Original research

Differentiated therapy in pre- and postmenopausal adnexal torsion based on malignancy rates: A retrospective multicentre study over five years

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HIGHLIGHTS

- Adnexal torsion (AT) is a rarely seen event in postmenopausal women.
- The malignancy rate in postmenopausal women accounts for 16% of all cases with AT.
- The management of AT should be different between pre and postmenopausal women.

ARTICLE INFO

ABSTRACT

Introduction: The purpose of this study was to investigate the clinical presentation, intra and post-operative outcomes in pre and postmenopausal women who underwent operations for adnexal torsion, and to define our experience diagnosing and managing postmenopausal women with adnexal torsion.
Methods: One hundred and fifty-seven patients who underwent operation with a diagnosis of adnexal torsion were analyzed according to demographic characteristics, menopausal status, preoperative signs and symptoms, surgical findings and applied surgical procedures, and pathological results in four tertiary centers.
Results: The main indication for surgery for the postmenopausal women was pelvic mass (58% vs. 40%), while for premenopausal women the main indication was suspicion of torsion (55% vs. 24%), (each p < 0.001). The duration of time between being admitted to the hospital and entering operating room as well as the duration of surgery and postoperative hospitalization were statistically longer in the postmenopausal group (each p < 0.001). While extensive surgeries were performed for 68% of the postmenopausal group, this was required for only 3% of the premenopausal group. Functional cysts were the most common pathologic finding in premenopausal women, and only 2 cases of malignancy (1.6%) were seen as opposed to the postmenopausal group, where malignancy was diagnosed in 16% of cases (p < 0.001).
Discussion: Adnexal torsion in postmenopausal women is an uncommon event. Malignancy risk should be considered before operation.
Conclusion: The malignancy rate was 16% in postmenopausal women with adnexal torsion. Thus, extensive surgeries are more common in postmenopausal women with adnexal torsion.

1. Introduction

Adnexal torsion is defined as the twisting of the ovary and the fallopian tube around a center line consisting of the infundibulo-pelvic ligament and the utero-ovarian ligament. Adnexal torsion,

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which is one of the most common gynecologic emergencies, can occur in patients of any age, from in utero to postmenopausal women, but most commonly occurs in women in the reproductive age group [1].

The incidence of adnexal torsion is unknown. In a classic report of a 10-year review of patients at a women's hospital, ovarian torsion accounted for 2.7% of emergency surgeries [2]. The most common symptom of adnexal torsion is acute onset of lower abdominal pain, generally isolated to one side [3]. Nausea and vomiting also frequently accompany this pain [3]. Although symptoms are nonspecific, prompt diagnosis is important to preserve ovarian function and to prevent other associated morbidities.

An ultrasound is the preferred initial imaging study for patients with suspected ovarian torsion, but the more precise diagnosis of adnexal torsion is often done intraoperatively [4]. Torsion generally occurs in women with temporarily enlarged ovaries, often in association with an ovarian cyst or neoplasm, as directly related to the mass size. Follicular cysts, corpus lutei, benign cystic teratomas, and cystadenomas are mainly associated with torsion [2,5]. The incidence of torsion may be lower in postmenopausal women because of their decreased risk of having benign ovarian cysts and benign teratomas. Furthermore, malign ovarian lesions that make adhesions with neighboring tissues are less often the cause of torsion than benign ovarian cysts [5]. As torsion in postmenopausal women was reported in only few series, the differences between premenopausal and postmenopausal torsions concerning the risk of malignancy are not accurately known, nor are clinical findings or modes of therapy.

The objective of this retrospective multicentered study is to present a comprehensive comparison regarding the risk factors, clinical findings, and modes of therapy between surgically treated adnexal torsions in postmenopausal and premenopausal women. In addition, we define our experience in diagnosing and managing postmenopausal women with adnexal torsions.

2. Materials and methods

The databases of four gynecology and obstetrics departments from Turkey, including Tepecik Education and Research Hospital (Izmir), Bakırköy Dr. Sadi Konuk Teaching and Research Hospital (Istanbul), Yeni Yuzyil University School of Medicine, GOP Hospital (Istanbul), and Hacettepe University School of Medicine (Ankara), were reviewed retrospectively using patient charts. A total of 173 patients were found to have undergone operations for adnexal torsion. Pregnant and premenarchal patients were excluded from the study, and 157 patients were analyzed according to demographic characteristics, menopausal status, preoperative signs and symptoms, surgical findings and applied surgical procedures, and pathological results between January 2010 and January 2015. Torsion was defined as a rotation of the ovary/adnexa of at least $360°$. Menopause was diagnosed when patients reported 12 months of amenorrhea with or without menopausal symptoms. The outcomes of malignant patients were also reviewed based on their follow-up charts. The study was conducted in accordance with the ethical standards of the Declaration of Helsinki and was approved by the local ethics committees of Tepecik Education and Research Hospital (Izmir).

2.1. Statistics

Data were analyzed using Statistical Package for the Social Sciences, version 18.0 (SPSS Inc., Chicago IL, USA). Variables were investigated using visual (e.g. histograms, probability plots) and analytical methods (e.g. Kolmogorov-Smirnov/Shapiro-Wilk test) to determine a normal distribution. Continuous data (presented as the mean _ SD) were analyzed using the Student's t-test. The chi-square and Fisher exact tests were used to compare the proportions of different groups. P-values of less than 0.05 were considered to indicate a significant difference.

3. Theory

If patients with suspected adnexal torsion are in the postmenopausal period, then preparation for more extensive surgery for malign diseases should be contemplated. Patients should be instructed and written informed consent for possible *oophorectomy* and/or hysterectomy and debulking should be obtained preoperatively.

4. Results

One hundred and fifty-seven patients who were treated surgically in four tertiary gynecologic centers in Turkey were analyzed in this study according to their menopausal status, presurgical evaluations, surgical methods, frozen section results, and pathological findings. Of those who met the inclusion criteria, 132 patients were premenopausal and 25 patients were postmenopausal.

Preoperative characteristics and intraoperative findings among pre and postmenopausal women with adnexal torsion are noted in Table 1. As expected, the postmenopausal group consisted of older women, with an average age of $59.2 ± 12.1$ years, as compared to the premenopausal group, which had an average age of $29 ± 8.6$ years (p < 0.001). Clinical signs were similar in both groups, including abdominal pain, nausea and vomiting, pelvic sensitivity and fever. The only statistically significant signs were the presence of an abdominal mass (50% in the postmenopausal ground vs. 3% in the premenopausal group: p < 0.001) and peritoneal signs-rebound (16% vs. 36%, respectively; p < 0.05).

Ultrasonographic findings, including ovarian diameter, the complexity of the ovarian mass, and the absence of Doppler flow, were also similar in both groups. In addition, the laboratory findings of white blood cells and CA125 levels were not significant in either group.

The main surgical indication for the postmenopausal women, as noted by the surgeon, was pelvic mass (58% vs. 40% in the premenopausal group; p < 0.001), while the main indication for premenopausal women was the suspicion of torsion (55% vs. 24% in the postmenopausal group; p < 0.001). When comparing surgical characteristics and operating times, the duration of time between being admitted to the hospital and entering the operating room as well as the duration of surgery and postoperative hospitalization were statistically longer in the postmenopausal group (p < 0.001) (Table 1).

The surgical procedures that were performed on women with adnexal torsion are shown in Fig. 1. The surgical procedures performed were significantly different between the two groups. The trend toward laparotomy was significant in the postmenopausal group (84% vs. 51% in the premenopausal group). While extensive surgery—total abdominal hysterectomy and bilateral salphingo-oopherectomy (TAH + BSO)—was performed on 68% of the postmenopausal group, it was only performed on 3% of the premenopausal group.

In premenopausal women, 51% of the cases had a laparotomy, which mainly consisted of unilateral salphingo-oopherectomy (USO) in 74% of laparotomies in premenopausal women and detorsion + cystectomy (D + CYS) in 16% of cases. Rates of detorsion and D + CYS were significantly higher in cases of laparoscopy (16% and 50%, respectively).

Pathologic specimens were available for only 120 of the 132 premenopausal patients due to conservative detorsion surgery.

Table 1
Preoperative and intraoperative findings between pre and postmenopausal women with adnexal torsion.

Characteristic	Postmenopausal (n = 25)	Premenopausal (n = 132)	p value
Demographics			
Age (years)	59.2 ± 12.1	29 ± 8.6	**<0.001**
Signs and symptoms			
Abdominal pain	18 (72%)	115 (87%)	0.054
Abdominal mass	12 (50%)	4 (3%)	**<0.001**
Peritoneal signs-rebound	4 (16%)	48 (36%)	**0.047**
Right side	12 (50%)	73 (55%)	0.501
Pelvic sensitivity	14 (58%)	80 (60%)	0.666
Fever > 38 °C	2 (8%)	11 (8%)	0.955
Nausea and vomiting	14 (58%)	80 (60%)	0.666
Ultrasound findings			
Ovarian diameter (cm)	10.65 ± 3.03	9.07 ± 4.29	0.054
Complex mass (%)	10 (40%)	54 (40%)	0.962
Absent flow on Doppler (%)	9 (60%)	62 (63%)	0.113
Laboratory findings			
WBC (cells/L)	10.4 ± 3.5	11.3 ± 3.3	0.841
CA125 (U/mL)	32.9 ± 24.9	31.4 ± 28.1	0.962
Main surgical indications			
Suspected torsion (%)	6 (24%)	73 (55%)	**<0.001**
Pelvic mass investigation (%)	14 (58%)	53 (40%)	**<0.001**
Durations			
Admission to surgery interval (hours)	39.37 ± 27.62	11.91 ± 10.39	**<0.001**
Duration of surgery (minutes)	105.83 ± 44.63	75.52 ± 32.35	**<0.001**
Post-surgical course			
Hospitalization (hours)	101.75 ± 81.06	52.81 ± 34.08	**<0.001**

Values for continuous variables are mean ± SD. Values for categorical variables are number/total number of cases (%). P value < 0.05 is considered statistically significant. Bold P values show statistically significance.
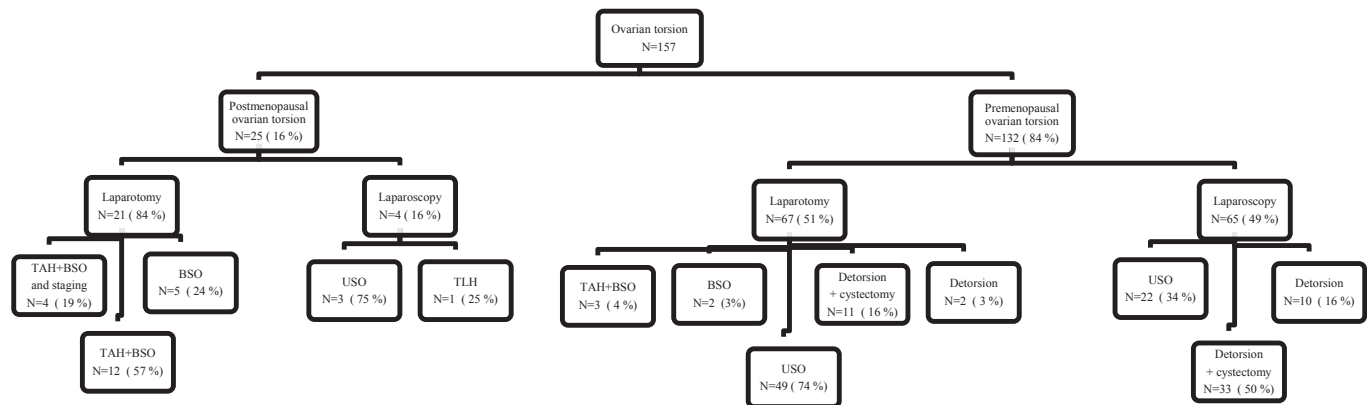
Fig. 1. Surgical procedure performed in women with adnexal torsion. TAH-total abdominal hysterectomy; BSO-bilateral salpingo-oophorectomy; USO-unilateral salpingo-oophorectomy; TLH-total laparoscopic hysterectomy.

Functional cysts were the most common pathologic finding (42%), followed by cyst adenomas (26%), and mature teratomas (20%). By contrast, in the postmenopausal group the most common pathology was cyst adenomas (48%), followed by ovarian fibromas (16%) and malignancy (16%). Finally, as expected, functional cysts were the most common pathologic finding in premenopausal women, and only 2 malignant (1.6%) and 3 borderline ovarian tumors (2.4%) were seen, as opposed to the postmenopausal group in which malignancy was diagnosed in 16% of cases (p < 0.001) (Table 2).

The characteristics of patients with adnexal torsion who are diagnosed with ovarian cancer are shown in Table 3. In the premenopausal group, malign cases were stage IA dysgerminoma and immature teratoma. In the postmenopausal group, the tumors were stage IB and IIB serous adenocarcinomas as well as stage IA endometrioid and stage IIA transitional cell carcinomas. Frozen section analyses were made in all 4 of the postmenopausal patients and only one of the premenopausal patients. All postmenopausal malign patients were staged according to their frozen section

results, and TAH + BSO + pelvic and paraaortic lymph node dissection, and omentectomy was applied. Two patients received 6 cycles of carboplatin + paclitaxel adjuvant chemotherapy according to their stages of The International Federation of Gynecology and Obstetrics. The transitional cell carcinoma patient relapsed 20 months after the surgery and received second-line chemotherapy. Two premenopausal patients had fertility sparing surgery and did not receive chemotherapy according to their stages (Table 3).

5. Discussion

Ovarian torsion is one of the most common gynecologic emergencies that needs prompt intervention, especially in premenopausal women in order to salvage the ovarian tissue for the preservation of fertility. It was the fifth most common surgical emergency, preceded by (in descending order) ectopic pregnancy, corpus luteum rupture with hemorrhage, pelvic inflammatory disease, and appendicitis. However, there is a paucity of data

Table 2
Histopathological evaluation of surgical specimens.

Characteristic	Postmenopausal (n = 25)	Premenopausal (n = 120)	p value
Mature teratoma	3 (12%)	25 (20%)	0.316
Cyst adenoma (mucinous, serous)	12 (48%)	32 (26%)	**0.032**
Functional cyst	0 (0%)	52 (42%)	**0.001**
Para-ovarian cyst	2 (8%)	7 (5.6%)	0.675
Ovarian fibroma	4 (16%)	3 (2.4%)	**0.003**
Serous borderline ovarian tumor	0 (0%)	3 (2.4%)	**0.001**
Malignancy	4 (16%)	2 (1.6%)	**0.001**

Bold P values show statistically significance.
P value < 0.05 is considered statistically significant. Values for categorical variables are number (%).

Table 3
Characteristics of all patients diagnosed with ovarian cancer.

Patient number	Age (y)	Surgical procedure	Frozen section pathology	Result of final pathology	FIGO Stage	Adjuvant therapy	Status and follow- up
#1	23	USO	Benign/Dermoid	Dysgerminoma	1A	None	NED at 60 months
#2	32	USO	None	İmmatur teratom	1A	None	NED at 48 months
#3	50	TAH + BSO Staging	Malign/Carsinoma	Serous adenocarcinoma	1B	None	NED at 24 months
#4	54	TAH + BSO Staging	Malign/Carsinoma	Transitional cell carcinoma	2A	Carboplatin/Taxol	AWD at 24 months
#5	62	TAH + BSO Staging	Malign/Carsinoma	Serous adenocarcinoma	2B	Carboplatin/Taxol	NED at 10 months
#6	77	TAH + BSO Staging	Malign/Carsinoma	Endometrioid adenocarcinoma	1A	None	NED at 12 months

TAH-total abdominal hysterectomy; BSO-bilateral salpingo-oophorectomy; USO-unilateral salpingo oophorectomy; AWD-alive with disease. NED-no evidence of disease.
FIGO - The International Federation of Gynecology and Obstetrics.

regarding the management of adnexal torsion before and after menopause. This study showed that malignant frozen section results and extensive surgery were more common in postmenopausal adnexial torsions. Furthermore, the duration of time between being admitted to the hospital and entering the operating room as well as the duration of surgery and postoperative hospitalization were statistically longer in postmenopausal adnexial torsions.

Adnexal torsion is more common in premenopausal women due to the increased frequency of benign cysts and teratomas. Since the conservation of fertility is the primary concern in premenopausal patients, and although signs and symptoms at presentation are not different from postmenopausal patients, this condition may rush surgeons into deciding to operate in order to avoid ovarian damage. In this study, we found a significant delay in surgical treatment for postmenopausal patients, which was 39.4 h on average. This delay was consistent with previous studies that reported that the operations for adnexal torsion were initiated after an average of 40–75 h [6,7].

An ultrasound is the first-line modality in imaging the ovaries due to its wide availability and cheaper cost. Its diagnostic performance is good, especially if used in combination with Doppler flow, but eventually a more precise diagnosis of adnexal torsion is often done intraoperatively [4]. In our study, preoperative ultrasonography was made used for all patients and Doppler flow was use for 112 of 157 patients. Herman et al. have reported that the complex adnexal masses were more commonly demonstrated via ultrasonography among the postmenopausal group, but in our study complex mass demonstration was same for both of the groups [6]. In other studies comparing pre and postmenopausal patients there were limitations such as the lack of Doppler imaging for all patients [6]. This is one of the limitations in our study as well, but the number of patients who had Doppler examinations (15 of 25 postmenopausal and 97 of 132 premenopausal patients) showed 60% and 63% absent flow on Doppler examinations, respectively. However, this was not statistically significant. On the other hand, because of these absent flows, the use of the resistance index for malignancy criteria was not possible. Therefore, in patients with ovarian torsion, Doppler examinations may not be useful for distinguishing between benign and malign cases.

Postmenopausal patients had more extensive surgery, both in

terms of laparotomy/laparoscopy and extensive surgery including TAH + BSO, which was performed in 68% of the postmenopausal group vs. 3% of the premenopausal group. The reasons for high rate of TAH + BSO in postmenopausal group were mostly due to patients concern about future malignancy and re-operation. In the premenopausal group, half of the patients underwent laparoscopy, and surgeries were more conservative in the laparoscopy arm compared to the laparotomy arm. Endobag was used in all cases to extirpate the cysts or andexa during laparoscopic surgery. In the laparoscopy arm the percentage of D and D + CYS was 65%, whereas it was only 19% in the laparotomy arm.

For premenopausal patients with ovarian torsion, we performed detorsion and ovarian conservation even in the case of a darkened, congested ovary. We performed salpingo-oophorectomy for patients with an obviously necrotic ovary or an ovarian mass that is suspicious for malignancy. We also performed salpingo-oophorectomy for patients who were postmenopausal.

Ovarian fixation was performed if ovarian cyst was not detected and no adnexectomy was performed during surgery. İn patients with ovarian cyst, only cystectomy was performed to reduce retorsion risk. Unilateral or bilateral oophoropexy following ovarian detorsion has also been used to prevent recurrence, although there are no high quality data regarding the efficacy of this approach [8,9]. Some experts advise this procedure be performed in every case of torsion [10,11], but others are concerned about the routine use of oophoropexy, since long-term follow-up fertility studies have not been performed [12].

In our practice, we perform oophoropexy on women with ovarian torsion who do not have an ovarian mass, but not in those with an ovarian mass present at the time of torsion. We also offer oophoropexy for women who have previously undergone surgery for prior ovarian torsion. The procedure can be performed laparoscopically and we shorten the utero-ovarian ligament. Additionally, Lo et al. and Bagci et al. have presented in their reports that laparoscopic surgery was more conservative, associated with a shorter hospitalization period and more patient satisfaction [13,14]. Cohen et al. have made a retrospective comparison of laparoscopy and laparotomy for the treatment of 102 torsions [15]. According to their study, as well as other recent literature, laparoscopy can be the first step for the definitive diagnosis and treatment of adnexal

torsions, especially in premenopausal patients [16].

We demonstrated malignancy rates of 16% among postmenopausal patients and 1.6% for premenopausal patients. In previous studies, Hermann et al. found the risk of malignancy in 3% of 33 postmenopausal patients, whereas Eitan et al. found the risk of malignancy in 22% of 27 postmenopausal patients [6,7]. In a study by Lee et al., the incidence of malignancy was 25% of 37 women with torsion and older than 60 years of age [17]. Our study is one of the biggest in the literature with regard to the number of postmenopausal patients. The difference between our study and others was the accuracy of the frozen section results: in our study, all of the four malign cases were accurately diagnosed intraoperatively by frozen section analysis. Eitan et al. stated that in their study they performed a frozen section analysis in 4 of the malign cases during surgery, but they were only able to detect malignancy one case with a specificity of 25%. Nonetheless, the staging procedure was performed in all but two cases due to the gross appearance of the ovary, which elevated clinical suspicion of malignancy [7]. In the study done by Balci et al., malignancy was suspected from the macroscopic appearance of the ovaries, and for that reason additional staging surgery was performed on 16 of the patients without any frozen section analysis. The pathologic results from four patients were consistent with malignancy, and an additional four patients had borderline ovarian tumors. Balci et al. also performed frozen section analyses for two of the postmenopausal patients; their results were benign and they did not perform staging surgery [14].

In their studies, Eitan et al. and Balci et al. stated that because of delays in treatment of menopausal patients with adnexal torsion, the ovaries became necrotic, which limited the reliability of the frozen section results [7,14]. As a result, surgeons should rely on clinical judgment in making their decisions, and decisions about the extent of staging should be made at the discretion of the operating surgeon depending on patient characteristics and the clinical situation. The surgery recommended by The *National Comprehensive Cancer Network* Guidelines® for epithelial ovarian cancer is an extensive surgery that should be performed by a gynecologic oncologist or by a surgeon who is an expert in gynecologic operations [18]. Additionally, these kinds of extensive surgery have much more serious complications than TAH + BSO. For this reason, clinical suspicion of malignancy cannot be the sole reason for performing such an extensive surgery. Further oncosurgery can also be done in a second step afterclearing the final histology, as frozen section in ovarian pathology is not always easy to interprete. In our study, all of the malign cases were detectable on the frozen section analysis. In postmenopausal patients, the average delay in the time before being admitted to the surgery room was between 39.4 and 75.5 h in the studies reviewed. Therefore, postmenopausal patients with ovarian torsion have enough time to undergo operations under elective conditions in cases when intraoperative frozen section analyses can be performed.

The major limitation of our study is the retrospective nature of the clinical data. Another limitation is that the surgeries were performed by different surgeons, and different attending physicians manage cases with varying degrees of conservativeness and aggressiveness. We attempted to minimize this effect through a uniform process of data collection for the 4 centers involved in the study. However, this method has the advantage of producing a rather large cohort in comparison to other researchs that compare pre and postmenopausal patients in terms of operation types and histological results.

6. Conclusions

In summary, adnexal torsion in postmenopausal women is an uncommon event with a unique presentation. A longer delay between presentation and surgery may be attributed to the rarity and irregularity of symptoms within this age group. Since malignancy and extensive surgery are more common in this group of patients, it seems likely that preparation for more extensive surgery should be contemplated.

Ethical approval

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Author contribution

Aykut Özcan – Study design, analysis and interpretation of data, corresponding author.
Sezcan Mumusoglu – Acquisition of data.
Mehmet Gökcü – Data analysis and writing.
Sema Süzen Caypınar - Acquisition of data.
Cengiz Sagiroglu- Acquisition of data.
Abdurrahman Hamdi Inan – Acquisition of data.
Fatih Aktöz - Interpretation of data.
Alper Biler- Article draft, concept.
Emrah Töz – Data analysis, analysis and interpretation of data.
Volkan Turan – Concept, revised article critically.
Isa Aykut Ozdemir – Revised article critically, data analysis.
Gürkan Bozdag- Revised article critically.

Conflicts of interest

None.

Guarantor

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References

[1] G.D. McWilliams, M.J. Hill, C.S. Dietrich 3rd, Gynecologic emergencies, Surg. Clin. North Am. 88 (2008) 265–283.
[2] L.T. Hibbard, Adnexal torsion, Am. J. Obstet. Gynecol. 152 (1985) 456–461.
[3] K.J. Sasaki, C.E. Miller, Adnexal torsion: review of literature, J. Minim. Invasive Gynecol. 21 (2014) 196–202.
[4] C. Wilkinson, A. Sanderson, Adnexal torsion – a multimodality imaging review, Clin. Radiol. 67 (2012) 476–483.
[5] Z. Tsafrir, J. Hasson, I. Levin, E. Solomon, J.B. Lessing, F. Azem, Adnexal torsion: cystectomy and ovarian fixation are equally important in preventing recurrence, Eur. J. Obstet. Gynecol. Reprod. Biol. 162 (2012) 203–205.
[6] G.H. Herman, A. Shalev, S. Ginath, R. Kerner, R. Keidar, J. Bar, R. Sagiv, Clinical characteristics and the risk for malignancy in postmenopausal women with adnexal torsion, Maturitas 81 (2015) 57–61.
[7] R. Eitan, N. Galoyan, B. Zuckerman, M. Shaya, O. Shen, U. Beller, The risk of malignancy in post-menopausal women presenting with adnexal torsion, Gynecol. Oncol. 106 (2007) 211–214.
[8] B. Kaleli, E. Aktan, S. Gezer, G. Kirkali, Reperfusion injury after detorsion of unilateral ovarian torsion in rabbits, Eur. J. Obstet. Gynecol. Reprod. Biol. 110 (2003) 99–101.
[9] S.E. Dolgin, Acute ovarian torsion in children, Am. J. Surg. 183 (2002) 95–96.
[10] M. Beaunoyer, J. Chapdelaine, S. Bouchard, A. Ouimet, Asynchronous bilateral ovarian torsion, J. Pediatr. Surg. 39 (2004) 746–749.
[11] M. Abeş, H. Sarihan, Oophoropexy in children with ovarian torsion, Eur. J.

Pediatr. Surg. 14 (2004) 168–171.

[12] E.R. Kokoska, M.S. Keller, T.R. Weber, Acute ovarian torsion in children, Am. J. Surg. 180 (2000) 462–465.

[13] L.M. Lo, S.D. Chang, S.G. Horng, T.Y. Yang, C.L. Lee, C.C. Liang, Laparoscopy versus laparotomy for surgical intervention of ovarian torsion, J. Obstet. Gynaecol. Res. 34 (2008) 1020–1025.

[14] O. Balci, M.S. Icen, A.S. Mahmoud, M. Capar, M.C. Colakoglu, Management and outcomes of adnexal torsion: a 5-year experience, Arch. Gynecol. Obstet. 284 (2011) 643–646.

[15] S.B. Cohen, A. Wattiez, D.S. Seidman, M. Goldenberg, D. Admon, S. Mashiach, G. Oelsner, Laparoscopy versus laparotomy for detorsion and sparing of twisted ischemic adnexa, JSLS 7 (2003) 295–299.

[16] G. Oelsner, S.B. Cohen, D. Soriano, D. Admon, S. Mashiach, H. Carp, Minimal surgery for the twisted ischaemic adnexa can preserve ovarian function, Hum. Reprod. 18 (2003) 2599–2602.

[17] R.A. Lee, J.S. Welch, Torsion of the uterine adnexa, Am. J. Obstet. Gynecol. 97 (1967) 974–977.

[18] NCCN Clinical Practice Guidelines in Oncology: Ovarian Cancer, Including Fallopian Tube and Primary Peritoneal Cancer. Version 2, 2015.