonis* exacerbate the symptoms of ALS.

Furthermore, *Sod*1-Tg mice that are administered *AM* are found to accumulate *AM*-associated nicotinamide in the central nervous system, and systemic supplementation of nicotinamide improves motor symptoms and gene expression patterns in the spinal cord of *Sod*1-Tg mice. In humans, the authors identified distinct microbiome and metabolite configurations, including reduced levels of nicotinamide systemically and in the cerebrospinal fluid, in a small preliminary study that compares patients with ALS with controls. The authors suggested that environmentally driven microbiome-brain interactions may modulate ALS in mice, and called for similar investigations in the human form of the disease.

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Capsule

Integrated meta-omics reveals a fungus-associated bacteriome and distinct functional pathways in *Clostridioides difficile* infection

There has been no prior application of matched metag-enomics and metatranscriptomics in *Clostridioides difficile* infection (CDI) evaluating the role of fungi in CDI or identi-fying community functions that contribute to the development of this disease. **Stewart** et al. collected diarrheal stools from 49 inpatients (18 of whom tested positive for CDI) under stringent inclusion criteria. The authors utilized a tiered sequencing approach to identify enriched bacterial and fungal taxa, using 16S and internal transcribed spacer (ITS) rRNA gene amplicon sequencing, with matched metagenomics and metatranscriptomics performed on a subset of the population. Distinct bacterial and fungal compositions distinguished CDI-positive and CDI-negative patients, with the greatest differentiation between the cohorts observed based on bacterial metatranscriptomics. Bipartite network analyses demonstrated that *Aspergillus* and *Penicillium* taxa shared a strong positive relationship in CDI patients and together formed negative cooccurring relationships with several bacterial taxa, including the *Oscillospira*, *Comamonadaceae*, *Microbacteriaceae*, and *Cytophagaceae*. Metatranscriptomics revealed enriched pathways in CDI patients associated with biofilm production primarily driven by *Escherichia coli* and *Pseudomonas*, quorum-sensing proteins, and two-component systems related to functions such as osmotic regulation, linoleic acid metabolism, and flagellar assembly. Differential expression of functional pathways unveiled a mechanism by which the causal dysbiosis of CDI may self-perpetuate, potentially contributing to treatment failures. The authors proposed that CDI has a distinct fungus-associated bacteriome, and this first description of metatranscriptomics in human subjects with CDI demonstrates that inflammation, osmotic changes, and biofilm production are key elements of CDI pathophysiology.

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