Original Research

Salpingectomy for Sterilization

Change in Practice in a Large Integrated Health Care System, 2011–2016

C. Bethan Powell, MD*, Amy Alabaster,* MPH*, Sarah Simmons,* MD*, Christine Garcia,* MD*,* MPH*, Maria Martin,* MD*, Sally McBride-Allen,* BS*, and Ramey D. Littell,* MD

OBJECTIVE: To evaluate the utilization rate of salpingectomy for cesarean deliveries and postpartum and interval tubal sterilization procedures.

METHODS: This is a retrospective cohort study using the electronic medical record to identify women older than 18 years of age undergoing surgical sterilization from June 2011 to May 2016 in an integrated health care system. The primary objective is to describe the change in utilization rate of salpingectomy for tubal sterilization procedures over time and after a systemwide practice recommendation was issued in 2013. Rates of salpingectomy and tubal occlusion were calculated for each of the five 1-year intervals in the study. Secondary outcomes included blood loss, operating time, length of stay, readmission, and emergency department visits.

RESULTS: A total of 10,741 tubal sterilization procedures were identified. There was an increase in salpingectomies from 0.4% (8/1,938; 95% CI 0.2–0.8) to 35.5% (902/2,538; 95% CI 33.7–37.4) of tubal sterilization procedures performed over the study period (test for trend, $P<.001$). Salpingectomy instead of tubal occlusion increased at cesarean delivery from 0.1% (1/1,141; 95% CI 0.0–0.5) to 9.2% (125/1,354; 95% CI 7.8–10.9) (test for trend, $P<.001$); postpartum from 0% (0/124; 95% CI 0.0–3.0) to 4.5% (9/201; 95% CI 2.4–8.3) (test for trend, $P=.003$); and as an interval (nonpartum) tubal sterilization procedure from 1% (7/673; 95% CI 0.5–2.1) to 78% (768/983; 95% CI 75.4–80.6) (test for trend, $P<.001$). Median operative minutes was increased from 52 (95% CI 51–52) to 61.5 (95% CI 57–64), from 33 (95% CI 32–34) to 50 (95% CI 35–64), and from 30 (95% CI 29–30) to 33 (95% CI 32–33), respectively, for salpingectomy compared with tubal occlusion at cesarean delivery and postpartum and interval sterilization. Median blood loss was similar for salpingectomy and tubal occlusion at cesarean delivery (660 mL; 95% CI 600–700 mL compared with 700 mL; 95% CI 680–700 mL) and interval sterilization (both 5 mL; 95% CI 5–5 mL) but was more for salpingectomy postpartum (250 mL; 95% CI 200–500 mL compared with 200 mL; 95% CI 200–200 mL).

CONCLUSION: There was a significant increase in salpingectomy for sterilization from June 2011 to May 2016. In the final year of the study, salpingectomy accounted for 78% of interval laparoscopic tubal sterilization procedures and 9% of intrapartum and postpartum procedures.

(Obstet Gynecol 2017;130:961–7)
DOI: 10.1097/AOG.0000000000002312

The evidence to support the fallopian tube as the potential site of origin of some ovarian cancers has led to new practice recommendations to perform opportunistic salpingectomies for the prevention of epithelial "ovarian" cancer.[1–7] Kaiser Permanente Northern California, a large integrated health care system in the United States, which encourages care by regional standard guidelines, published a policy statement in May 2013 recommending salpingectomies for surgical tubal sterilization and at the time of hysterectomy. This practice guideline was widely

From the Kaiser Permanente Northern California Gynecologic Cancer Program, San Francisco, Kaiser Permanente Northern California, Division of Research, Oakland, and Kaiser Permanente Obstetrics–Gynecology Residency Program, San Francisco, California; and the Department of Obstetrics and Gynecology, Division of Gynecologic Oncology, University of Virginia, Charlottesville, Virginia.

Supported in part by the Kaiser Permanente Northern California Graduate Medical Education Program, Kaiser Foundation Hospitals.

Presented at the Annual Meeting of the Western Association of Gynecologic Oncologists, June 14–17, 2017, Rancho Mirage, California.

Each author has indicated that he or she has met the journal's requirements for authorship.

Corresponding author: C. Bethan Powell, MD, Kaiser Permanente Northern California Gynecologic Cancer Program, 2350 Geary Boulevard, San Francisco, CA 94115; email: Bethan.Powell@kp.org.

Financial Disclosure
The authors did not report any potential conflicts of interest.

ISSN: 0029-7844/17

Table 1. Characteristics of the Study Population

	Cesarean Delivery			Postpartum			Interval		
	Tubal Occlusion (n=5,979)	Salpingectomy (n=206)	P*	Tubal Occlusion (n=760)	Salpingectomy (n=13)	P	Tubal Occlusion (n=2,229)	Salpingectomy (n=1,483)	P
Age (y)	35 (32–38)	35 (32–38)	.68	34 (31–37)	39 (37–40)	.002	36 (32–39)	36 (32–40)	.24
Parity†			.36			.76			.66
0	25 (96.2)	1 (3.8)		1 (100)	0		109 (57.1)	82 (42.9)	
1	332 (95.4)	16 (4.6)		3 (100)	0		243 (58.1)	175 (41.9)	
2	2,475 (97.1)	75 (2.9)		179 (98.9)	2 (1.1)		864 (60.4)	567 (39.6)	
3 or more	3,147 (96.5)	114 (3.5)		577 (98.1)	11 (1.9)		1,013 (60.6)	659 (39.4)	
Race–ethnicity			.81			.86			.003
Asian	1,417 (96.5)	51 (3.5)		159 (98.8)	2 (1.2)		294 (66.7)	147 (33.3)	
Black	483 (97.4)	13 (2.6)		63 (96.9)	2 (3.1)		181 (52.9)	161 (47.1)	
Hispanic	1,799 (96.9)	58 (3.1)		371 (98.1)	7 (1.9)		862 (60.1)	572 (39.9)	
White	2,038 (96.4)	76 (3.6)		142 (98.6)	2 (1.4)		838 (59.7)	566 (40.3)	
Other or unknown	247 (96.9)	8 (3.1)		25 (100)	0		88 (56.1)	69 (43.9)	
BMI (kg/m²)†			.59			.18			.005
Less than 30	1,761 (96.8)	58 (3.2)		244 (99.2)	2 (0.8)		1,385 (61.8)	855 (38.2)	
30–39.9	3,180 (96.5)	116 (3.5)		434 (98.2)	8 (1.8)		772 (58.3)	552 (41.7)	
Greater than 40	1,033 (97.1)	31 (2.9)		78 (96.3)	3 (3.7)		103 (49.0)	107 (51.0)	
Socioeconomic status, % households below poverty level†			.95			.53			.71
Greater than 10%	3,848 (96.7)	133 (3.3)		418 (98.6)	6 (1.4)		1,323 (60.2)	876 (39.8)	
Less than 10%	2,130 (96.7)	73 (3.3)		342 (98.0)	7 (2.0)		940 (59.6)	638 (40.4)	
Concurrent surgery			.01			1.00			.67
No	5,960 (96.7)	202 (3.3)		757 (98.3)	13 (1.7)		2,057 (60.0)	1,371 (40.0)	
Yes	24 (85.7)	4 (14.3)		3 (100)	0		206 (58.9)	144 (41.1)	
Service area†			<.001			<.001			<.001
A	1,610 (96.9)	51 (3.1)		159 (99.4)	1 (0.6)		303 (40.3)	448 (59.7)	
B	719 (99.9)	1 (0.1)		0	0		336 (64.1)	188 (35.9)	
C	916 (99.5)	5 (0.5)		336 (100)	0		463 (70.9)	190 (29.1)	
D	1,051 (94.2)	65 (5.8)		2 (100)	0		572 (62.2)	347 (37.8)	
E	877 (95.9)	38 (4.1)		176 (100)	0		348 (62.0)	213 (38.0)	
F	793 (94.5)	46 (5.5)		87 (87.9)	12 (12.1)		241 (65.1)	129 (34.9)	

IQR, interquartile range; BMI, body mass index.
Data are median (interquartile range) or n (row %) unless otherwise specified.
* Statistical test performed: χ^2 or Fisher exact test for categorical variables and Kruskal-Wallis test for age.
† Missing data: parity, n=71; BMI, n=8; households below poverty level, n=7; service area, n=18.

distributed, accompanied with an educational campaign, and is available online in the electronic health record system (http://links.lww.com/AOG/A829).[8] Subsequently, the practice of salpingectomy has been supported by national societies including the Society of Gynecologic Oncology and the American College of Obstetricians and Gynecologists.[9,10]

Studies show not only an increase in physician acceptance of prophylactic salpingectomy, but also the feasibility of performing the procedure at the time of hysterectomy.[11–17] Recent reports show the feasibility and safety of salpingectomy as a tubal sterilization procedure, but utilization is not well described.[14,18–22] The purpose of our study is to characterize the utilization of salpingectomy for tubal sterilization procedures in Kaiser Permanente Northern California. It is hypothesized that salpingectomy rates increased over the study period.

MATERIALS AND METHODS

The primary objective of the study is to evaluate the utilization of salpingectomy for tubal sterilization in the cesarean, postpartum, and interval settings over the study period June 1, 2011, to May 31, 2016, and to compare utilization before and after May 2013 publication of the Kaiser Permanente Northern California salpingectomy practice resource. Secondary objectives were to compare surgical outcomes, including blood loss, surgery time, operating time, length of stay, emergency department (ED) visits within 7 days, and readmission rates within 30 days between salpingectomies and tubal occlusion.

A retrospective cohort study with chart review using the Kaiser Permanente Northern California electronic medical record was performed. Eligibility criteria included all adult women (age 18 years or older) who underwent a surgical sterilization procedure in the study period. The cohort was identified by searching an operative procedure database for tubal occlusion, ligation, or fulguration, salpingectomy, and cesarean procedures. Women were excluded if they underwent a hysterectomy or a procedure that involved oophorectomy; had a diagnosis

Table 2. Rates of Sterilization by Salpingectomy and Tubal Occlusion by Surgical Setting in Kaiser Permanente Northern California 2011–2016

Procedure	Total	June 2011–May 2012	June 2012–May 2013	June 2013–May 2014	June 2014–May 2015	June 2015–May 2016	*P* Trend*
Total sterilizations	10,741 (100)						<.001
Total tubal occlusion	9,007 (83.9)	1,930 (99.6)	1,981 (98.5)	1,793 (87.5)	1,667 (76.3)	1,636 (64.5)	
Total salpingectomy	1,734 (16.1)	8 (0.4)	30 (1.5)	255 (12.5)	519 (23.7)	902 (35.5)	
Total interval sterilizations	3,778 (100)						<.001
Interval tubal occlusion	2,263 (59.9)	666 (99.0)	655 (93.2)	486 (67.4)	241 (34.5)	215 (21.9)	
Interval salpingectomy	1,515 (40.1)	7 (1.0)	28 (6.8)	235 (32.6)	457 (65.5)	768 (78.1)	
Total cesarean sterilizations	6,190 (100)						<.001
Cesarean tubal occlusion	5,984 (96.7)	1,140 (99.9)	1,187 (99.8)	1,170 (99.5)	1,258 (95.5)	1,229 (90.8)	
Cesarean salpingectomy	206 (3.3)	1 (0.1)	2 (0.2)	18 (1.5)	60 (4.5)	125 (9.2)	
Total postpartum sterilizations	773 (100)						
Postpartum tubal occlusion	760 (98.3)	124 (100)	139 (100)	137 (98.6)	168 (98.8)	192 (95.5)	.003
Postpartum salpingectomy	13 (1.7)	0	0	2 (1.4)	2 (1.2)	9 (4.5)	

* Statistical test performed: Mantel-Haenszel χ^2 test.
Data are n (%) unless otherwise specified.

of ectopic pregnancy; had a personal history of ovarian cancer; or were a BRCA1, BRCA2, or Lynch mutation carrier. The tubal occlusion sterilization procedure was used to include clips, rings, fulguration, partial salpingectomy, and cutting and suture interruption as previously described by Westberg et al.[22] Peripartum sterilization procedures are defined as those performed at the time of cesarean delivery and within 3 days of vaginal delivery. All other sterilization procedures were referred to as "interval" regardless of temporal relationship to any pregnancy.[23] Of the 206 salpingectomies performed at the time of cesarean delivery, 99 were completed using a bipolar cautery device and 95 were completed with suture ligation and monopolar electrocautery. Two were performed with a surgical stapler device and in 10, the technique was not well described. For the 13 postpartum salpingectomies, 10 were performed with the bipolar cautery device and the remainder with suture ligation. All interval salpingectomies were performed using a bipolar cautery device.

Information on patient age, race, parity, neighborhood poverty level, body mass index (BMI, calculated as weight (kg)/[height (m)]^2), and medical center as well as surgical factors such as operating time, postoperative length of stay, and estimated blood loss were collected by electronic data extraction. For women with peripartum sterilization, BMI closest to sterilization was taken. Hospital readmissions within 30 days and ED visits within 7 days were extracted electronically as markers of complications. Surgical time was defined as from incision to skin closure, operating room time was from patient entry to leaving the operating room, and postoperative length of stay was from the time the patient left the operating room until time of discharge. Sterilization and presence of bilateral fallopian tubes were verified using a regional pathology database. Structured medical record review was performed by physician investigators (C.B.P., M.M., S.S.) to validate electronic coding of salpingectomies and tubal occlusion. Of the 733 charts reviewed, coding was accurate in 96% (95% CI 94–97). All 312 coded tubal fulgurations were confirmed to be fulguration for the purpose of sterilization. All 321 (primarily interval sterilization) procedures without listed surgical route (eg, laparoscopic compared with minilaparotomy) were reviewed as well as 100 randomly sampled peripartum procedures. Of the 421 salpingectomies and tubal occlusion procedures reviewed, 392 were coded accurately. Almost all data errors (27/29) were determined to be tubal occlusions coded incorrectly as

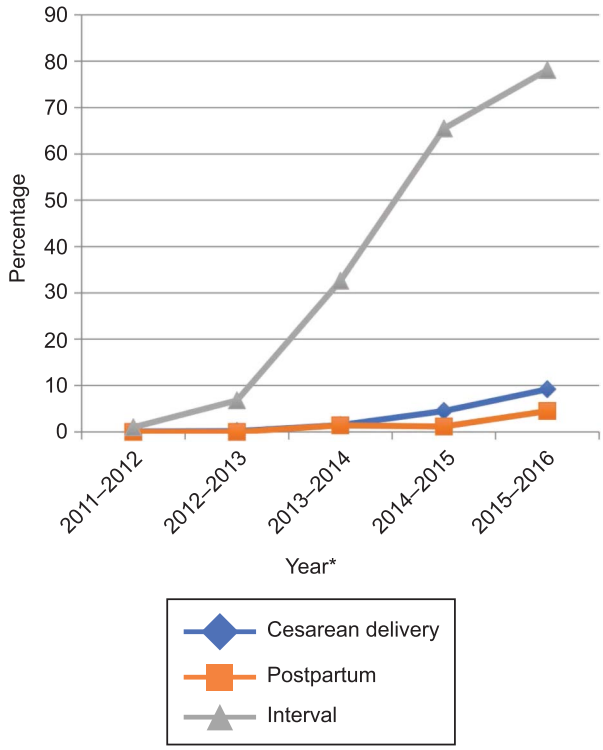

Fig. 1. Proportion of salpingectomy as a sterilization procedure, by surgical setting, 2011–2016. The increase in salpingectomy over the period 2011–2016 is shown as a percentage of tubal sterilization procedures performed at the time of cesarean delivery, postpartum, and as an interval procedure (test of trend, $P<.001$, $P=.003$, and $P<.001$, respectively). *Yearly intervals are June 1 to May 31.

Powell. Experience of Salpingectomy for Sterilization. Obstet Gynecol 2017.

salpingectomies. Misclassification was nondifferential with regard to time. Additionally, all 219 peripartum salpingectomy cases were reviewed and a random sample of 100 interval salpingectomies was reviewed for surgical technique. Concurrent procedures were defined as sterilizations performed with any other major procedure, including such procedures as cholecystectomy, ovarian cystectomy, or appendectomy. Minor procedures such as cervical biopsy or endometrial biopsy were not included as concurrent procedures. Sterilizations with concurrent procedures (n=390) were included in the trend analysis but not in the analysis of surgical outcomes.

Rates of salpingectomy and tubal occlusion were calculated for each of the five 1-year intervals in the study (June 2011–May 2012 through June 2015–May 2016). Because May 2013 marked the date of publication of the Kaiser Permanente Northern California salpingectomy practice guideline, we evaluated change in salpingectomy utilization prepublication and postpublication using χ^2 and Fisher exact tests. The prepublication–postpublication change was evaluated for each of the six geographic Kaiser Permanente Northern California regions, age, BMI, race, socioeconomic status, and concurrent surgery with an additive difference in change compared between regions using a linear regression model, where only the effect modification term is interpreted, as suggested by Ai and Norton.[24] Overall P value was obtained from a likelihood ratio statistic with P values based on the limiting χ^2 distributions (type 3 option for PROC GENMOD in SAS 9.3). The linear trend from the first-year interval to the last was evaluated using a Mantel-Haenszel χ^2 test. Bivariate analyses were performed to identify demographic and clinical factors as well as surgical factors associated with performance of salpingectomy in each of the three settings described. Continuous variables were described with medians and compared with the Kruskal-Wallis test. χ^2 and Fisher exact tests were used for categorical variables. All tests were two-tailed with $P<.05$ considered statistically significant and all analyses were performed using SAS 9.3. The Kaiser Foundation Research Institute's institutional review board approved this study with a waiver of consent.

RESULTS

A total of 10,973 procedures including salpingectomies or tubal occlusion for the indication of sterilization, excluding hysterectomy or oophorectomy cases, were identified in the surgical electronic record from June 1, 2011, to May 31, 2016. Two hundred twelve women were excluded for a genetic mutation and 22 excluded for age unknown or younger than 18 years. The study cohort consisted of the remaining 10,741 women. Sterilizations were classified into three groups as described in the "Methods." Characteristics of the study population are shown in Table 1. In the interval setting, salpingectomy was performed more frequently in women with BMI greater than 30 and performed more frequently in black women and less frequently in Asian women compared with Hispanic and non-Hispanic white women. Tubal sterilization procedure rates vary substantially by geographic region within northern California. One geographic region was twice as likely to perform interval salpingectomy (63.1%) compared with all others ($P<.001$), whereas other regions had higher rates of cesarean salpingectomy ($P<.001$). One region performed zero postpartum sterilization procedures over the study period, and 12 of the 13 postpartum salpingectomies were performed at another geographic region.

Salpingectomy utilization rates increased significantly each year from 2011 to 2016 for all procedure categories combined with an overall rate of 0.4% in 2011 increasing to 35.5% in 2016 (test for trend $P<.001$). Salpingectomy utilization rates also increased for each tubal sterilization procedure: during cesarean deliveries from 0.1% to 9.2% ($P<.001$), postpartum from 0% to 4.5% ($P=.003$), and interval tubal sterilization procedures from 1.0% to 78.1% ($P<.001$) over the study period (Table 2; Fig. 1). When performance of salpingectomy compared with tubal occlusion sterilization procedures was evaluated before and after publication of the Kaiser Permanente Northern California practice resource in May 2013, the rate of salpingectomy postpublication was statistically higher for all procedures. There were 3 of 2,330 (0.1%) compared with 203 of 3,860 (5.3%, $P<.001$) salpingectomies with cesarean delivery, 0 of 263 compared with 13 of 510 (2.6%, $P=.006$) for postpartum salpingectomies, and 55 of 1,376 compared with 1,460 of 2,502 (60.8% $P<.001$) for interval salpingectomies prepublication and postpublication, respectively.

Effect modification in change from the prepublication to postpublication period was evaluated for variables including age, parity, race, BMI, socioeconomic status, concurrent surgery, and region. The only variable that showed a pre- to post- May 2013 difference in trend across strata was region (Table 3). Although among individual regions the rate of interval salpingectomy significantly increased preresource publication to postresource publication across the board, the rate of change varied by region with increases in interval salpingectomy ranging from 43% to 72% (effect modification $P<.001$). In the cesarean delivery setting, increases ranged from 0% to 10% (effect modification $P<.001$). Because of hospital policies not allowing postpartum tubal sterilizations, most postpartum salpingectomies were done within a single region in the post period, resulting in significant effect modification on the additive scale ($P<.001$). Because there were no differences in trend in the other demographic variables, this effect is not likely to be related to the demographic composition of each region.

Surgery time was 9.5, 17, and 3 minutes longer for salpingectomy at cesarean delivery and postpartum and interval sterilization, respectively, compared with surgery time for tubal occlusion ($P<.001$, $P=.003$, and $P<.001$) (Table 4). Median blood loss was similar between salpingectomy and tubal occlusion procedures in the setting of cesarean (660 mL compared with 700 mL, respectively; $P=.24$) and interval sterilization (5 mL for both, $P=.65$). In the postpartum setting, median blood loss was 50 mL more for salpingectomy than for tubal occlusion (250 mL compared with 200 mL, $P=.04$). There was no significant difference in length of stay, 30-day readmission rates, or 7-day ED visits.

DISCUSSION

Our study contributes to the literature by describing the significant increase in utilization rates of salpingectomy as a tubal sterilization procedure in our health care system. This change was particularly remarkable for interval salpingectomies, which increased from 1% to 78% from 2011 to 2016. There was no increased blood loss with salpingectomy

Table 3. Salpingectomy Practice for Tubal Sterilization, Before (June 2011–May 2013) and After (June 2013–May 2016) Practice Guideline Publication

	Cesarean Delivery			Postpartum			Interval		
Variable	Before	After	P*	Before	After	P	Before	After	P
Total	3 (0.1)	203 (5.3)	<.001	0	13 (2.6)	.006*	55 (4.0)	1,460 (60.8)	<.001
Geographic region†									
A	1 (0.2)	50 (4.4)	<.001	0 (0.0)	1 (1.0)	1.00	22 (9.7)	426 (81.3)	<.001
B	1 (0.3)	0 (0.0)	1.00	—	—	—	4 (1.8)	184 (62.2)	<.001
C	0 (0.0)	5 (0.8)	.17	0 (0.0)	0 (0.0)	—	4 (1.7)	186 (44.8)	<.001
D	0 (0.0)	65 (9.5)	<.001	0 (0.0)	0 (0.0)	—	7 (2.3)	340 (55.0)	<.001
E	0 (0.0)	38 (6.6)	<.001	0 (0.0)	0 (0.0)	—	5 (2.3)	208 (61.2)	<.001
F	1 (0.3)	45 (8.5)	<.001	0 (0.0)	12 (18.5)	.007	13 (8.1)	116 (55.5)	<.001
Difference in change‡			<.001‡			<.001‡			<.001‡

Data are n (%) unless otherwise specified.
* Statistical test performed: Fisher exact test or χ^2, unless otherwise specified. Overall *P* value obtained from type 3 statistics using PROC GENMOD in SAS 9.3.
† Service area name intentionally masked.
‡ Additive difference in change between regions compared using a linear regression model, where only the effect modification is interpreted.

Table 4. Surgery Outcomes of Sterilization Done Without Concurrent Procedure

Characteristic	Cesarean Delivery			Postpartum			Interval		
	Tubal Occlusion	Salpingectomy	*P**	Tubal Occlusion	Salpingectomy	*P*	Tubal Occlusion	Salpingectomy	*P*
LOS (h)	57 (50–74)	52 (49–72)	.008	24.7 (21–28)	26 (24–38)	.08	1.8 (1.4–2.4)	1.8 (1–2.4)	.47
Surgery time (min)	52 (42–65)	61.5 (47–76)	<.001	33 (26–41)	50 (38–64)	.003	30 (23–39)	33 (26–42)	<.001
OR time (min)	89 (77–105)	98.5 (85–118)	<.001	65 (56–79)	100 (72–108)	.002	64 (56–74)	66 (58–78)	<.001
EBL (mL)†	700 (500–800)	660 (450–800)	.24	200 (15–300)	250 (250–400)	.04	5 (5–10)	5 (5–10)	.65
Readmission within 30 d	498 (8.4)	20 (9.9)	.4	16 (2.1)	1 (7.7)	.25	9 (0.4)	4 (0.3)	.49
ED visit within 7 d	0	0		0	0		4 (0.7)	7 (0.5)	.53

LOS, length of stay; OR, operating room; EBL, estimated blood loss; ED, emergency department.
Data are median (quartile 1–quartile 3) or n (%) unless otherwise specified. Percentages are percentage with outcome; percentage without outcome not shown.
* Statistical tests used: nonparametric Kruskal-Wallis for continuous variables and χ^2 test for categorical variables among cesarean and interval procedure and Fisher exact test for 30-day readmission among postpartum procedures.
† Missing: EBL, n=174, not differential by procedure.

compared with tubal occlusion during cesarean delivery or interval sterilization procedures and the increase of 50 mL for salpingectomy compared with tubal occlusion postpartum is likely not clinically significant. There was, however, an increase in surgical time. Although 3 minutes may be small for interval salpingectomy, the additional 9.5 and 17 minutes for cesarean delivery and postpartum tubal sterilization procedures, respectively, has a greater effect.

The adoption of salpingectomy by gynecologists for interval sterilizations is consistent with our prior study of opportunistic salpingectomy at the time of hysterectomy, where we found a similar increase in the performance of salpingectomies of 14.7–72% from 2011 to 2014. Others have also reported feasibility and adoption rates of salpingectomy in the setting of hysterectomy in the United States and Canada.[12–17] Utilization and safety of salpingectomy as a tubal sterilization procedure are less well characterized. McAlpine et al[14] report the increase in salpingectomy for sterilization from 0.4% to 33% in British Columbia, with a 10-minute increase in surgical time for salpingectomy with no other differences in length of stay, hospital readmission, or blood transfusion. Tubal sterilizations were not compared by relation to pregnancy.

At cesarean delivery, Shinar[19] showed no difference in operative time for total (using a vessel sealer) compared with partial salpingectomy (using a modified Pomeroy technique) at cesarean delivery. In contrast, Ganer Herman[20] showed an increase of 13 minutes for salpingectomy (using suture ligation) compared with tubal occlusion by the Parkland technique. Neither study showed a difference in surgical complications or blood loss. Ganer Herman[20] also evaluated levels of anti-müllerian hormone at 6 weeks postpartum and showed no difference. After vaginal delivery, Dania et al[21] showed a 12-minute increase in surgical time for salpingectomy without an increase in complications or blood loss for salpingectomy using suture ligation. Westberg[22] reported laparoscopic salpingectomy took 6 minutes longer than tubal occlusion with no significant difference in postoperative complications noted.

Given the lack of complications seen in these studies, the lower utilization of salpingectomy in the peripartum than interval setting provides an opportunity to explore barriers to salpingectomy. In our system, general obstetrician–gynecologists are tracked into one of three practice areas: hospitalists, office-based health care providers, and a small group who perform gynecologic surgery. Thus, the similarity in adoption of salpingectomy at hysterectomy and interval sterilization may reflect the change in practice among the same gynecologic surgeons. In contrast, it is possible that the hospitalist performing peripartum tubal occlusions may not have had the same exposure to this new practice. Another barrier to peripartum salpingectomy is that consent for sterilization is usually obtained by office-based health care providers before onset of labor, making deviation from the planned procedure difficult. In many Kaiser Permanente Northern California regions, postpartum tubal sterilizations are not offered because of operating room availability. The regional differences seen in practice change over time may also reflect gaps in equipment availability, education, or the presence of local advocates. The racial disparity noted in interval sterilization procedures, with a trend to greater use of salpingectomy in black Women than Hispanic and non-Hispanic white women and lowest in Asian, should be addressed in future studies.

Strengths of our study include the large population and access to electronic data and follow-up.

Limitations of our study include our health system may not be representative of care in the United States in general or in systems with different health coverage, costs, and reimbursements. Some misclassification was identified, as described. However, this was not differential by time. We were unable to electronically ascertain transfusion data and intraoperative complications and we used a crude marker of postoperative complications of length of stay, ED visits, and readmission rate. Ultimately, the value of salpingectomy requires more study to accurately balance the risks including complications, cost, surgical time, lack of reversibility, and potential effect on ovarian reserve against the benefits, including a higher rate of sterilization, lower reoperation rates, and, most importantly, the comparative reduction in ovarian cancer offered by salpingectomy over tubal occlusion.

REFERENCES

1. Kindelberger DW, Lee Y, Miron A, Hirsch MS, Feltmate C, Medeiros F, et al. Intraepithelial carcinoma of the fimbria and pelvic serous carcinoma: evidence for a causal relationship. Am J Surg Pathol 2007;31:161–9.
2. Kurman RJ, Shih IeM. The origin and pathogenesis of epithelial ovarian cancer: a proposed unifying theory. Am J Surg Pathol 2010;34:433–43.
3. Colgan TJ, Murphy J, Cole DE, Narod S, Rosen B. Occult carcinoma in prophylactic oophorectomy specimens: prevalence and association with BRCA germline mutation status. Am J Surg Pathol 2001;25:1283–9.
4. Powell CB, Kenley E, Chen LM, Crawford B, McLennan J, Zaloudek C, et al. Risk reducing salpingo-oophorectomy in BRCA mutation carriers: role of serial sectioning in the detection of occult malignancy. J Clin Oncol 2005;23:127–32.
5. Crum CP, Drapkin R, Miron A, Ince TA, Muto M, Kindelberger DW, et al. The distal fallopian tube: a new model for pelvic serous carcinogenesis. Curr Opin Obstet Gynecol 2007;19:3–9.
6. Karst AM, Levanon K, Drapkin R. Modeling high-grade serous ovarian carcinogenesis from the fallopian tube. Proc Natl Acad Sci U S A 2011;108:7547–52.
7. Society of Gynecologic Oncology of Canada. Salpingectomy and ovarian cancer prevention. Ottawa (Ontario, Canada): Society of Gynecologic Oncology of Canada; 2011.
8. Garcia C, Martin M, Tucker LY, Lyon L, Armstrong MA, McBride-Allen S, et al. Experience with opportunistic salpingectomy in a large, community-based health system in the United States. Obstet Gynecol 2016;128:277–83.
9. Society of Gynecologic Oncology. Salpingectomy for ovarian cancer prevention. Chicago (IL): Society of Gynecologic Oncology; 2013.
10. Salpingectomy for ovarian cancer prevention. Committee Opinion No. 620 [published erratum appears in Obstet Gynecol 2016;127:405]. American College of Obstetricians and Gynecologists. Obstet Gynecol 2015;125:279–81.
11. Gill SE, Mills BB. Physician opinions regarding elective bilateral salpingectomy with hysterectomy and for sterilization. J Minim Invasive Gynecol 2013;20:517–21.
12. Potz FL, Tomasch G, Polterauer S, Laky R, Marth C, Tamussino K. Incidental (prophylactic) salpingectomy at benign gynecologic surgery and cesarean section: a survey of practice in Austria. Geburtshilfe Frauenheilkd 2016;76:1325–9.
13. Reade CJ, Finlayson S, Mcalpine J, Tone AA, Fung-Kee-Fung M, Ferguson SE. Risk-reducing salpingectomy in Canada: a survey of obstetrician-gynaecologists. J Obstet Gynaecol Can 2013;35:627–34.
14. McAlpine JN, Hanley GE, Woo MM, Tone AA, Rozenburg N, Swenerton KD, et al. Opportunistic salpingectomy: uptake, risks, and complications of a regional initiative for ovarian cancer prevention. Am J Obstet Gynecol 2014;210:471.e1–11.
15. Morelli M, Venturella R, Mocciaro R, Di Cello A, Rania E, Lico D, et al. Prophylactic salpingectomy in premenopausal low-risk women for ovarian cancer: primum non nocere. Gynecol Oncol 2013;129:448–51.
16. Minig L, Chuang L, Patrono MG, Cárdenas-Rebollo JM, García-Donas J. Surgical outcomes and complications of prophylactic salpingectomy at the time of benign hysterectomy in premenopausal women. J Minim Invasive Gynecol 2015;22:653–7.
17. Hanley GE, McAlpine JN, Pearce CL, Miller D. The performance and safety of bilateral salpingectomy for ovarian cancer prevention in the United States. Am J Obstet Gynecol 2017;216:270.e1–9.
18. Duncan JR, Schenone MH, Mari G. Technique for bilateral salpingectomy at the time of cesarean delivery: a case series. Contraception 2017;95:509–11.
19. Shinar S, Blecher Y, Alpern S, Many A, Ashwal E. Total bilateral salpingectomy versus partial bilateral salpingectomy for permanent sterilization during cesarean delivery. Arch Gynecol Obstet 2017;295:1185–89.
20. Ganer Herman H, Gluck O, Keidar R, Kerner R, Kovo M, Levran D, et al. Ovarian reserve following cesarean section with salpingectomy vs tubal ligation: a randomized trial. Am J Obstet Gynecol 2017 [Epub ahead of print].
21. Danis RB, Della Badia CR, Richard SD. Postpartum permanent sterilization: could bilateral salpingectomy replace tubal ligation? J Minim Invasive Gynecol 2016;23:928–32.
22. Westberg J, Scott F, Creinin MD. Safety outcomes of female sterilization by salpingectomy and tubal occlusion. Contraception 2017;95:505–8.
23. Benefits and risks of sterilization. Practice Bulletin No. 133. American College of Obstetricians and Gynecologists. Obstet Gynecol 2013;121:392–404.
24. Chunrong A, Norton EC. Interaction terms in logit and probit models. Econ Lett 2003;80:123–9.