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Adnexal masses in adolescents: Clinical predictors of torsion and outcomes of fertility-sparing surgery

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ABSTRACT

Objective: Adnexal masses in adolescents present unique clinical challenges, particularly regarding fertility preservation. This study aimed to characterize the clinical profile, management, and outcomes of adolescents with surgically treated adnexal masses, with a specific focus on identifying risk factors for torsion and evaluating rates of ovarian conservation.

Materials and Methods: This retrospective cohort study included 92 adolescents (10-21 years) who underwent surgery for adnexal masses at a tertiary University Hospital between 2008 and 2018. Data on demographics, clinical presentation, imaging (IOTA classification), surgical details, and pathology were analyzed. A comparative analysis between torsion (n=29) and non-torsion (n=63) groups was performed, followed by multivariate logistic regression to identify independent predictors of torsion.

Results: The mean age was 17.3 years, and abdominal pain was the most common symptom (43.5%). Torsion occurred in 31.5% of cases. Younger age was the only independent risk factor for torsion (aOR =0.85 per year, p=0.018). Laparoscopy was the primary surgical approach (68.5%), and cystectomy was the most frequently performed procedure (68.5%). Final pathology was benign in 89.1% of cases, with cystadenofibroma (20.7%), hemorrhagic cyst (19.6%), and dermoid cyst (14.1%) being the most common. Malignancy was identified in 10.9% of cases.

Conclusion: Adnexal torsion is common in adolescents, and due to low cancer risk and advances in minimally invasive techniques, laparoscopy has become the gold standard, aligning with patient and parent preferences for less aggressive surgeries. Adnexal torsion is common in adolescents, and due to low cancer risk and advances in minimally invasive techniques, laparoscopy has become the gold standard, aligning with patient and parent preferences for less aggressive surgeries.

Keywords: Adolescents; adnexal torsion; laparoscopy; fertility-sparing

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INTRODUCTION

Ovarian masses in adolescents represent a significant clinical challenge, distinct from adult presentations in both pathology and management goals. While rare, with an estimated incidence of 2.6 cases per 100,000 girls, these lesions can profoundly impact future reproductive health and quality of life.[1,2] The predominant symptom, abdominal pain, is a common emergency department complaint, often leading to diagnostic difficulty in differentiating benign conditions from rare malignancies or surgical emergencies like ovarian torsion.[3,4]

The majority of adnexal masses in children and adolescents are benign, with malignancy present in only 4-11% of surgically excised neoplasms. Non-neoplastic lesions include functional cysts, torsion, and abscesses, while neoplasms consist of germ cell, epithelial, and other tumor types. Germ cell tumors are most common in this population, with mature teratoma being the prevalent type. Clinical symptoms often include abdominal pain, palpable masses, nausea, and hormonal changes such as menstrual irregularities. Management varies, with small benign masses treated conservatively and larger or complex ones requiring surgical intervention for diagnosis and symptom relief.[5,6]

Adnexal torsion is a serious surgical emergency that constitutes a considerable portion of surgical cases. The ovarian blood supply comes from both the ovarian and uterine arteries, and when the ovary twists, it can cause venous congestion, swelling, and a disruption in blood flow. This condition can affect females of any age but is most prevalent among women in their reproductive years. According to a 10-year review of surgical cases, ovarian torsion ranked as the fifth most frequent emergency, accounting for 2.7% of all cases. In children and adolescents, the incidence of adnexal torsion is 4.9 per 100,000 girls.[7,8]

Prompt diagnosis and intervention are crucial for preserving ovarian function, but this can be difficult since preoperative assessments often suggest a problem more than surgical findings confirm it. Pelvic ultrasound serves as the primary imaging method; however, clinical signs—especially the sudden onset of severe pain accompanied by nausea and vomiting—are critical and should take precedence over ambiguous imaging results. Given the importance of maintaining fertility and hormonal balance in younger patients, there has been a significant shift towards using minimally invasive techniques in ovarian-conserving surgical approaches.[9]

This study aimed to identify risk factors for adnexal torsion and evaluate ovarian preservation outcomes in adolescents undergoing surgery for ovarian masses, comparing torsion and non-torsion cases.

MATERIALS AND METHODS

This investigation was designed as a retrospective cohort study conducted at a King Saud University Hospital. The research covered an 11-year period from January 2008 through December 2018 and focused on female adolescents aged 10 to 21 years who underwent surgical treatment for adnexal masses. Data were gathered from patients admitted via the emergency department or through the gynecology ambulatory service, including pregnant individuals who presented with adnexal masses not related to ectopic pregnancy. Ethical approval for the study was obtained from the Institutional Review Board of King Saud University Hospital (number: 19/0068/IRB, date: 30.01.2019). All methods were carried out in accordance with relevant guidelines and regulations (Declaration of Helsinki). Informed general consent was obtained from each patient upon admission, which includes the right to use any information from the patient's file while maintaining the patient's confidentiality.

Eligibility Criteria

Eligibility criteria were strictly applied. Exclusion criteria included cases of ectopic pregnancy, Müllerian duct anomalies, autoamputated adnexa, masses not arising from gynecologic structures, biopsy-confirmed malignancies, recurrent or metastatic cancers, and disseminated cancer. The cohort consisted specifically of patients undergoing surgical management for adnexal masses, with case identification based on admission records from the obstetrics and gynecology department. Data collection drew from both electronic medical records (Cerner system) and archived paper records, popularly known as "yellow files," to ensure a comprehensive capture of relevant information.

Outcomes

Demographic data and clinical characteristics encompassed age, body mass index (BMI), presenting symptoms, imaging results (primarily ultrasound and alternative imaging modalities), and tumor marker levels. Surgical outcomes included the chosen operative approach, the origin of the mass (as determined intraoperatively versus pathology-confirmed), intraoperative complications, estimated blood loss, and procedures performed. Postoperative metrics comprised hospital stay duration, final histopathological diagnosis, and recurrence rates. Additional data points recorded to enrich the clinical portrait included the operating surgeon's subspecialty, the laterality of adnexal involvement, and any documentation of adnexal torsion, all contributing to a thorough appraisal of management and outcomes.

For imaging-based assessment, the study adhered to the International Ovarian Tumor Analysis (IOTA) classification system. This standardized sonographic framework evaluates adnexal lesions using predefined ultrasound criteria, considering features such as cyst wall characteristics, septations, presence of solid components, papillary projections, and vascular patterns as assessed by Doppler imaging. Benign versus malignant categorization relied on IOTA diagnostic rules, which integrate tumor size, echogenicity, and flow characteristics. In this adolescent cohort, ultrasound findings were consistently interpreted in line with IOTA guidelines to enable uniform risk stratification and to inform clinical decision-making regarding adnexal masses.

Statistical Analysis

Statistical methods All analyses were conducted in SPSS, version 25 (IBM Corp., Armonk, NY). Descriptive statistics are presented as means and standard deviations for continuous variables and as frequencies and percentages for categorical variables. To identify factors associated with adnexal torsion (TO vs. non-TO), univariate logistic regression analyses were first performed for candidate predictors (age, BMI, presenting symptoms, IOTA category, imaging, tumor markers, mass laterality, mass origin, and initial surgical plan). Variables with $p<0.10$ in univariate analyses were entered into a multivariate logistic regression model to obtain adjusted odds ratios (aOR) and 95% confidence intervals (CIs). For sparse cells, Fisher's exact test was used as appropriate. Model fit was assessed with the Hosmer-Lemeshow test. A two-sided p-value <0.05 was considered statistically significant. The study complied with ethical standards, with data collection commencing after formal departmental approval and consent where applicable.

RESULTS

Clinical characteristics of all girls presenting with abdominal pain and a pelvic mass are presented in Table 1. The study cohort

Table 1. Comparison of clinical characteristics between patients with and without torsion

Characteristic	TO (n=29)	Non-TO (n=63)	*P*-value
Demographics			
Mean age (years ± SD)	16.1±2.8	17.7±3.1	0.021
Mean BMI (kg/m² ± SD)	23.4±5.1	25.4±7.2	0.151
Presenting symptoms, n (%)			
Abdominal pain (isolated)	14 (48.3%)	26 (41.3%)	0.520
Abdominal pain + nausea/vomiting	8 (27.6%)	15 (23.8%)	0.694
Incidental finding	2 (6.9%)	9 (14.3%)	0.288[1]
Preoperative assessment, n (%)			
IOTA: Benign	17 (58.6%)	35 (55.6%)	0.782
IOTA: Malignant	3 (10.3%)	6 (9.5%)	0.900[1]
Other imaging (CT/MRI) performed	20 (69.0%)	43 (68.3%)	0.943
Tumor markers elevated	2 (6.9%)	5 (7.9%)	0.847[1]
Surgical & pathological factors			
Mass laterality, n (%)			
- Right	15 (51.7%)	30 (47.6%)	0.705
- Left	12 (41.4%)	27 (42.9%)	0.892
- Bilateral	2 (6.9%)	6 (9.5%)	0.643[1]
Mass origin: Ovarian, n (%)	25 (86.2%)	53 (84.1%)	0.794
Procedure performed, n (%)			
- Cystectomy	20 (69.0%)	43 (68.3%)	0.943
- Salpingo-oophorectomy	2 (6.9%)	5 (7.9%)	0.847[1]
- Salpingectomy	1 (3.4%)	3 (4.8%)	0.738[1]
Final pathology: Benign, n (%)	26 (89.7%)	55 (87.3%)	0.744

[1]: *P*-value calculated using Fisher's exact test due to expected cell counts <5. Statistically significant ($p<0.05$); SD: standard deviation; BMI: body mass index; TO: torsion; CT: computed tomography; MRI: magnetic resonance imaging; IOTA: International ovarian tumor analysis

comprised 92 adolescent females with a mean age of 17.25 years (±3.04) and a mean BMI of 24.92 kg/m² (±6.86). Abdominal pain was the most common presenting symptom (43.5%, n=40), frequently accompanied by nausea/vomiting (n=23). Other presentations included combined symptoms such as pressure symptoms with nausea/vomiting (n=3) and amenorrhea with vomiting (n=1), alongside incidental findings (n=11), isolated pressure symptoms (n=5), and abnormal uterine bleeding (n=4). Preoperative ultrasound (IOTA classification) indicated benign masses in 56.5% of cases (n=52) and malignant in 9.8% (n=9). Additional imaging computed tomography/magnetic resonance imaging was utilized in 68.5% of patients (n=63), with 40.2% (n=37) exhibiting normal imaging findings. Tumor markers were elevated in a minority, specifically HCG and CA125 in 2.2% (n=2), LDH and CA125 in 1.1% (n=1), and AFP and CA125 in 4.3% (n=4).

Surgical procedure for patients and pathology review is presented in Table 2. Surgical management was primarily laparoscopic (68.5%, n=63). Intraoperatively, masses were of ovarian origin in 84.8% (n=78), with paratubal (12.0%, n=11) and paraovarian (3.3%, n=3) sources less common. Fertility-sparing cystectomy was the most frequent procedure (68.5%, n=63). Other interventions included conservative surgery (10.9%, n=10), salpingo-oophorectomy (7.6%, n=7), salpingectomy (4.3%, n=4), cyst aspiration (3.3%, n=3), partial oophorectomy (3.3%, n=3), and oophorectomy (2.2%, n=2). Final pathology was predominantly benign (89.1%), with common diagnoses being cystadenofibroma (20.7%, n=19), hemorrhagic cyst (19.6%, n=18), and dermoid cyst (14.1%, n=13). Malignant pathology (10.9%, n=10) included dysgerminoma (n=2), mixed germ cell tumor (n=2), and single cases of immature teratoma, mucinous adenocarcinoma, granulosa cell tumor, Sertoli cell tumor, pure yolk sac tumor, and a sex cord tumor. For confirmed malignancies, management involved comprehensive surgical staging (including lymph node sampling and peritoneal cytology), multidisciplinary tumor board review, and adjuvant chemotherapy for advanced-stage disease. Recurrence was rare (4.35%, n=4).

Table 2. Surgical method for patients with and without adnexal torsion

Procedure and pathology	TO (n=29)	non-TO (n=63)
Adnexectomy	3	11
· Cystadenofibroma	1	3
· Hemorrhagic cyst	1	2
· Malignant (dysgerminoma, mixed GCT, granulosa)	1	4
· Other (e.g., complex benign)	0	2
Cystectomy	20	43
· Cystadenofibroma	6	13
· Hemorrhagic cyst	6	12
· Dermoid cyst	4	9
Mucinous cystadenoma	2	5
· Paratubal cyst	2	4
Salpingectomy	1	4
· Paratubal cyst	1	4
Conservative surgery	3	10
· Hemorrhagic cyst	2	5
· Endometrioma	1	3
· Other benign	0	2
Cyst aspiration	1	3
· Simple cyst	1	3
Partial oophorectomy	1	2
· Cystadenofibroma	1	2
Oophorectomy	0	2
· Benign pathology	0	2

GCT: giant cell tumor; TO: torsion

Clinical Characteristics Comparing Patients with Torsion and Those with An Alternate Diagnosis

The cohort was divided into two groups: Those with surgically confirmed torsion (TO, n=29) and those without (non-TO, n=63). Comparative analysis revealed that patients in the TO group were significantly younger (16.1±2.8 vs. 17.7±3.1 years, p=0.021). The prevalence of symptoms, including abdominal pain with nausea/vomiting (27.6% vs. 23.8%), and the use of additional imaging (69.0% vs. 68.3%) were similar between groups. Incidental discovery was less common in the TO group (6.9% vs. 14.3%), though not statistically significant. Surgical management emphasized cystectomy in both groups (69.0% vs. 68.3%), with no significant differences in the rates of more radical procedures or final benign pathology (89.7% vs. 87.3%) (Table 1).

The multivariate logistic regression analysis revealed that younger age significantly increases the risk of adnexal torsion. Specifically, for each additional year in age, the odds of torsion decrease by about 15% (aOR =0.85, 95% CI: 0.74-0.97, p=0.018), indicating higher risk in younger adolescents. Other factors, such as BMI and incidental mass discovery, did not significantly predict torsion after adjusting for age. Additionally, there was no significant association found between nausea and vomiting, pain, or malignant IOTA classification in the univariate analysis Table 3.

Table 3. Univariate and multivariate logistic regression analysis of factors associated with adnexal torsion

Factor	Univariate analysis		Multivariate analysis	
	OR	*P*-value	aOR	*P*-value
Age (per year)	0.86 (0.75-0.98)	0.021	0.85 (0.74-0.97)	0.018
BMI (per kg/m²)	0.95 (0.88-1.02)	0.155	0.95 (0.88-1.02)	0.173
Incidental finding	0.45 (0.09-2.17)	0.317	0.42 (0.08-2.12)	0.293
Abdominal pain + N/V	1.22 (0.46-3.21)	0.694	-	-
IOTA: Malignant	1.10 (0.26-4.68)	0.900	-	-

OR: odds ratio; CI: confidence interval; N/V: nausea/vomiting; aOR: adjusted odds ratio; BMI: body mass index; IOTA: International ovarian tumor analysis

DISCUSSION

Our Results and Their Interpretation

Our examination of 92 teenagers with adnexal masses reveals a clinical profile highlighting the significance of abdominal pain as a key symptom for surgical assessment, with an average age of 17.3 years. Laparoscopic surgery was frequently employed (68.5%), with a strong preference for fertility-sparing cystectomy, demonstrating effective conservative surgical techniques. Pathological findings are promising, showing 89.1% benign conditions and a low recurrence rate of 4.35%, which supports this organ-preserving strategy. Furthermore, the organized management of malignant cases, including tumor board assessments and personalized adjuvant treatment, reflects a thorough and standardized care approach at our facility.

The comparative study of the torsion (TO, n=29) and non-torsion (non-TO, n=63) groups reveals a significant finding: individuals with torsion are notably younger, with an average age difference of 1.6 years, which is clinically relevant in adolescents. Other factors, such as symptoms, preoperative imaging, and tumor marker levels, were remarkably similar between the groups, making it challenging to differentiate torsed from non-torsed masses before surgery. Additionally, high rates of cystectomy in both groups suggest that torsion did not increase the likelihood of radical surgery, highlighting a notable achievement in clinical practice.

The multivariate logistic regression analysis revealed that younger age significantly increases the risk of adnexal torsion. Specifically, for each additional year in age, the odds of torsion decrease by about 15% (aOR =0.85, 95% CI: 0.74-0.97, p=0.018), indicating higher risk in younger adolescents. Other factors, such as BMI and incidental mass discovery, did not significantly predict torsion after adjusting for age. Additionally, there was no significant association found between nausea and vomiting, pain, or malignant IOTA classification in the univariate analysis.

Comparison of Our Results to Similar Studies

Our study and Liu et al.'s[10] study share fundamental methodological similarities as retrospective cohort analyses of adolescent adnexal masses using multivariate logistic regression, yet reveal distinctly different torsion risk profiles. While we identified younger age as the sole significant predictor of torsion (mean 16.1 vs. 17.7 years in non-torsion, p=0.021), Liu et al.[10] demonstrated that clinical presentation characteristics—specifically acute onset pain (OR: 15.9), persistent/recurrent pain (OR: 24.2), and mass size >5 cm (OR: 4.1)—were the predominant risk factors. This contrast suggests potential population-specific differences or varying clinical assessment protocols. Methodologically, Liu et al.'s[10] larger sample (212 vs. our 92 patients) enabled more detailed pain characterization and identified a higher torsion prevalence (36.9% vs. 31.5%), while both studies maintained rigorous statistical approaches. Notably, Liu et al.'s[10] reported significantly lower ovarian conservation rates in torsion cases (66.7% vs. our 89.7%), which they attributed to necrotic changes requiring adnexectomy in 29.5% of torsion cases—a factor not specifically analyzed in our study. Both investigations confirmed the predominance of benign pathology and right-sided laterality in torsion cases, but diverged on mass size significance; Liu et al.'s[10] found categorical size >5 cm predictive, while we found no continuous size difference. These comparative findings suggest that torsion risk assessment should incorporate both demographic factors (age) and clinical presentation patterns, providing complementary rather than contradictory evidence for clinical decision-making.

Bergeron et al.'s[11] study did not specifically analyze adnexal torsion as a primary outcome, focusing instead on surgical specialty differences and general mass management. Our study provided dedicated torsion analysis, revealing that younger age was the sole significant predictor of torsion (16.1 vs. 17.7 years, p=0.021), while Bergeron's data showed gynecologists managed more torsion cases (24 vs. 35 by surgeons) without analyzing torsion-specific risk factors. Both studies found similar

high rates of benign pathology in torsion cases (89.7% in our study), but only our research conducted multivariate regression specifically for torsion prediction. Bergeron's work highlighted that emergent procedures—often including torsion cases—were associated with higher ovarian conservation rates, which aligns with our finding that cystectomy was equally common in both torsion and non-torsion groups (69%).

Luthra and Kumar's[12] study and our research both analyzed adolescent adnexal masses but differed significantly in methodology and demographics. Their 20-year series featured younger patients (median age 11 years) and included cases involving neonates, while our focus was solely on adolescents with a mean age of 17.25 years. Both studies reported high torsion rates (66.7% in Luthra vs. 31.5% in ours), but Luthra and Kumar's[12] had lower ovarian conservation (66.7% vs. our 89.7%), attributed to gangrenous cases requiring adnexectomy. Our larger sample (92 vs. 28) and multivariate regression provided stronger evidence for age as a torsion predictor. While both studies confirmed right-sided predominance and benign pathology, Luthra and Kumar's[12] reported higher malignancy rates (3.7% vs. 10.9%) and unique complications, highlighting the importance of fertility preservation.

Clinical Implications of Our Study

Our study highlights younger age as a key risk factor for adnexal mass torsion, emphasizing the need for early suspicion and intervention in patients under 16. With a 68.5% success rate for laparoscopic, fertility-sparing approaches, conservative surgical management is often warranted, even in torsion cases. The findings of consistent benign pathology (89.1%) and low recurrence (4.35%) advocate for age-aware triage and ovarian conservation through timely intervention in younger adolescents.

The strengths of our study include the use of robust multivariate regression analysis that identifies age as the key predictor of torsion, the application of standardized IOTA classification for imaging evaluations, thorough tracking of surgical and pathological outcomes, and careful statistical analysis. This was done within a clearly defined group of adolescents with specific exclusion criteria, ensuring our findings are focused and clinically relevant for this particular demographic.

Study Limitations

However, the limitations of our study include its retrospective, single-center design, which may impact the generalizability of our findings. The relatively small sample size (n=92) affects the statistical power regarding rare outcomes. There is also a possibility of selection bias due to hospital-based sampling, along with unmeasured confounding factors that might affect our results. Additionally, the absence of long-term follow-up data hinders our ability to evaluate fertility outcomes and patterns of late recurrence.

Recommendation for Future Research

In the future, research should focus on larger, multicenter studies to better understand how age can predict ovarian torsion in various populations. Long-term follow-ups will be crucial to evaluating fertility outcomes and recurrence rates after conservative surgery. Additionally, using advanced imaging techniques and molecular profiling could greatly improve our ability to assess risks before surgery. Conducting comparative studies on different surgical methods and their effects on ovarian function would be valuable for creating evidence-based approaches to preserving fertility in adolescents dealing with adnexal masses.

CONCLUSION

Adnexal torsion is common in adolescents, and due to low cancer risk and advances in minimally invasive techniques, laparoscopy has become the gold standard, aligning with patient and parent preferences for less aggressive surgeries. Adnexal torsion is common in adolescents, and due to low cancer risk and advances in minimally invasive techniques, laparoscopy has become the gold standard, aligning with patient and parent preferences for less aggressive surgeries.

ETHICS

Ethics Committee Approval: Ethical approval for the study was obtained from the Institutional Review Board of King Saud University Medical City (number: 19/0068/IRB, date: 30.01.2019).

Informed Consent: After explaining the procedure, all participants gave informed consent. We confirm that all methods were performed according to the relevant guidelines and regulations, per the Declaration of Helsinki.

FOOTNOTES

Contributions

Surgical and Medical Practices: K.A., E.A., G.A-S., H.A., A.K., A.B., M.B., M.A., Concept: K.A., E.A., Design: K.A., E.A., A.G., Data Collection or Processing: M.M.A., L.A., N.A., A.G., A.B., Analysis or Interpretation: A.S.A., M.E., N.A., Literature Search: A.S.A., M.E., Writing: A.S.A., M.E.

DISCLOSURES

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