Original Study

The Relationship between Intraoperative Rupture and Recurrence of Pediatric Ovarian Neoplasms: Preliminary Observations

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A B S T R A C T

Study Objective: We investigated whether rupture increased the recurrence rate of pediatric ovarian neoplasms.
Design: 20-year single-institution retrospective study.
Setting: Tertiary, free-standing, university children's hospital.
Participants: All girls with ovarian neoplasms treated during between 1991 and 2011.
Main Outcome Measure: Tumor recurrence.
Results: Fifty-nine tumors in 53 patients were managed, including 51/59 (86%) benign and 8/59 (14%) malignant. Laparotomy was employed in 44/59 (75%), laparoscopy in 8/59 (14%), and laparoscopy converted to laparotomy in 7/59 (12%). Total and partial oophorectomy (cystectomy) was used for 15/51 (29%) and 36/51 (71%) of benign tumors, respectively. All malignant tumors underwent total oophorectomy. Accidental rupture or intentional tumor puncture occurred in 26/56 cases (46%), 23/51 benign and 3/5 malignant. Rupture was associated with increasing cyst size on univariate and multivariate analyses ($p = 0.002$ and $p = 0.004$, respectively). There were 5 recurrences (9%) in 4 patients, including 4 benign (3 mature teratomas, 1 mucinous cystadenoma), and 1 malignant yolk sac tumor. Recurrence occurred in 2/30 (7%) without rupture and 3/26 (12%) with rupture, $p = 0.66$. Follow-up was available for 50/53 patients (94%), with a median of 23.8 months [range 0.2-189 months]. All recurrences were salvaged by surgery.
Conclusions: In this limited study, intra-operative rupture did not increase the recurrence rate or worsen the prognosis of pediatric ovarian neoplasms.
Key Words: Pediatric, Adolescent, Ovarian tumors, Rupture, Recurrence, Outcomes

Introduction

Ovarian lesions are not uncommon in childhood. Approximately half of these lesions are neoplastic. The best estimate of malignancy rate among neoplastic lesions is approximately 10%, representing 1% of childhood cancers.[1,2] This low malignancy rate has spurred a move toward minimally invasive resection of pediatric ovarian masses, and an increasing trend toward ovarian preservation, over the past 2 decades.[2–9] However, concerns remain regarding the potential effects of intraoperative rupture on outcomes. These concerns, which are not limited to malignant lesions, include recurrence, upstaging of malignant tumors, chemical peritonitis, and adhesions that might affect future fertility.[1,4,7,10] Although the Children's Oncology Group no longer dictates adult staging protocols for ovarian neoplasms, oncologic resections are still recommended.[1]

There are very few data at the present time to support or discourage surgical procedures, either laparoscopic or open, which might entail intentional or unintentional rupture during resection of pediatric ovarian masses. Our main goal in conducting this study was to investigate the effect of rupture on outcomes of pediatric ovarian lesions. A secondary goal was to examine the factors associated with a greater chance of rupture.

Materials and Methods

A retrospective review of all pediatric ovarian neoplasms treated at The Montreal Children's Hospital of the McGill University Health Centre, during a 20-year period (October, 1991-September 2011), was conducted. The hospital is 1 of 2 pediatric tertiary referral centers that serves a population of approximately 3.5 million. To capture all girls with neoplastic ovarian lesions, the search started with all patients coded for adnexal procedures. All data for patients who had undergone ovarian biopsies or resections were extracted, and patients with neoplastic pathology were selected for inclusion in the study. One patient, who presented with advanced choriocarcinoma, had a very complex course. Her details are reported in the results section, but were not included in the analysis of recurrence or intra-operative rupture.

Patient demographic characteristics, biochemical markers, imaging results, tumor characteristics, surgical management, oncologic management, pathology results, and outcomes were evaluated. Biomarkers evaluated included β-human chorionic gonadotropin (hCG), alfa-feto protein (AFP), cancer antigen 125, carcinoma antigen 19-9, and carcinoembryonic antigen, when available for individual cases.

Evidence of preoperative or intraoperative rupture was carefully retrieved from each patient's medical record. Preoperative rupture was determined to have occurred if

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suggested on preoperative imaging and confirmed intraoperatively. Intraoperative rupture was determined to have occurred if: (1) the surgical report mentioned spill, tumor rupture, or tumor violation during the surgery; (2) cyst aspiration occurred intra-abdominally to decompress the tumor despite no mention of spill in the surgical report; or (3) both. Endobags are routinely used in our institution during laparoscopic cases. Intact specimens decompressed or removed in pieces within an endobag were not considered ruptured.

In addition to the index hospitalization, all subsequent outpatient follow-up notes, laboratory tests, imaging studies, hospitalizations, and tumor board discussion reports were reviewed. These were used to determine if recurrence or other complications occurred.

The primary outcome was recurrence. The independent binary variable was intraoperative rupture. Confounders included the following 3 categorical variables: pathology (benign vs malignant), biomarkers (normal vs increased level), and resection (cystectomy vs oophorectomy).

The secondary outcome was intraoperative rupture. Independent variables consisted of maximum tumor diameter (cm) and approach (laparoscopy vs laparotomy).

Other outcomes analyzed were tumor upstaging, and readmissions for peritonitis or bowel obstruction. Data were not available to assess fertility.

Because the primary goal of the study was to analyze the determinants and outcomes of intraoperative rupture, each surgical intervention was analyzed as a separate event when it occurred in the same patient.

For analyses, χ^2, Fisher exact test, independent sample *t* test, and univariate and multivariate binary logistic regression were performed. All hypotheses tests were 2-sided and considered significant if $P < .05$.

The study was approved by the Pediatric Research Ethics Board of the McGill University Health Centre (12-215-PED).

Results

Study Cohort

Fifty-three patients were treated for 59 tumors during the study period. These included 51 benign lesions (86.4%) and 8 malignant ones (13.6%), with a mean diameter of 14.1 cm. Details of the study cohort are shown in Table 1. Preoperative biomarker levels were increased in 13/53 cases (23%), with individual marker levels shown in Table 1. Ultrasound (US) was the most common method of diagnosis used in 56/59 cases (95%). Preoperative computed tomography (CT) and magnetic resonance imaging were used in 26/57 (44.1%) and 2/58 (3.4%) cases, respectively.

Fifteen of fifty one (28.8%) benign tumors were resected using total oophorectomy; the rest (36/51) were removed using cystectomy. All malignant tumors were removed by at least total oophorectomy. Two patients with malignant germ cell tumors initially underwent surgical staging procedures. Of the benign tumors, 45/51 (88.2%) were removed using laparotomy and 6/51 (11.8%) using laparoscopy. Six of eight (75%) malignant tumors were removed using laparotomy, and 2/8 (25%) using laparoscopy. Details regarding the histopathology of the tumors are reported in Table 2.

Table 1
Details of 59 Ovarian Neoplasms

Characteristic	Total
Patient age at time of surgery, years	
Mean (SD)	13.6 (3.31)
Range	1.53-18.05
Preoperative increased biomarker levels	
AFP	2/49 (4)
β-hCG	3/50 (6)
CA-125	7/17 (41)
CA 19-9	1/1 (100)
Approach	
Laparotomy*	51/59 (86.5)
Laparoscopy	8/59 (13.6)
Type of surgery	
Oophorectomy	21/59 (35.6)
Cystectomy	36/59 (61)
Other resection†	2/59 (3.4)
Ovary	
Unilateral	55/58 (93.2)
Bilateral	3/58 (5.1)
Preoperative rupture	
No	58/59 (98.8)
Yes	1/59 (1.2)
Intraoperative rupture	
No	30/56 (54)
Yes	26/56 (46)
Pathology	
Malignant	8/59 (13.6)
Benign	51/59 (86.4)
Maximum tumor diameter, cm	
Mean (SD)	14.1 (9.97)
Range	1.5-40
Recurrence**	5/56 (9)

AFP, alfa-feto protein; CA, cancer antigen; hCG, human chorionic gonadotropin.
Data are presented as n (%), except where otherwise stated.
* Includes 7 cases of conversion from laparoscopy to laparotomy.
† Both surgeries occurred in the same patient with advanced choricarcinoma. One was a staging laparotomy without resection, and the other was laparotomy for resection of a presumed recurrence.
** Does not include patient with advanced choriocarcinoma at presentation, whose course is outlined in the text.

Follow-up was available for 50/53 patients (94%), with a median follow-up of 23.8 months (range, 0.2-188.9 months). There were no admissions for postoperative granulomatous peritonitis or symptomatic adhesions during the follow-up period.

Determinants of Recurrence

There was no intraoperative rupture in 30/56 cases (54%), and accidental rupture or intentional intra-abdominal

Table 2
Histopathology of Ovarian Neoplasms

Benign		Malignant	
Germ cell tumor			
Mature teratoma	31 (52.5%)	Choriocarcinoma*	3 (5.1%)
		Yolk sac tumor	1 (1.7%)
		Gonadoblastoma	1 (1.7%)
		Immature teratoma	1 (1.7%)
		Immature and mature teratoma	1 (1.7%)
Sex cord stromal tumor			
Follicular cyst	1 (1.7%)	Steriod cell tumor not otherwise specified	1 (1.7%)
Surface epithelial			
Mucinous cystadenoma	10 (16.9%)		
Serous cystadenoma	5 (8.5%)		
Adenofibroma	4 (6.8%)		

Data are presented as n (%).
* Three procedures in the same patient.