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Original Article

Clinical characteristics of ovarian torsion and high-risk factor analysis for ovarian necrosis

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Abstract: Objective: Ovarian torsion is a common gynecological condition significantly affecting the health and fertility of women. Therefore, this study discussed the clinical characteristics of ovarian torsion and the high-risk factors for ovarian torsion and necrosis. Methods: Clinical data of 95 patients with ovarian torsion were analyzed, of which 78 patients diagnosed with complete ovarian torsion (≥ 360°) were categorized into two groups based on the pathological diagnosis: the ovarian necrosis group (24 patients) and the ovarian non-necrosis group (54 patients). Results: Age, ovarian torsion degree, preoperative fever incidence, proportion of bluish-purple ovaries, and ovarian necrosis rate of the patients undergoing adnexectomy were significantly higher than those of patients undergoing cystectomy ($P < 0.05$). Univariate analysis showed that ovarian torsion time and torsion degree were high-risk factors for ovarian necrosis ($P < 0.05$). The results of multivariate logistic regression analysis showed that the rate of ovarian necrosis was significantly higher in cases with less than 24 h of torsion than in those with longer than 48 h of torsion [odds ratio (OR) = 7.925, 95% confidence interval (CI): 2.192-28.654]. The necrosis rate with a torsion degree of < 720° would be significantly lower than that with a torsion degree of ≥ 720° (OR = 4.985, 95% CI: 1.274-19.512). Conclusion: The longer the ovarian torsion time and the greater the ovarian torsion degree, the higher will be the possibility of ovarian necrosis. Once ovarian torsion is suspected, surgical treatment should be initiated actively.

Keywords: Ovarian torsion, necrosis, torsion time, torsion degree, high-risk factors

Introduction

The ovaries are a pair of oval reproductive organs located on both sides of the uterus and formed by a layer of epithelial tissue and thin layers of connective tissue. Their internal structure is composed of the cortex and medulla. The surrounding part of the ovaries forms cortex, which is mainly composed of connective tissue and follicles, and the central part is called medulla, which is formed by loose connective tissues and includes many lymphatics, vessels, and nerves. The ovary is the female sex gland for generating oocytes and secreting sex hormones; thus, it has reproductive and endocrine functions [1].

The ovaries play very important roles in female fertility. However, the number of ovarian torsion cases have recently increased [2], causing a serious threat to the fertility of female patients. Accordingly, when diagnosed, treatment for ovarian torsion should be initiated as early as possible. varian torsion is one of the most common gynecological acute abdominal conditions with the clinical manifestation of acute lower abdominal pain on one side, commonly on the right side, relievable spontaneously in a short time and with frequent relapses [3]. Severe torsion is difficult to treat. Because of the venous flow obstruction, the oviduct and ovary hyperemia are always observed. If the blood vessels rupture owing to the torsion, it may result in shock caused by internal bleeding. If the thickened accessories are touchable with obvious tenderness and rebound pain in the lower abdomen accompanied by abdominal muscle tension of varying degrees during the rectoabdominal examination, ovarian torsion should be highly suspected [4]. The gynecological examination would show lumps and tenderness on one side of the appendages.

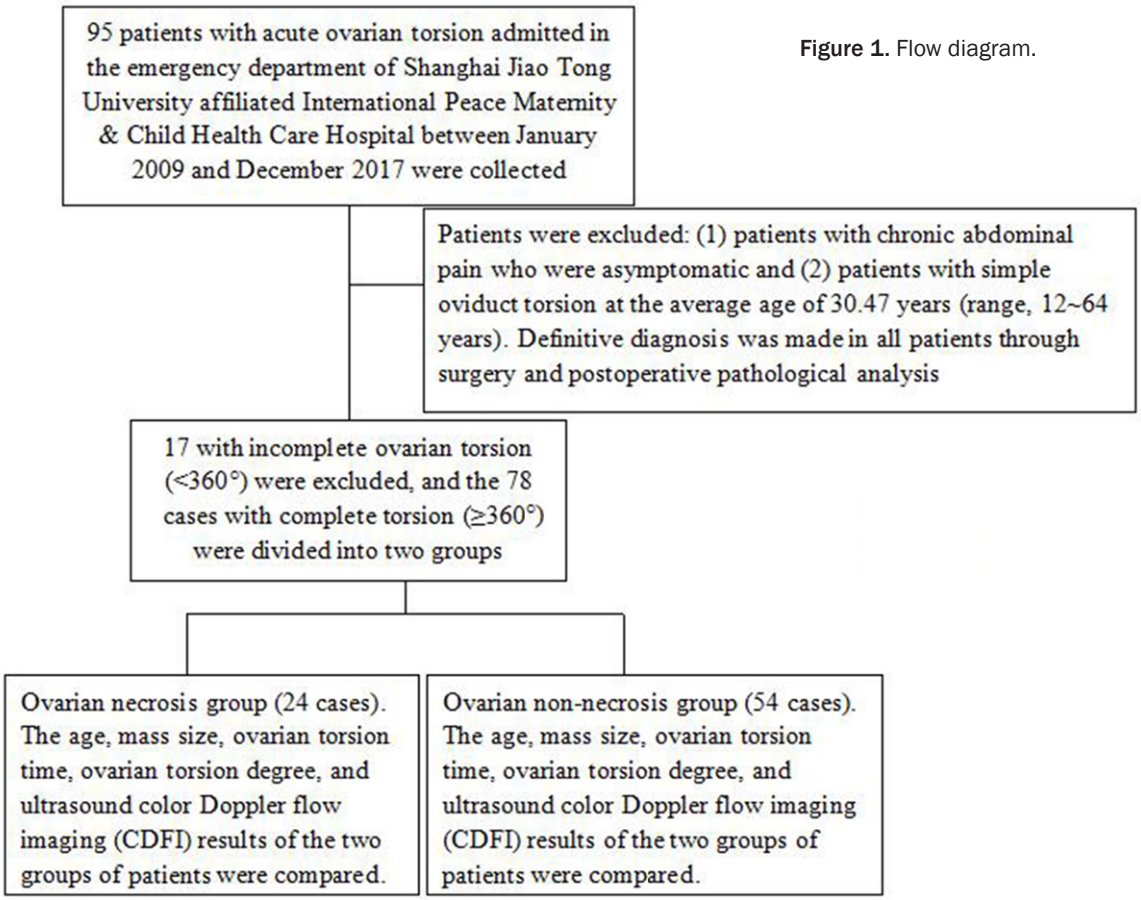

Figure 1. Flow diagram.

Ovarian torsion may lead to ovarian necrosis [5], but ovarian viability cannot be determined in advance before the operation and the color of ovaries is the main indicator for determining the retention or removal of the ovary. The main cause of ovarian torsion is congenital abnormalities [6], e.g., an excessively long and spiral oviduct or ovarian mesangial. Congenitally abnormal reproductive organs, such as a single-angle uterus without bilateral asymmetry, rank as the second major cause of ovarian torsion [7]. With regard to treatment, mild torsion needs to be further observed before intervention and severe torsion should be treated by laparotomy.

Given the significance of ovaries in women and the harm caused by ovarian torsion, this study retrospectively analyzed the clinical features of 95 cases with ovarian torsion to explore the clinical characteristics of ovarian torsion patients and the high-risk factors for ovarian torsion and necrosis to provide more data for the prevention and treatment of female ovarian torsion. In this study, we analyzed the clinical symptoms, surgical conditions, and pathological features of 95 patients with ovarian torsion with an aim to treat the patients and protect their ovaries as more as possible.

Materials and methods

Subject

In all, data for 95 patients with acute ovarian torsion admitted in the Gynecology Department of International Peace Maternity and Child Health Hospital, Shanghai Jiao Tong University School of Medicine between January 2009 and December 2017 were collected. The following patients were excluded: (1) patients with chronic abdominal pain who were asymptomatic and (2) patients with simple oviduct torsion. Definitive diagnosis was made in all patients through surgery and postoperative pathological analysis.

Research method description

The subjects were divided into two groups depending on the selected operative modality, the adnexectomy group (44 cases) and the cystec-

Table 1. Comparison of clinical features of patients with adnexectomy and cystectomy

Clinical features	Adnexectomy (n = 44)	Cystectomy (n = 51)	t/χ^2	P
Age (years old)*	35.20±12.65	26.39±5.95	4.236	< 0.001
Torsion degree (°)*	675.00±282.94	502.94±279.54	2.975	0.004
Torsion time (h)*	54.57±50.00	39.63±44.89	1.535	0.128
Mass size (cm)*	9.66±3.70	8.71±2.37	1.516	0.133
Symptom/n (%)				
Fever**	8 (18.2%)	2 (3.9%)	-	0.041
Vomiting	27 (61.4%)	32 (62.7%)	0.019	0.890
Ultrasound blood flow/n (%)	13 (29.5%)	17 (33.3%)	0.157	0.692
Combined pregnancy/n (%)	14 (31.8%)	18 (35.3%)	0.128	0.721
Operation-laparoscopy/n (%)	20 (45.5%)	32 (62.7%)	2.850	0.091
Complete torsion/n (%)	40 (90.9%)	38 (74.5%)	4.324	0.038
Ovarian color-bluish purple/n (%)	33 (75%)	5 (9.8%)	41.834	< 0.001
Ovarian necrosis/n (%)	24 (54.5%)	0	37.222	< 0.001

Remarks: *dada is presented with $\bar{X} \pm s$ and **represents the Fisher exact probability method.

tomy group (51 cases), and the clinical characteristics of the two groups of patients were compared. Of the 95 cases, 17 with incomplete ovarian torsion (< 360°) were excluded, and the 78 cases with complete torsion (≥ 360°) were divided into two groups based on the pathological diagnosis: the ovarian necrosis group (24 cases) and the ovarian non-necrosis group (54 cases). The age, mass size, ovarian torsion time, ovarian torsion degree, and ultrasound color Doppler flow imaging (CDFI) results of the two groups of patients were compared. The mass size was obtained by calculating the mean of the three diameter lines measured by CDFI. The ovarian torsion time is the time span from onset of acute lower abdominal pain to the beginning of the surgery. The ultrasound blood flow signal was detected by the CDFI instrument and the probe examined the abdomen or vagina to observe the blood flow distribution in the pedicle of the ovary by CDFI and the presence or absence of a blood flow signal was observable on CDFI. The 17 cases with incomplete ovarian torsion (< 360°), who were excluded from the study, were not diagnosed with ovarian necrosis regardless of the torsion time and degree. The patient's flow diagram was shown in **Figure 1**.

Statistical analysis

All data were analyzed by SPSS 23.0 software and the data in normal distribution were expressed by mean ± standard deviation ($X \pm s$). The paired t test was used for statistical analysis. For skewed distribution data, Mann-Whitney U test was used and the data were expressed as medians (quartile) [M (P25-P75)]. The qualitative data were analyzed by χ^2 test or Fisher's exact test. Logistic regression analysis was used to analyze the relationship between ovarian necrosis and ovarian torsion time and ovarian torsion degree and the OR and 95% CI were calculated. $P < 0.05$ implied statistical significance.

Results

General information and pathological results of patients

All 95 patients had lower abdominal pain, with accompanying nausea and vomiting in 59 patients (62.1%) and accompanying fever (body temperature higher than 38°C) in 10 patients (10.5%); all patients exhibited lower abdominal tenderness during gynecological examination. In this study, 44 (46.3%), 51 (53.7%), 52 (54.7%), and 43 patients (45.3%) underwent adnexectomy, cystectomy, laparoscopic surgery, and transventral surgery, respectively. During surgery, 49 patients (51.6%) and 46 patients (48.4%) were found to have right ovarian torsion and left ovarian torsion, respectively. Bluish-purple ovaries were observed in 38 patients, of which ovarian necrosis was suggested to be present in 24 patients (63.2%) on postoperative pathological analysis; partial bluish-purple or dark red ovaries were observed in 12 patients, normal colored and lustrous ova-

Table 2. Postoperative pathological pattern of 95 patients

Pathological type	N	Percentage (%)
Mature teratoma of ovary	32	33.7
Benign ovarian cyst (no epithelium)	12	12.6
Simple cysts of ovary	11	11.6
Luteal cyst	9	9.5
Ovarian serous cystadenoma	9	9.5
Ovarian mucinous cystadenoma	8	8.4
Endometrioid cyst of ovary	3	3.1
Follicular cyst	1	1.1
Struma of ovary	1	1.1
Ovarian serous adenocarcinoma	1	1.1
Borderline endometrioid cystic fibroma of the ovary	1	1.1
Gyneduct tubule cyst	4	4.2
Hydrosalpinx	2	2.1
Papillary cystadenoma of the fallopian tube junction	1	1.1
Total	95	100

ries were observed in 45 patients, and ovarian torsion combined with pregnancy was observed in 32 patients (33.7%). Complete ovarian torsion (≥ 360°) was observed in 78 patients (82.1%), while the incomplete torsion (< 360°) was found in 17 patients (17.9%).

One case of ovarian malignancy (1.1%) and two cases of borderline tumors (2.1%) were observed. Ovarian torsion caused by fallopian tube factor was found in 7 patients (7.4%). The age, ovarian torsion degree, preoperative fever incidence, the proportion of bluish-purple ovaries, and the rate of ovarian necrosis in patients undergoing adnexectomy were all significantly higher than those in patients undergoing cystectomy and the difference was of significant ($P < 0.05$) (**Table 1**). The postoperative pathology of the torsion ovaries is presented in **Table 2**.

Comparison between the ovarian necrosis group and the ovarian non-necrosis group

The average torsion time in the ovarian necrosis group was (50.50 h) was significantly longer than that in the ovarian non-necrosis group (17 h) ($P < 0.05$), and the ovarian torsion degree in the necrosis group was significantly greater than that in the non-necrosis group ($P < 0.05$). There was no difference in age and tumor size between the two groups ($P > 0.05$) and no differences in preoperative ultrasound blood flow signals were observed between the two groups ($\chi^2 = 2.654$, $P > 0.05$) (**Tables 3**, **4**).

Logistic regression analysis of factors related with complete torsion and ovarian necrosis

Logistic regression analysis showed that ovarian torsion time and torsion degree were the high-risk factors for ovarian necrosis. The risk of ovarian necrosis was seven times higher in the cases where the ovarian torsion time was ≥ 48 h than in cases where the ovarian torsion time was < 24 h (OR = 7.925, 95% CI: 2.192-28.654). Further, the risk of ovarian necrosis was four times higher with a torsion degree of ≥ 720° than with a torsion degree of < 720° (OR = 4.985, 95% CI: 1.274-19.512; **Table 5**).

Discussion

Clinical characteristics of ovarian torsion

Ovarian torsion refers to partial or complete torsion of ovarian vessels or ovarian appendages with themselves as the axis, which may involve the oviduct and other appendage structures of the same side. As the fifth major gynecological emergency, ovarian torsion has frequent occurrence in healthy ovaries or secondary to ovarian or para-ovarian masses [8]. Torsion of ovarian masses and ovarian torsion involving the oviduct accounted for 92.6% and 7.4% cases, respectively, in this study, and the torsion of healthy ovaries was not observed. Ovarian torsion was usually found in tumors with good mobility and those with a gravity centered unilaterally; the pathological results in this group suggested that ovarian teratoma accounted for 33.7% cases, which was consistent with results of previous studies [9]. Patients usually develop acute unilateral hypogastric pain accompanied by nausea and vomiting (60%-70%) [10] and fever (10%) [11, 12].

Ovarian torsion often starts when the position of individual changes suddenly or the position of an enlarged uterus changes during pregnancy [13]. In this study, 33.7% of ovarian torsion patients were found to be pregnant, which sug-

Table 3. Comparison of age, mass size, torsion time and degree of torsion between the necrosis group and the non-necrosis group [M (P25-P75)]

Items	Necrosis group (n = 24)	Non-necrosis group (n = 54)	Z	P
Age (years old)	29.50 (23.25-36.75)	28.50 (24.00-34.00)	-0.439	0.661
Mass size (cm)	10.00 (7.25-10.75)	9.00 (8.00-10.00)	-1.019	0.308
Torsion time (h)	50.50 (17.00-93.00)	17.00 (7.75-48.00)	-2.670	0.008
Torsion degree (°)	794.23 (720.00-900.00)	518.71 (360.00-720.00)	-2.247	0.025

Table 4. One-way logistic regression analysis of ovarian complete torsion and necrosis

Factors	Necrosis group (n = 24)	Non-necrosis group (n = 54)	X^2	P
Torsion time (h)**				
< 24	8	33		
24-48	2	7	-	0.022
≥ 48	14	14		
Torsion degrees (°)**				
360-720	4	25		
720-1080	15	24	-	0.034
≥ 1080	5	5		
Ultrasound blood flow				
Yes	6	24	2.654	0.103
No	18	30		

Note: **Fisher exact probability method.

Table 5. Multivariate logistic regression analysis for ovarian complete torsion and necrosis

Danger factors	Control	OR value	95% CI	*P* value
Torsion time (h)	< 24	-	-	-
24-48		1.344	0.202-8.963	0.760
≥ 48		7.925	2.192-28.654	0.002
Torsion degrees (°)	360-720	-	-	-
720-1080		4.985	1.274-19.512	0.021
≥ 1080		12.295	1.913-79.009	0.008

gested that unilateral hypogastralgia during pregnancy may also be associated with ovarian torsion. Because of the absence of a specific clinical manifestation, the possibility of ovarian torsion should be considered in women with unilateral abdominal pain [14]. Once the ovarian torsion is suspected, the surgery should be initiated as soon as possible. However, many foreign studies have demonstrated that the restoration of blood flow in ovarian torsion does not result in an increased risk of pulmonary embolism [14, 15]. There were no complications of pulmonary embolism in the 51 patients who were operated for ovarian restoration and cyst removal in this study. Among the excluded cases of this study, there was one case of asymptomatic incomplete ovarian torsion wherein the patient experienced venous embolism in the left lower extremity and partial embolism in the pulmonary artery trunk one week after ovarian restoration and cyst removal and the postoperative venous embolism of the lower extremity rather than the appendage restoration was considered to have caused the pulmonary embolism. Therefore, restoration of blood flow in ovarian torsion is safe.

The results of this study demonstrated that the age, ovarian torsion degree, the rate of preoperative fever, the proportion of bluish-purple ovaries, and the incidence of ovarian necrosis in the adnexectomy group were significantly higher than those in the cystectomy group, which suggested that the age, ovarian torsion degree, and the ovarian appearance changes were principally considered in the selection of the surgical method. However, 1.1% ovarian malignant tumors and 2.1% borderline tumors were reported in our study group, which is consistent with the results of previous studies [16]. Further, it is also suggested that the malignant tumors shall be excluded as the intraoperative frozen pathological analysis before determining whether or not selecting the uterus preservation surgery.

High-risk factors for predicting ovarian torsion and necrosis

It is very important to differentiate between necrosis or non-necrosis in torsion ovaries, and as in previous studies, the ovarian viability was

determined based on the appearance and color of ovaries. Further, based on this observation, the decision concerning the retention or removal of ovaries was made; for example, if an ovary has turned bluish purple, necrosis was considered and excision was accordingly performed [17]. In this study, bluish-purple ovaries observed in 38 patients were considered necrotic, of which 24 patients were definitively diagnosed after pathological analysis, suggesting a diagnostic accordance rate of 63.2% by naked eyes, which was consistent with the conclusions of other studies [9, 18].

There have also been some studies where scholars have tried to retain ovaries by cystectomy and by restoration of the dark bluish torsion ovaries and observed postoperative ovarian follicle growth by ultrasonography during follow-up [19]. These studies suggest that ovarian necrosis cannot be determined only by the appearance of the ovary and the bluish-purple necrosis-like change may be secondary to venous stasis rather than arterial blood supply interruption. Even when arterial blood supply is interrupted, the ovarian activity may still be recovered after the restoration of the ovaries. The double blood supplies (from the ovarian artery and the uterus) also ensure the activity of the ovaries. At present, there are foreign scholars proposing that once ovarian torsion is diagnosed, conservative surgery should be performed to restore the ovaries and the excision of appendages should be avoided; this is also applicable to the purple and black ovaries [14, 15]. We believe this proposition is not sufficiently proved considering that approximately 62% of the patients with bluish-purple ovaries were definitively diagnosed with necrosis by pathological analysis. Accordingly, if conservative therapy was chosen for these cases, the risk of infection may have increased. Whether restored ovaries increase the risk of infection and lead to abortion is required to be verified in large samples by statistical analysis particularly in pregnant women with ovarian torsion [20, 21]. Therefore, it is very important to find an objective indicator of ovarian necrosis to guide surgeons in decision-making regarding ovary removal or retention.

The results of the present study were controversial on whether preoperative CDFI is predictive of the ovarian viability. Some scholars believe the embolism and necrotic lesions were found by postoperative ovarian pathological analysis in patients without flow signal and the embolism and necrotic lesions were not found in the patients with arteriovenous blood flow signals [22]; however, some scholars are convinced that the existence of ultrasound blood flow signal has no predictive value for ovarian necrosis [23]. The results of this study demonstrated no significant difference in the presence or absence of ultrasound blood flow signals between the necrosis and non-necrosis groups, implying that ovarian necrosis could not be determined by relying on ultrasound blood flow signals.

In this study, the 17 cases with incomplete ovarian torsion who underwent ovarian cystectomy were not diagnosed with ovarian necrosis regardless the torsion time, and were therefore excluded. In this study, the 78 cases with complete torsion were studied, and the results showed that the ovarian torsion time and the ovarian torsion degree were the independent risk factors for ovarian necrosis, suggesting that the torsion time and torsion degree determined the necrosis levels of the appendage; the longer the torsion time and the greater the torsion degree, the higher will the possibility of ovarian necrosis be. Foreign scholars have shown that appendage necrosis cases during two torsion days were significantly lower than those during six torsion days. Animal experiments in China demonstrated that ovarian torsion in rabbits if maintained for more than three days would induce an irreversible change [17], and further, in the study, it was shown that the risk of ovarian necrosis during the torsion time longer than 48 h was seven times of that during a torsion time less than 24 h. There was no difference in the risk of ovarian necrosis within 48 h. The risk of ovarian necrosis at the torsion degree greater than 720° was four times of that at the torsion degree less than 720°.

There have been some reports on factors affecting ovarian necrosi but no ideal predictor has been found yet [24]. Ovarian torsion time and torsion degree are the direct factors associated with ovarian necrosis, but a combination analysis of these two factors has not been reported. The results of this study are of reference value for predicting necrosis of ovaries, but the time and ovarian torsion degree cannot be directly used for diagnosing ovarian necro-

sis, and cyst removal or ovarian resection should be decided based on comprehensive evaluation. We believe that the ovaries can be restored slowly, by observing the ovarian color change for half an hour. If the ovarian color improves, cyst removal should be sufficient; otherwise, the appendages should be removed. Ovarian torsion may occur in women of any age and should be considered in patients presenting with relevant symptoms after conducting assistive examinations such as ultrasonography. If ovarian torsion is highly suspected, surgery should be performed urgently and the ovaries should be preserved or removed during the surgery depending on the patient will, age, ovarian torsion time, ovarian torsion degree, and the color change after ovarian restoration in patients.

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Disclosure of conflict of interest

None.

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