Original Study

Preoperative Risk Stratification of Adnexal Masses: Can We Predict the Optimal Surgical Management?

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A B S T R A C T

Study Objective: To characterize preoperative risk stratification with aim of identifying the accurate surgical approach of benign and malignant adnexal masses in pediatric patients.
Design: A retrospective chart review of all cases of adnexal masses surgically managed between January 2001 and December 2006.
Setting: The Hospital for Sick Children, Toronto, Canada.
Participants: 129 cases of 126 pediatric and adolescent patients who underwent operative management of their adnexal masses.
Main Outcome Measures: Ultrasonographic characteristics (cyst size and character), surgical approach (laparoscopy vs laparotomy) and method of cyst removal (cystectomy vs oophorectomy). Data was assessed with a Fisher Exact test where appropriate ($P < .05$).
Results: Malignancies were more frequently treated by laparotomy (n = 14, 98.6%, $P < .001$), and benign cases by laparoscopy (n = 78, 97%, $P < .001$). On ultrasonography, malignant masses were more often complex (n = 16, 100%, $P = .006$) and ≥8 cm (n = 16, 100%, $P < .001$) than benign masses (≥8 cm n = 60, 53%, complex n = 76, 67%). Combining ultrasonographic measurements of ≥8 cm and complexity identified 100% of malignant masses (n = 16) and 36% of benign masses (n = 41, $P < .001$, PPV = 37.1, NPV = 100%). Additional imaging including CT/MRI was ordered by pediatric surgeons (n = 17, 77%) more often than pediatric gynecologists (n = 44, 41%, $P = .002$). Furthermore, pediatric surgeons managed adnexal masses by oophorectomy (n = 12, 55%) more often as compared to pediatric gynecologists (n = 19, 18%, $P < .001$).
Conclusion: Using preoperative characteristics of complexity and ≥8 cm reduces the number of benign masses treated with laparotomy while ensuring malignant masses are managed with an open approach.
Key Words: Adnexal mass, Benign, Malignant, Laparoscopy, Laparotomy

Introduction

Malignancies of the ovary are relatively rare in the pediatric population accounting for approximately 1% of all pediatric malignancies.[1,2] Given the high proportion of benign adnexal disease, there is an opportunity to minimize the number of open procedures used in managing adnexal masses.[3–5] Generally, laparotomy is the preferred surgical method for malignant disease, and most benign pathology can be approached in a minimally invasive manner.

In order to choose the optimal surgical approach, children and adolescents with adnexal masses should be preoperatively stratified as either likely benign or malignant.[6,7] The existence of a precise marker to stratify pediatric patients preoperatively remains contentious. Differentiating benign and malignant cases is complex, and often the presentations of these 2 groups are quite similar preoperatively.[5,7–9] In a recent study, Oltmann et al[7] underlined criteria that could define benign versus malignant cases based on imaging and mass size. The objective of our study was to review the cases of all adnexal masses treated at the Hospital for Sick Children in Toronto according to these criteria and identify if adhering to these markers can translate into an optimum operative approach to benign versus malignant adnexal masses.

Methods

Between January 2001 and December 2006, 126 pediatric and adolescent patients underwent 129 procedures either laparoscopically or open (laparotomy) for the management of their adnexal masses at the Hospital for Sick Children in Toronto. All patients were under 18 years of age at the time of their surgery. With approval from the Research Ethics Board, a retrospective chart review of these patients was undertaken. Demographic, clinical, radiologic, biochemical, and pathologic data were collected. Variables such as histology, tumor size, radiographic appearance, elevation in tumor markers, tumor spillage rate, length of stay and age were assessed. Data was statistically assessed with either a Student t-test, chi-square analysis, or Fisher exact test to compare the 2 cohorts where appropriate. Statistical significance was at $P < .05$.

Results

A total of 126 patients' charts undergoing 129 operations for adnexal masses treated by pediatric surgery or adolescent

The authors indicate no conflicts of interest.

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1083-3188/$ - see front matter
http://dx.doi.org/10.1016/j.jpag.2013.09.003

Table 1
Demographics of Laparoscopic Versus Laparotomy Management for Adnexal Masses

	Laparoscopy	Laparotomy	*P*
No. of Cases	80 (62%)	49 (38%)	
Age (y)			
mean ± SEM	12.1 ± 4.2	12.5 ± 3.8	.53
Size by imaging (cm)			
mean ± SEM	8.3 ± 5	14.8 ± 7	<.001
Malignancy	2 (3%)	14 (29%)	<.001
Staged completed*	0 (0%)	11 (79%)	.08
Borderline tumor	0 (0%)	5 (36%)	1
Immature teratoma	1 (50%)	3 (21%)	.45
Mixed germ cell tumor	0 (0%)	2 (14%)	1
Juvenile granulose cell	1 (50%)	1 (7%)	.24
Dysgerminoma	0 (0%)	1 (7%)	1
Yolk sac tumor	0 (0%)	1 (7%)	1
Embryonal	0 (0%)	1 (7%)	1
Benign	78 (97%)	35 (71%)	<.001
Simple cyst	42 (54%)	10 (29%)	.02
Mature teratoma	26 (33%)	15 (43%)	.4
Cystadenoma	9 (12%)	10 (29%)	.03
Endometriod	1 (1%)	0 (0%)	1

* Indicates staging completed at the first surgical intervention after an adnexal mass was detected.

gynecology at the Hospital for Sick Children in Toronto from 2001-2006 were reviewed. Some relevant and important data of children and adolescents undergoing surgery by gynecology between 2003 and 2006 from a previous publication on the management of adnexal masses were included in this study (n = 67, 52%).[5] A description of the masses evaluated in this current paper can be found in Table 1.

Comparing the cohort of patients that received either laparoscopy or an open procedure for removal of their adnexal mass revealed the following trends. There was no significant difference in patient age between laparoscopy (12.1 ± 4.2 y) and laparotomy (12.5 ± 3.8 y). Masses treated with an open approach were larger on preoperative imaging (14.8 cm ± 7.0) compared to masses treated with laparoscopy (8.3 cm ± 5, $P < .001$). Malignancies were more frequently managed with an open approach (n = 14, 28%) while only 2 were managed with laparoscopy (2.5%, $P < .001$). Conversely, 78 benign masses were managed with laparoscopy (97%) and only 35 were managed with laparotomy (71%, $P < .001$). Of the malignant masses, none of the cases undergoing laparoscopy at their first surgery received formal staging, while 11 undergoing laparotomy (78.5%, $P = .08$) were formally staged according to the children's oncology group (COG) germ cell tumor staging criteria.[10,11] The stages of malignant tumors ranged from stage 1 to 3. The unstaged cases went on to be surgically managed at another site. Simple cysts were managed by minimally invasive laparoscopy in 54% of our cases (n = 42) and laparotomy in 29% (n = 10, $P = .02$), and cystadenomas were managed by laparoscopy in 12% of our cases (n = 9) and 29% of laparotomy (n = 10, $P = .3$) while there was no significant difference in the surgical treatment of other specific benign and malignant tumors (Table 1).

Comparison of benign and malignant pathology according to their preoperative clinical presentation on pain, age, mass complexity and size is underscored in Table 2. There was no significant difference between the 2 pathologic groups in terms of presentation with pain in benign (n = 83, 73%) or malignant cases (n = 12, 75%, $P = 1$). Furthermore,

Table 2
Preoperative Positive and Negative Predictive Value for Malignancy

	Benign	Malignant	*P*	PPV	NPV
No. of Cases	113 (87%)	16 (12%)			
Pain	83 (73%)	12 (75%)	1	4.6%	72.2%
≤8 years old	17 (15%)	5 (31%)	.11	39.7%	95.2%
Abnormal Markers	9/49 (18%)	9/16 (56%)	.003	17.1%	94.4%
Lactate dehydrogenase (LDH)	7/9 (77%)	4/9 (44%)	.34	15.9%	56.2%
beta-human chorionic gonadotriopin (βHCG)	0/9 (0%)	2/9 (22%)	.47	98.6%	79.7%
Alpha-fetoprotein (AFP)	2/9 (22%)	6/9 (66%)	.15	50%	87.8%
cancer antigen 125 (CA-125)	1/9 (11%)	2/9 (22%)	1	41.8%	78%
Complex*	76 (67%)	16 (100%)	.006	15.5%	100%
≥8 cm*	60 (53%)	16 (100%)	<.001	21.1%	100%
≥10 cm*	34 (30%)	9 (56%)	.04	17.1%	89.8%
≥8 cm + Complex*	41 (36%)	16 (100%)	<.001	37.1%	100%

* As measured by ultrasound preoperatively.

there was no significant difference between benign (n = 17, 15%) or malignant (n = 5, 31%) masses in patients ≤8 years old ($P = .11$). When ordered preoperatively, abnormal tumor markers (LDH, βHCG, AFP, CA-125) were present in 56% of malignant cases (n = 9) and in only 18% of benign cases (n = 9, $P = .003$). Abnormal markers were able to discriminate malignant masses with a high negative predictive value (NPV) of 94.4% and a poor positive predictive value (PPV) of 17.1%. No individual tumor markers were significantly different between benign or malignant masses. Furthermore, the predictive value of each of these markers independently was low.

All 16 malignant masses (100%) were identified as complex on ultrasonography while only 67% (n = 76) of benign masses were complex ($P = .006$) with a PPV of 15.48%. Significantly more malignant masses (n = 16, 100%) compared to benign masses (n = 60, 53%) were ≥8 cm in size on ultrasonography ($P < .001$). Fewer malignant masses were ≥10 cm in size (n = 9, 56%). There were significantly more malignant masses ≥10 cm than benign masses (n = 34, 30%, $P = .04$). Using ≥10 cm on ultrasonography as a measure to predict malignancy preoperatively has a lower negative predictive value (NPV = 89.78%) compared to a cut off of ≥8 cm (NPV = 100%). Preoperatively combining the ultrasonographic measures of ≥8 cm size and complexity identified 100% of the malignancies (n = 16), while only 36% of benign masses (n = 41) were both ≥8 cm size and complex ($P < .001$). As a predictor of malignancy, combining both ≥8 cm size and complex resulted in a PPV of 37.1% and a NPV of 100%.

Retrospectively applying these thresholds to our cohort would influence the surgical approach of many of the 129 adnexal masses treated. Between 2001 and 2006, a total of 35 benign cases were surgically managed by an open procedure. If we stratify these cases preoperatively using the criteria of ≥8 cm cyst size alone, it would have reduced the number of open procedures in benign cases from 35 to 28 (20% reduction). Similarly, using mass complexity alone would have reduced the number of open procedures in benign cases from 35 to 28 (20% reduction). Combining the 2 criteria together would have reduced the number of benign cases treated with open procedures from 35 to 21 (40% reduction). The combined criteria of ≥8 cm mass size