RESEARCH ARTICLE

Predictors of Oophorectomy in Girls Hospitalized in Texas With Ovarian Torsion

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ABSTRACT

OBJECTIVES: Inconsistent results have been reported by authors of studies of the management of pediatric patients with ovarian torsion (OT). Our objective was to identify predictors of oophorectomy in girls hospitalized throughout Texas with OT.

METHODS: The Texas Public Use Data File (years 2013–2014) was queried for the records of girls under the age of 18 years who had a principal or secondary discharge diagnosis of OT (*International Classification of Diseases, Ninth Revision, Clinical Modification* code 620.5). Adjusted odds ratios were estimated from a logistic regression model by using Firth's bias-reducing penalized likelihood. Variables for inclusion in the final model were identified by using a directed acyclic graph.

RESULTS: A sample of 158 girls was identified with an overall risk of oophorectomy during the hospital stay of 41.1% (65 out of 158). After adjusting for the patient's age, health insurance status, and the presence of an ovarian cyst, girls who were treated at a nonteaching hospital were more than twice as likely to undergo oophorectomy than girls who were treated at a teaching hospital (odds ratio = 2.22; 95% confidence interval: 1.05–4.69).

CONCLUSIONS: Our analysis of a statewide database revealed that girls with OT who presented at nonteaching hospitals were significantly more likely to undergo oophorectomy compared with girls who presented at teaching hospitals.

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Ovarian torsion (OT) is a rare cause of abdominal pain in the pediatric population as only 2.7% of patients who present to emergency departments with abdominal pain are confirmed to have OT.[1] However, OT requires immediate diagnosis and urgent surgical treatment.[2–4] OT is usually caused by an ovarian enlargement such as functional or dermoid ovarian cyst or developmental abnormality of the adnexa, but this is not always the case.[5,6] A swift diagnosis is necessary because torsion obstructs venous flow and lymphatic drainage.[2] As blood supply to the ovary is decreased, ischemia can progress to tissue necrosis and infection.[2]

The surgical management of OT has evolved in the past several decades with an increased emphasis on ovarian conservation.[3] In a study by Sola et al,[3] the authors reported on national trends in the surgical treatment of OT in 2041 children. These authors noted the following distribution in regards to surgical management: oophorectomy was performed in 78% of the patients, oophoropexy in 6% of patients, and release of the torsed ovary (RT) in 15% of patients.[3] They found that the majority of OT patients in the United States are still treated with oophorectomy, although the frequency of RT noticeably increased during their study period (1998–2011).[3] An analysis of pediatric OT patients found in a national database, the Pediatric Health Information System, revealed that pediatric surgeons were more likely than gynecologists to perform oophorectomy: 38% vs 27% ($P < .01$).[7]

As far as the treatment of choice in OT, oophorectomy is not always indicated, even in cases with a necrotic-appearing ovary.[5–7] Long-term studies show that OT treated with conservative surgery can result in normal or near normal function of the previously torsed ovary[5–8]; however, this is not always the case. Oophorectomy is performed in children with OT for fear of decreased function, malignancy, and thromboembolism.[3,5] In reality, conservative treatment does not increase the incidence of pulmonary embolism in this population, and the risk of leaving in an ovarian malignancy is low.[6]

Large epidemiologic studies may help refine and improve the management of OT in the pediatric population.[8] Additionally, statewide hospital discharge databases can be used to monitor regional trends in the management of OT. A PubMed search did not reveal any population-based, statewide studies that focused on the management of OT in girls hospitalized throughout Texas. The objective of our study was to identify predictors of oophorectomy in patients <18 years of age who were hospitalized for OT and found in the Texas Public Use Data File (PUDF).

METHODS

Our study protocol was reviewed by our institutional review board for the Protection of Human Subjects and deemed exempt. A retrospective cohort study was conducted by using the Texas PUDF (Texas Health Care Information Collection, Texas Department of State Health Services, Austin, TX), years 2013 and 2014. The PUDF contains clinical and demographic information on individuals who were discharged throughout Texas from reporting hospitals. In the fourth quarter of 2013, a total of 700 hospitals were state licensed, and of those, 88.1% were required to report their data to the Texas Health Care Information Council. Similarly, in the fourth quarter of 2014, 729 hospitals were state licensed, and of those, 88.9% were required to report their data to Texas Health Care Information Council. The 2013 database has 2 910 853 records, whereas the 2014 database has 2 947 191 records. The frequency of pediatric (<18 years) hospitalizations was 564 590 and 576 939 in the 2013 and 2014 PUDFs, respectively.

Inclusion and Exclusion Criteria

The records of girls under the age of 18 years were included in the study. The PUDF contains each patient's principal discharge diagnosis and up to 24 secondary diagnoses. The PUDF also contains a principal procedure field and up to 24 secondary procedure fields. These diagnosis and procedure variables were coded by using the *International Classification of Diseases, Ninth Revision, Clinical Modification* (ICD-9-CM).[9]

Records were included in our sample if any of the 25 discharge diagnosis fields contained the ICD-9-CM code for OT, which is 620.5 (Table 1). Records were excluded if any of the diagnosis fields contained codes 183.0, 183.2, 183.3, 183.4, 183.5, 183.8, or 183.9 (malignant neoplasm of ovary and

TABLE 1 ICD-9-CM Codes of the Diagnoses and Procedures Under Study

Diagnosis or Procedure	ICD-9-CM code(s)
Diagnoses	
Torsion of ovary, ovarian pedicle, or fallopian tube	620.5
Benign neoplasm of ovary	220
Malignant neoplasm of ovary and other uterine adnexa	183.0, 183.2, 183.3, 183.4, 183.5, 183.8, 183.9
Ovarian cyst (follicular cyst of ovary, corpus luteum cyst or hematoma, or other and unspecified ovarian cyst)	620.0, 620.1, 620.2
Procedures	
Ovarian cystectomy (marsupialization of ovarian cyst, laparoscopic marsupialization of ovarian cyst, or manual rupture of ovarian cyst)	65.21, 65.23, 65.93
Oophorectomy or salpingo-oophorectomy (unilateral oophorectomy, unilateral salpingo-oophorectomy, removal of solitary ovary, or laparoscopic removal of remaining ovary)	65.31, 65.39, 65.41, 65.49, 65.52, 65.52, 65.54
Oophoropexy (other simple suture of ovary, laparoscopic simple suture of ovary, or other repair of ovary and/or oophoropexy)	65.71, 65.74, 65.79
Release of torsion of ovary	65.95

other uterine adnexa) or code 220 (benign neoplasm of the ovary).

The following 3 procedures were identified by searching the 25 procedure fields for the ICD-9-CM procedure codes listed in Table 1: oophorectomy, oophoropexy, and release of torsion.

Data Analysis

Data were analyzed by using SAS 9.3 software (SAS Institute, Inc, Cary, NC). The distributions of selected clinical and demographic variables by oophorectomy status were examined. Two-sided χ^2 or Fisher's exact tests were performed depending on the expected cell values using a significance level of 0.05.

Adjusted incidence odds ratios (ORs) for the outcome of oophorectomy (underwent oophorectomy versus did not) were calculated from logistic regression models. The following 5 predictor variables were eligible for inclusion in the final model: age, race/ethnic group, health insurance status, treatment received at a teaching hospital, and the presence of an ovarian cyst.

The patient's age in the PUDF is classified into several age groups. For our logistic regression analysis, age was dichotomized at 1 year: ≥1 vs <1 year. Hispanic ethnicity and the patient's race are separate variables in the PUDF, and both were used to create the following 4 race/ethnic groups: Hispanics of any race, black non-Hispanic, non-Hispanics of a race other than black or white, and white non-Hispanic.

The FIRST_PAYMENT_SRC variable found in the PUDF represents the expected primary source of payment. This variable was collapsed into the following 3 categories and entered in the logistic regression models using 2 dummy variables: Medicaid, charity or indigent or unknown, and other (the reference category). The "other" category included various sources and/or payers including Blue Cross Blue Shield. If the patient had been discharged from a facility that was a member of the Council of Teaching Hospitals or was classified as an "other teaching facility," then the patient was considered to have been treated at a teaching hospital versus a nonteaching hospital. The presence of an ovarian cyst was defined as the appearance of ICD-9-CM codes 620.0 (follicular cyst of ovary), 620.1 (corpus luteum cyst or hematoma), and 620.2 (other and unspecified ovarian cyst) in any of the 25 diagnosis fields (Table 1).

A causal diagram known as a directed acyclic graph (DAG) was created to aid in the identification of predictor variables that were included in our final logistic regression model.[10] Health insurance status can be viewed a rough measure of socioeconomic status. Our DAG (Fig 1) revealed that the patient's race/ethnic group impacted health insurance status and presentation to a teaching hospital, both of which in turn may be related to the outcome of oophorectomy. Given the link between race and social class in the United States, both health insurance status and the teaching hospital variable were viewed as causal intermediates between the race/ethnic variable and the risk of oophorectomy.[11] Controlling for causal intermediates using standard methods will generally lead to biased estimates of the total effect of race/ethnic group, and hence, the 4-level race/ethnic variable was not included in the final model.[11,12]

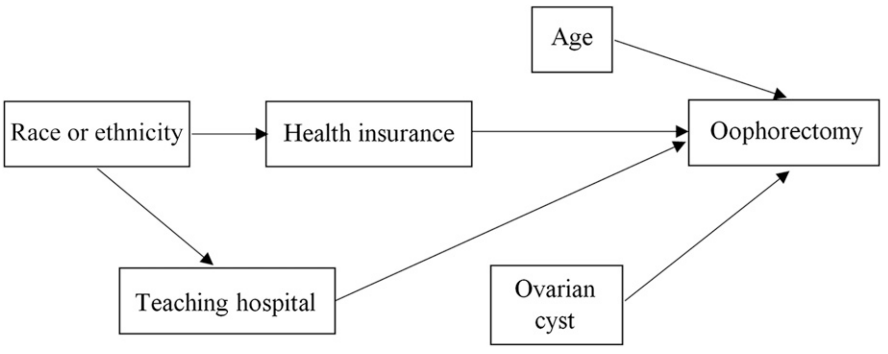

FIGURE 1 DAG causal diagram depicting the effects of various factors on the risk of oophorectomy in girls with OT.

Given that the ratio of the number of outcome events (girls who had an oophorectomy) to the number of predictor variables in the initial logistic regression model was <10, the possibility of inducing sparse data bias was a concern.[13] To minimize the risk of sparse data bias, Firth's bias-reducing penalized likelihood was used.[14] Adjusted ORs were reported along with 95% confidence intervals (CIs) and P values. A significance level of 0.05 was used.

RESULTS

A total of 158 records met our inclusion criteria. None of these records contained missing values for the outcome variable or any of the predictor variables. Selected characteristics of the study sample are reported in Table 2, along with P values from χ^2 or Fisher's exact tests testing the univariate association between oophorectomy status and these selected patient characteristics. Infants comprised 4.6% of the patients who underwent oophorectomy and 2.6% of the patients who did not undergo oophorectomy ($P = .40$). Hispanics were overrepresented in the oophorectomy group versus the nonoophorectomy group; 60.0% vs 51.6% respectively. A majority of oophorectomy patients were treated at nonteaching hospitals (78.5%), whereas 62.4% of the nonoophorectomy group were treated at a nonteaching facility ($P = .03$). The prevalence of ovarian cyst did not vary by oophorectomy status (Table 2).

Adjusted ORs for the outcome of oophorectomy are displayed in Table 3. In our initial model, infants appeared to have almost 3 times the odds of undergoing oophorectomy than older patients; however, this result was not statistically significant ($P = .28$). The race/ethnic variable was not retained in the final model (see Methods for details). After adjusting for age, health insurance, and presence of an ovarian cyst, patients who were treated at a nonteaching facility were more likely to undergo oophorectomy than patients who were

TABLE 2 Characteristics of 158 Girls <18 Years of Age Who Were Hospitalized Throughout Texas and Discharged in 2013 or 2014 With a Principal or Secondary Discharge Diagnosis of OT

Characteristic	Underwent Oophorectomy (*N* = 65), No. (%)	No Oophorectomy (*N* = 93), No. (%)	*P*
Demographic and health system variables			
Age group			.65
1–28 d	1 (1.5)	0 (0.0)	—
29–365 d	2 (3.1)	2 (2.2)	—
1–4 y	1 (1.5)	0 (0.0)	—
5–9 y	5 (7.7)	11 (11.8)	—
10–14 y	36 (55.4)	50 (53.8)	—
15–17 y	20 (30.8)	30 (32.3)	—
Infant (<1 y)	3 (4.6)	2 (2.2)	.40
Race and Hispanic ethnicity			.049
Hispanic of any race	39 (60.0)	48 (51.6)	—
Black non-Hispanic	6 (9.2)	4 (4.3)	—
Non-Hispanic of a race other than black or white	1 (1.5)	11 (11.8)	—
White non-Hispanic	19 (29.2)	30 (32.3)	—
Health insurance			.54
Charity, indigent, or unknown	6 (9.2)	5 (5.4)	—
Medicaid	20 (30.8)	34 (36.6)	—
Other	39 (60.0)	54 (58.1)	—
Type of facility			.03
Teaching	14 (21.5)	35 (37.6)	—
Nonteaching	51 (78.5)	58 (62.4)	—
Clinical variables			
Ovarian cyst present	37 (56.9)	49 (52.7)	.60
Procedures performed during hospital stay			—
Ovarian cystectomy	0 (0.0)	0 (0.0)	—
Oophoropexy	1 (1.5)	8 (8.6)	.08
Release of torsion of ovary	8 (12.3)	41 (44.1)	<.0001

Results are presented by oophorectomy status. Patients with benign or malignant ovarian neoplasm were excluded from the sample. —, not applicable.

treated at a teaching facility (adjusted OR = 2.22; 95% CI: 1.05–4.69).

DISCUSSION

This study used the Texas PUDF database to analyze predictors of oophorectomy in girls hospitalized in Texas with OT. Our results indicate that girls with OT presenting to nonteaching hospitals were significantly more likely to have an oophorectomy compared with those presenting to teaching hospitals (adjusted OR of 2.22). This finding is comparable to the results of a study conducted by Sola et al[3] who reported an adjusted OR of 2.3 (95% CI: 1.8–3.0) for oophorectomy for nonteaching versus teaching hospitals. The beneficial effect of being treated at a teaching hospital may be a result of the possibility that they are more likely to have gynecologic surgeons (including those with expertise in pediatric and adolescent gynecology) on staff than nonteaching hospitals. Sola et al[3] controlled for hospital region and hospital location (rural or urban). We did not explore regional differences in the incidence of oophorectomy using our statewide Texas database.

Guthrie et al[8] identified factors associated with oophorectomy in female patients with OT aged 1 to 20 years. They did not detect a relationship between hospital teaching status (nonteaching compared with teaching) and the odds of oophorectomy; OR = 0.91 (95% CI: 0.68–1.21). These authors did note an OR for oophorectomy of 0.54 (95% CI: 0.38–0.77) for median household income of ≥$62 000 vs $1 to $37 999. Guthrie et al[8] did not find an association between the primary expected payer (a 4-level variable) and oophorectomy. Their adjusted OR for Medicaid versus private insurance was 1.04 (95% CI: 0.78–1.38). Our study revealed a similar OR for Medicaid compared with other payer mix; adjusted OR = 0.85 (95% CI: 0.42–1.72).

The strengths of our study include the use of a DAG to identify the inclusion of variables in the final model. Inspection of the DAG indicated that controlling for both the patient's race/ethnicity and health insurance status may lead to overadjustment bias (see Methods for details). Additionally, to minimize the risk of sparse data bias we used Firth's bias-reducing penalized likelihood.

An additional strength is the use of a statewide database, which includes data from multiple facilities rather than a single institution. We used data from Texas between 2013 and 2014 in our study. During this 2-year period, over 88% of the state-licensed hospitals in Texas were required to report their data to the Texas Health Care Information Council.

A possible limitation of our study is that diagnoses and procedures may be miscoded. Previous investigators have reported on the accuracy of the ICD-9-CM coding of various obstetrics diagnoses and procedures; however, we could not find any reports on the accuracy of the coding of OT.[15,16] An additional limitation of our investigation was the lack of information on household income. However, we were able to control for a general measure of socioeconomic status: the patient's health insurance status.

Our study noted a higher risk of oophorectomy among girls with OT who were treated at nonteaching facilities. This disparity may be because of the

TABLE 3 Adjusted OR for Oophorectomy in 158 Girls <18 Years of Age Who Were Hospitalized Throughout Texas and Discharged in 2013 or 2014 With a Principal or Secondary Discharge Diagnosis of OT and Were Free of Benign or Malignant Ovarian Neoplasms

Variable	Initial Model			Final Model		
	OR	95% CI	*P*	OR	95% CI	*P*
Age, y						
<1	2.87	0.42–19.63	.28	1.98	0.32–12.38	.47
≥1	1	(Reference)	—	1	(Reference)	—
Race and Hispanic ethnicity						
Hispanic of any race	1.44	0.66–3.14	.36	[a]	—	—
Black non-Hispanic	2.54	0.61–10.62	.20	[a]	—	—
Non-Hispanic of a race other than black or white	0.26	0.04–1.84	.18	[a]	—	—
White non-Hispanic	1	(Reference)	—	1	(Reference)	—
Health insurance						
Charity, indigent, or unknown	1.58	0.42–5.92	.50	2.10	0.57–7.77	.27
Medicaid	0.72	0.34–1.54	.40	0.85	0.42–1.72	.66
Other	1	(Reference)	—	1	(Reference)	—
Type of facility						
Nonteaching	1.76	0.81–3.83	.16	2.22	1.05–4.69	.04
Teaching	1	(Reference)	—	1	(Reference)	—
Ovarian cyst						
Present	0.94	0.48–1.85	.87	1.08	0.56–2.08	.82
Absent	1	(Reference)	—	1	(Reference)	—

Each OR is adjusted for the remaining variables found on the appropriate side of the table. —, not applicable.
[a] Race/ethnicity was not retained in the final model (see Methods).

unavailability of pediatric and adolescent gynecologic surgeons at nonteaching hospitals. Although our database did not contain information on the specialty of the surgeon who performed the oophorectomy, it has been reported that pediatric surgeons are more likely to perform oophorectomy than gynecologists who tend to opt for RT.[17] Similarly, Campbell et al[7] reported pediatric surgeons were more likely to perform oophorectomy than gynecologists. Detorsion, regardless of the gross appearance of the ischemic adnexa, has been shown to result in full recovery of ovarian function.[17] Aziz et al[17] found that a black-bluish ischemic appearance of the ovary was not always associated with irreversible necrosis. Conservative management of the ischemic adnexa, avoiding any additional surgery (eg, cystectomy) and focusing on observation and preservation of the adnexa is recommended for pediatric and adolescent patients with OT. This conservative approach is warranted given the high rate of normal ovaries and the low risk of malignancy associated with OT.[17]

Our study demonstrates the usefulness of a statewide database. Analysis of large hospital discharge data sets allow investigators to elucidate the clinical epidemiology of a variety of conditions including rare outcomes such as pediatric OT in a relatively rapid manner.[18] Additionally, these types of studies allow for the monitoring of the trends in the management of pediatric OT over time.

CONCLUSION

We found that girls with OT who presented at nonteaching hospitals in Texas were more likely to undergo oophorectomy, a possibly avoidable intervention, than girls who presented at teaching hospitals. Efforts to improve the surgical management of pediatric OT may need to focus on nonteaching hospitals. Statewide administrative databases provide a potentially valuable tool in identifying practice patterns and monitoring the effect of statewide health initiatives.

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