Variation in Oophorectomy Rates for Children with Ovarian Torsion across US Children's Hospitals

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In this multicenter study of 1783 children diagnosed with ovarian torsion from 2012 to 2017, 402 children (22.5%) underwent oophorectomy. The odds of oophorectomy were higher in children under 11 years of age, children with public insurance, and children with complex chronic conditions. Future efforts should target a preservation-first approach. *(J Pediatr 2021;231:269-72).*

Pediatric ovarian torsion is rare, with an estimated incidence of 4.9 cases per 100 000 children and a median age of 14.5 years.[1] The ideal outcome is detorsion and preservation of the ovary; however, up to 78% of children undergo oophorectomy after ovarian torsion.[2] Potential reasons for oophorectomy include necrotic appearance of the ovary, suspicion of underlying malignancy, and concerns about thromboembolism as a result of detorsion. However, recent evidence suggests these concerns are generally unwarranted, emphasizing a detorsion-first approach.[3-5] We sought to describe variation in the rates of oophorectomy procedures in children treated at US children's hospitals, and to identify patient- and hospital-level factors predicting oophorectomy. Identification of variation in care and risk factors for oophorectomy provide an opportunity for improvement in the care of children with ovarian torsion.

Methods

We performed a retrospective cohort study using the Pediatric Health Information System (PHIS) database. PHIS is a non-nationally representative administrative database that contains inpatient, emergency department, ambulatory surgery, and observation encounter-level data from over 49 not-for-profit, tertiary care pediatric hospitals in the US. These hospitals are affiliated with the Children's Hospital Association (Lenexa, Kansas). Data quality and reliability are assured through a joint effort between the Children's Hospital Association and participating hospitals. Portions of the data submission and data quality processes for the PHIS database are managed by Truven Health Analytics (Ann Arbor, Michigan).

We included female patients under 22 years of age who visited a PHIS-participating ED with a diagnosis of ovarian torsion (*International Statistical Classification of Diseases and Related Health Problems* (ICD)-Ninth Revision 620.5; ICD-Tenth Revision N83.5x) over a 6-year period from January 1, 2012 to December 31, 2017. For this study, we included data from the 48 hospitals that contributed data for the entire study period. In addition to a diagnosis code for ovarian torsion, to increase the specificity of our case definition we required that patients have a surgical code for an ovarian procedure within the first 3 days of hospitalization because ovarian torsion is a surgical diagnosis.

The primary outcome was oophorectomy, defined as presence of a procedure code for oophorectomy during the hospitalization (qualifying codes included ICD- Ninth Revision, 65.31, 65.39, 65.41, 65.49 and ICD-Tenth Revision 0UT00ZZ, 0UT04ZZ, 0UT10ZZ, 0UT14ZZ). Ovarian procedures other than oophorectomy (eg, ovarian detorsion, cyst drainage) were considered preservation procedures. The primary exposure was the patient's surgeon type, either gynecologist or general surgeon, defined using PHIS proceduralist codes. Patient-level covariates included age, race, ethnicity, presence of a complex chronic condition, presentation on a weekend, transfer in to the study institution, type of insurance, and a concurrent diagnosis of malignancy as abstracted from diagnosis codes. A hospital-level covariate was hospital case volume in (absolute numbers) of ovarian torsion, separated into quartiles.

We described the demographics of the cohort, including age, race, ethnicity, and insurance status. We defined age categories of <3 years, 3-10 years, and 11+ years, to reflect preverbal, school age, and pubertal age groups. We calculated rates of oophorectomy over time and by hospital, and assessed for a trend with univariable logistic regression, using

ICD	International Statistical Classification of Diseases and Related Health Problems
PHIS	Pediatric Health Information System

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oophorectomy as the dependent variable and year as the independent variable. We used multivariable logistic regression to determine which patient- and hospital-level factors were independently associated with oophorectomy. Patients with diagnosis codes for malignancy were excluded from the multivariable analysis, as oophorectomy is usually indicated in such cases.[6] All regressions used clustered sandwich standard error estimates to address within-hospital correlation. Data were analyzed using R version 3.6.2 (R Foundation) and STATA (version 15, StataCorp). The Institutional Review Board at the study institution deemed this study exempt from review.

Results

Over the 6-year study period, there were 2717 visits with a primary diagnosis code for ovarian torsion. Of these, 1783 (66%) had an associated ovarian procedure code and were included in our study cohort. The median patient age was 12.9 years (IQR 10.5-14.9 years). The majority of patients were White (64%) and non-Hispanic (64%). Complex chronic conditions were present in 114 patients (6.4%), and 848 patients (47.6%) had public insurance or free care. One-quarter of patients (25.2%) were transferred to the study institution. The primary surgeon type was general surgeon in 1227 cases (68.8%), gynecologist in 328 cases (18.4%), and unknown in 228 cases (12.8%). Fifteen patients (0.8%) had a co-diagnosis of ovarian malignancy in the same encounter (Table I).

Oophorectomy was performed in 402 patients (22.5%). The oophorectomy rate decreased over the study period, from 36.1% in 2012 to 17.1% in 2017. The odds of oophorectomy decreased 18% per year (95% CI -28%, -8%, $P = .001$ for trend). The frequency of oophorectomy was higher in children managed by general surgeons (24%) than in children managed by gynecologists (16%). However, after addressing within-hospital correlation, the unadjusted odds of oophorectomy did not significantly differ by surgeon type (Table II). Wide variation existed in the oophorectomy rate across hospitals (median 24.5%, IQR 12.9-34.6%) (Figure; available at www.jpeds.com). Of the 15 children with a diagnosis of ovarian malignancy, 12 (80%) underwent oophorectomy. The 15 children with co-diagnoses of ovarian malignancy were excluded from further analysis.

On multivariable analysis, patient age was independently associated with oophorectomy. Compared with children 11 years of age and older, the odds of oophorectomy were increased in children <3 years of age (aOR 3.54, 95% CI 2.31-5.44) and children 3-10 years of age (aOR 1.63, 95% CI 1.24-2.16) (Table II). Children with a complex chronic condition had higher odds of oophorectomy than children without a complex chronic condition (aOR 1.51, 95% CI 1.03-2.20). Children with public insurance had higher odds of oophorectomy than children with private insurance (aOR 1.68, 95% CI 1.24-2.27). Patient race, ethnicity, hospital case volume of ovarian torsion, presentation on a weekend, transfer status, and primary surgeon type were not independently associated with oophorectomy.

Discussion

In this retrospective study of 1783 children with ovarian torsion managed at US children's hospitals, we found that

Table I. Demographics of study cohort

n = 1783	n (%)
Age in y, median [IQR]	12.9 (10.5, 14.9)
Age <3 y	63 (3.5)
Age 3-10 y	455 (25.5)
Age ≥11 y	1265 (71.0)
Race	
White	1141 (64.0)
Non-white	642 (36.0)
Ethnicity	
Hispanic	535 (30.0)
Non-Hispanic	1140 (63.9)
Unknown	108 (6.1)
Complex chronic condition	114 (6.4)
Weekend presentation	502 (28.2)
Transferred to study institution	449 (25.2)
Public insurance or free care	848 (47.6)
Co-diagnosis for adnexal malignancy at current visit	15 (0.84)
Primary surgeon type	
Gynecologist	328 (18.4)
General surgeon	1227 (68.8)
Other/unknown	228 (12.8)
Institutional adnexal torsion frequency	
Highest quartile	870 (48.8)
Third quartile	475 (26.6)
Second quartile	302 (16.9)
Lowest quartile	136 (7.6)

Table II. Multivariable logistic regression predicting oophorectomy

n = 1768	Oophorectomy, n (%)	Unadjusted OR (95% CI)	aOR (95% CI)
Age			
<3 y	29 (46.8)	**3.78 (2.47-5.78)**	**3.54 (2.31-5.44)**
3-10 y	124 (27.6)	**1.64 (1.25-2.14)**	**1.63 (1.24-2.16)**
11+ y	237 (18.9)	Referent	Referent
Non-white race	160 (24.9)	1.23 (0.92-1.64)	1.19 (0.89-1.60)
Hispanic	100 (18.7)	0.71 (0.48-1.06)	0.73 (0.52-1.02)
Complex chronic condition	40 (35.1)	**1.51 (1.03-2.22)**	**1.51 (1.03-2.20)**
Weekend presentation	117 (23.3)	1.10 (0.85-1.43)	1.13 (0.85-1.49)
Transferred to study institution	100 (22.3)	0.98 (0.62-1.54)	1.02 (0.64-1.63)
Public insurance*	222 (26.2)	**1.53 (1.13-2.06)**	**1.68 (1.24-2.27)**
Primary surgeon type			
Gynecologist	52 (15.9)	Referent	Referent
General surgeon	294 (24.0)	1.67 (0.69-4.03)	1.39 (0.71-2.74)
Other/unknown	56 (24.6)	1.64 (0.67-4.00)	1.36 (0.61-3.05)
Institutional adnexal torsion frequency			
Highest quartile	149 (17.1)	Referent	Referent
Third quartile	130 (27.4)	**1.89 (1.04-3.41)**	1.73 (0.99-3.02)
Second quartile	79 (26.2)	1.78 (0.90-3.51)	1.65 (0.87-3.10)
Lowest quartile	44 (32.4)	2.13 (0.95-4.76)	1.76 (0.77-4.01)

We excluded malignancy cases (n = 15) as oophorectomy is generally indicated in such cases. Significant regression terms ($P < .05$) are shown in bold.
*Includes free care.

although the frequency of oophorectomy for ovarian torsion has decreased over the last decade, a substantial portion of children still undergo oophorectomy.

Multiple prior database studies have examined management of pediatric ovarian torsion in the last 2 decades. Sola et al examined 2041 children with ovarian torsion from 1998 to 2011 and found that although the overall rate of oophorectomy was decreasing, two-thirds of children in the most recent year of their sample were still undergoing oophorectomy.[2] In a prior PHIS database study of ovarian torsion management from 2007 to 2011, Campbell et al found that overall, 35% of children underwent oophorectomy, but did not explore trends over time.[7] Our study, which took place in the 6-year period following this one, found a steadily decreasing rate of oophorectomy across children's hospitals. Although Campbell et al observed that oophorectomy rates were higher in patients managed by general surgeons than by gynecologists, their findings were purely descriptive and did not account for hospital-level practices or potential confounding variables.[7] Although the frequency of oophorectomy in our cohort was higher in children managed by general surgeons than by gynecologists, we did not find surgeon type to be an independent risk factor of oophorectomy after clustering by hospital and performing multivariable regression.

The American College of Obstetricians and Gynecologists recently emphasized that ovarian torsion in adolescent patients is epidemiologically different from ovarian torsion in adults and that malignancy causing ovarian torsion is rare in children.[3,4,8] Furthermore, even ovaries that appear necrotic at the time of detorsion may appear normal after surgery, and the concern about venous thromboembolism following detorsion appears to be theoretical in nature, without reported cases.[4,5] Therefore, American College of Obstetricians and Gynecologists strongly recommends a minimally invasive surgical approach with detorsion and preservation of the ovary in all cases, "unless oophorectomy is unavoidable, such as when a severely necrotic ovary falls apart."[4] Although we are encouraged by the decreasing rates of oophorectomy over the study period, there remains significant opportunity for improvement, and improvement is indeed achievable. At one tertiary care pediatric hospital, over 90% of ovarian torsion cases over a 10-year period resulted in detorsion and preservation.[9] Another institution saw an increase in the rate of ovarian preservation from 48% to 86% with implementation of a multifaceted quality improvement initiative.[10] These success stories should inspire us to strive for better in the care of children with ovarian torsion.

The reason behind the increased odds of oophorectomy in younger children are unclear and may relate to differing pathology, delays in diagnosis, or the comfort level of the operating surgeon. Children with complex chronic conditions were also more likely to undergo oophorectomy. These children may have neurologic compromise, communication impairment, and significant comorbid conditions that may lead to delays in diagnosis and/or intervention. It is also possible that future fertility and in vivo hormone production may be perceived to be of less importance in this population, leading to bias in the care rendered. The increased odds of oophorectomy in children with public health insurance and lack of health insurance may reflect disparities in access to timely surgical care, bias in care rendered, or the known association between low socioeconomic status and poor health outcomes.[11]

This study requires interpretation in the context of its limitations. As a study of administrative data, detailed clinical information was unavailable. However, we used strict definitions for inclusion and outcome determination. We mitigated the risk of defining a case of ovarian torsion based on an erroneous diagnostic code by requiring an ovarian surgical procedure during the hospitalization. We could not evaluate the reasons underlying the association between complex chronic condition or public insurance with oophorectomy. Because this sample was drawn from academic, tertiary care children's hospitals, the results may not generalize to other settings and patient populations. One-quarter of patients our cohort were transferred from other hospitals. However, transfer status was not associated with the performance of oophorectomy. Finally, we could not fully determine the role of differences in case mix to explain the variation in rates of oophorectomy across hospitals.

In conclusion, we found that a significant proportion of children with ovarian torsion managed at US children's hospitals undergo oophorectomy, although oophorectomy rates have steadily decreased over time. Children of younger age, those with complex chronic conditions, and those with public insurance had higher odds than their counterparts of undergoing oophorectomy. The wide variability in oophorectomy rates suggests an opportunity for hospitals with high rates of oophorectomy to adopt a preservation strategy. ■

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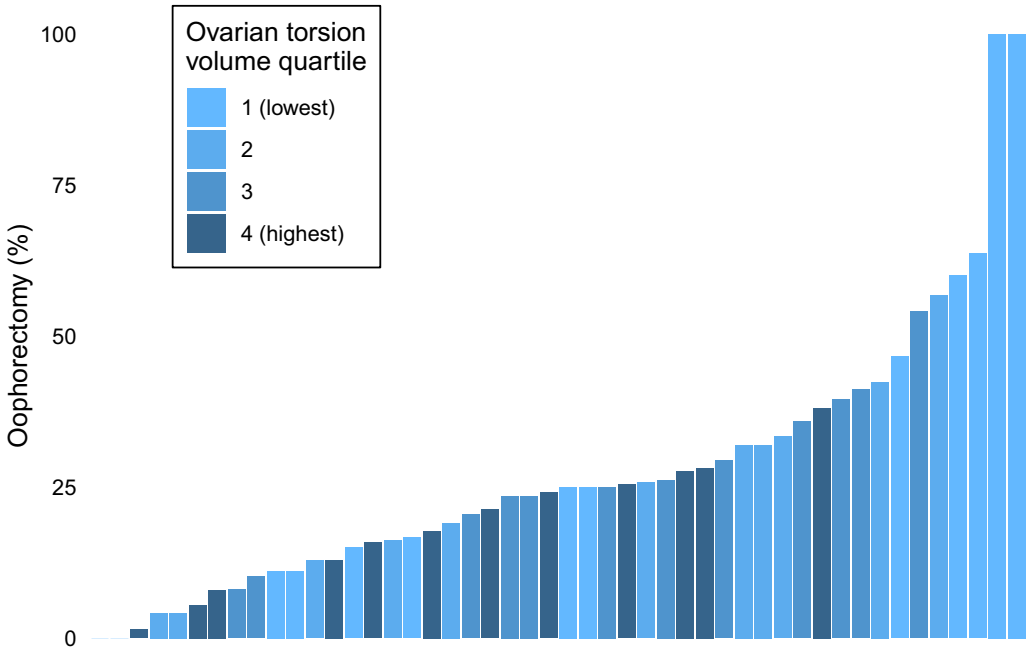

Figure. Variation in rates of oophorectomy among children with ovarian torsion managed at US children's hospitals, 2012-2017. Each bar represents 1 hospital, and bars are colored according to the quartile of the total volume of ovarian torsion cases. One bar is blank because zero children underwent oophorectomy.