Complications after opportunistic salpingectomy compared with tubal ligation at cesarean section: a retrospective cohort study

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Objective: To compare perioperative and postoperative complications in patients who underwent opportunistic salpingectomy (OS) (removal of the fallopian tubes for ovarian cancer risk reduction during another surgery) at the time of cesarean section (C-section) with those in patients who underwent tubal ligation.
Design: A population-based, retrospective cohort study.
Setting: British Columbia, Canada.
Patient(s): A total of 18,184 patients were included in this study, of whom 8,440 and 9,744 underwent OS and tubal ligation, respectively.
Intervention(s): Patients who underwent OS during a C-section were compared with those who underwent tubal ligation during a C-section.
Main Outcome Measure(s): We examined the perioperative outcomes, including operating room time, length of hospital stay, surgical complications such as infections, anemia, incision complications, injury to a pelvic organ, or operating room return; postoperative complications, including physician visits for a postoperative infection or visits that resulted in ultrasound or laboratory examinations and hospital readmissions in the 6 weeks after discharge; and likelihood to fill a prescription for antibiotics or analgesics.
Result(s): The OS group had decreased odds of perioperative complications compared with the tubal ligation group (adjusted odds ratio [aOR], 0.77; 95% confidence interval [CI], 0.61–0.99). Patients who underwent OS did not have increased risks of physician visits for surgical complications, such as infection, or hospital readmissions in the 6 weeks after hospital discharge. In addition, these patients had 18% and 23% increased odds of filling prescriptions for nonsteroidal anti-inflammatory drugs (aOR, 1.18; 95% CI, 1.07–1.28) and opioids (aOR, 1.23%; 95% CI, 1.12–1.35), respectively.
Conclusion(s): In this population-based, real-world study of OS at C-section, we report decreased perioperative complications and no difference in postoperative complications between patients who underwent OS and those who underwent tubal ligation. Patients who underwent OS had an increased likelihood of filling a prescription for nonsteroidal anti-inflammatory drugs and opioids in the 6 weeks after hospital discharge. This result should be interpreted with caution because we did not have data on over-the-counter medication use and, thus, not all prescription analgesics were captured in our data. Our data suggest that OS after C-section is a safe way to provide effective contraception and ovarian cancer risk reduction. (Fertil Steril® 2023;■:■–■. ©2023 by American Society for Reproductive Medicine.)
Key Words: Ovarian cancer, permanent contraception, population-based, safety outcomes, sterilization

Ovarian cancer is the fifth most common cause of cancer deaths among females and is the most lethal gynecologic malignancy (1). In 2022, there were an estimated 19,880 new cases and 12,810 deaths in the United States (2). Although it is a relatively rare disease, with a mean lifetime risk of 1.4% in the general population (3), the 5-year survival rates are low, and no effective screening methods have been established (4–6). This underscores the importance of primary prevention. Evidence suggests that high-grade serous carcinoma (HGSC), which is the most common and lethal type of ovarian cancer, representing 70% of all ovarian cancers and 90% of all deaths from ovarian cancer, originates in the fallopian tubes rather than in the ovaries (7–10).

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This motivated a change in strategy toward primary prevention for the general population, recommended in British Columbia, Canada, since September 2010, namely, opportunistic salpingectomy (OS) (11). Opportunistic salpingectomy is the removal of the fallopian tubes at the time of hysterectomy or instead of tubal ligation while leaving the ovaries intact. Opportunistic salpingectomy removes the tissue of origin for HGSC while avoiding adverse consequences associated with removal of the ovaries (12–14). The American College of Obstetricians and Gynecologists and Society of Obstetricians and Gynaecologists of Canada have recommended OS as a primary prevention strategy (15). Since the recommendations were published, uptake has increased in both countries (16–20). In 2018, 9 countries published formal recommendations for OS (21).

In the United States, approximately 700,000 permanent contraception procedures are performed annually, of which 350,000 and more than 100,000 are conducted immediately postpartum after 8%–9% of all deliveries (22) and at the time of cesarean section (C-section) (23–25), respectively. In Canada, 25,000 tubal ligations are performed annually (26), offering a large number of opportunities to reduce ovarian cancer risk through OS. Multiple studies have shown that OS during hysterectomy and in lieu of tubal ligation is safe (16, 27). Recent data from British Columbia, Canada, have also indicated preliminary evidence of the effectiveness of OS. A population-based, retrospective cohort study of 25,889 individuals who underwent OS during hysterectomy or for sterilization and 32,080 individuals who underwent hysterectomy alone or tubal ligation reported 0 serous ovarian cancers in the OS group. The age-adjusted expected number, had serous cancers been increasing at the same rate in the OS group as in the group unexposed to OS, was 5.27 (95% confidence interval [CI], 1.78–19.29) (28). There have been concerns surrounding OS at the time of C-section compared with OS during benign hysterectomy because of the state of the reproductive organs during pregnancy, particularly with respect to the potential increased risk of bleeding. Although existing safety data on postpartum OS, including at the time of C-section, have been reassuring (29–33), a systematic review on OS at the time of C-section concluded that the literature was limited by a high number of single-centered studies of small sample sizes focusing on a limited number of outcomes (34). Herein, we examined real-world outcomes among a population of patients in British Columbia who underwent OS in the same hospital stay as a live birth. We compared the risk of perioperative and postoperative complications in patients who underwent OS with that of patients who underwent tubal ligation.

MATERIALS AND METHODS

This was a large population-based, retrospective cohort study of all individuals who underwent OS or tubal ligation during a C-section in the Canadian province of British Columbia (population, 5.2 million) between January 1, 2008, and March 31, 2021. This period was selected for analysis as an educational campaign recommending practice change took place in British Columbia in 2010; however, some practitioners began changing practice in 2008. There were too few contraception procedures performed in the same hospital stay as a vaginal birth to conduct stratified analyses; therefore, we focused exclusively on C-sections. The Discharge Abstract Database (35) was used, which contains data on all hospital stays and day surgeries (36, 37). These data were linked with data for all physician visits (38) and the BC PharmaNet (39), which is a database that contains all prescription drugs dispensed in community and outpatient pharmacies. Access to data provided by the Data Stewards is subject to approval but can be requested for research projects through the Data Stewards or their designated service providers. All inferences, opinions, and conclusions drawn in this publication are those of the investigators and do not reflect the opinions or policies of the Data Stewards. To protect patient privacy, small cell sizes were reported as ≤ 5. Ethics approval was obtained from the Clinical Research Ethics Board of the University of British Columbia.

We identified patients who underwent bilateral OS or tubal ligation during the same hospital stay as a live birth using the Canadian Classification of Health Interventions codes for bilateral OS (1.RF.89.X) and tubal ligation (1.RF.87.X). The inclusion criterion for our study was to have undergone a bilateral OS or tubal ligation for the purpose of permanent contraception (identified using the International Classification of Diseases, 10th edition, CA code Z30.2). All references to OS in this manuscript represent bilateral OS. Patients would have been counseled regarding tubal sterilization during their prenatal visits and would have decided on OS or tubal ligation with their provider weeks before C-section. This is true even for emergent C-sections because this decision-making was performed in advance. We excluded patients who did not give birth in the same stay as their OS or tubal ligation, were <15 years old, were not of female sex, and did not reside in British Columbia for at least 275 days of the year they delivered; those with stillbirths; and those without 6 complete weeks of follow-up.

Outcomes

Perioperative outcomes. We examined the total operating room (OR) time (time from the first skin incision to completed skin closure) and length of hospital stay (LOS), as well as surgical complications such as infections, anemia, incision complications, pelvic organ injury, and any return to the OR during the hospital stay.

Postoperative outcomes. We also examined complications that would not be captured in hospital data. We used physician visit data to examine visits to a physician for a postoperative infection, ultrasound imaging or laboratory tests ordered, and any hospital readmissions in the 6 weeks after hospital discharge. In addition, we examined the likelihood of filling a prescription for an antibiotic or a prescription-level analgesic (we did not have access to over-the-counter medications), identified using the Anatomical Therapeutic Chemical Classification Codes: J01 for antibiotics; M01 for nonsteroidal anti-inflammatory drugs (NSAIDs); and N02A and N02B for opioid agonist analgesics.

TABLE 1

Characteristics of patients who underwent tubal ligation and opportunistic salpingectomy.

Characteristic	Tubal ligation (N = 9,744)	Opportunistic salpingectomy (N = 8,440)	*P* value	Standardized mean difference
Age in years, mean (standard deviation)	33.6 (5.03)	34.5 (4.65)	<.001	0.186
Age groups, y				
15–24	401 (4.1%)	160 (1.9%)	<.001	—
25–29	1,720 (17.7%)	1,084 (12.8%)		
30–34	3,156 (32.4%)	2,834 (33.6%)		
35–39	3,304 (33.9%)	3,146 (37.3%)		
≥40	1,163 (11.9%)	1,216 (14.4%)		
Income quintile				
1	2,150 (22.1%)	1,717 (20.3%)	<.001	—
2	2,169 (22.3%)	1,797 (21.3%)		
3	1,946 (20.0%)	1,792 (21.2%)		
4	1,833 (18.8%)	1,746 (20.7%)		
5	1,540 (15.8%)	1,321 (15.7%)		
Missing	106 (1.1%)	67 (0.8%)		
Year of surgery, mean (standard deviation)	2,011.8 (3.26)	2,016.5 (2.76)	—	1.550
Year of surgery				
2008–2014	7,694 (79.0%)	2,019 (25.0%)	<.001	1.284
2015–2021	2,050 (21.0%)	6,331 (75.0%)		
Total No. of pregnancies, mean (standard deviation)	3.49 (1.60)	3.50 (1.70)	—	0.005
Total No. of pregnancies				
1	72 (0.7%)	98 (1.2%)	.021	—
2	2,621 (26.9%)	2,342 (27.7%)		
3	3,097 (31.8%)	2,535 (30.0%)		
4	1,751 (18.0%)	1,514 (17.9%)		
5	927 (9.5%)	814 (9.6%)		
≥6	932 (9.6%)	824 (9.8%)		
Missing	344 (3.5%)	313 (3.7%)		
Total live births, mean (standard deviation)	2.74 (0.95)	2.71 (0.99)	—	0.030
Total live births				
1	124 (1.3%)	141 (1.7%)	.004	—
2	4,278 (43.9%)	3,893 (46.1%)		
3	3,528 (36.2%)	2,843 (33.7%)		
4	1,064 (10.9%)	900 (10.7%)		
5	262 (2.7%)	223 (2.6%)		
≥6	144 (1.5%)	127 (1.5%)		
Missing	344 (3.5%)	313 (3.7%)		
Previous C-sections, mean (standard deviation)	1.20 (0.79)	1.18 (0.80)	—	0.023
Previous C-sections				
0	378 (3.9%)	370 (4.4%)	.009	—
1	1,476 (15.1%)	1,314 (15.6%)		
2	4,616 (47.4%)	4,114 (48.7%)		
3	2,304 (23.6%)	1,804 (21.4%)		
≥4	58 (0.6%)	50 (0.6%)		
Missing	912 (9.4%)	788 (9.3%)		
Previous gynecologic surgeries, mean (standard deviation)	0.18 (0.45)	0.11 (0.37)	—	0.165
Previous gynecologic surgeries				
0	125 (1.3%)	72 (0.9%)	<.001	—
1	7,461 (76.6%)	6,943 (82.3%)		
2	1,221 (12.5%)	614 (7.3%)		
≥3	25 (0.3%)	23 (0.3%)		
Missing	912 (9.4%)	788 (9.3%)		

C-section = cesarean section.

Rufin. OS vs. tubal ligation after C-section. Fertil Steril 2023.

Statistical Analysis

We compared patients who underwent tubal sterilization by OS with those who underwent tubal ligation using standardized mean differences (SMDs) for continuous variables, because of the large sample size, and *P* values generated by the chi-square test for categorical variables. An SMD of >0.1 was considered clinically meaningful, and statistical significance was defined as $P<.05$. Logistic regression models were used to estimate the crude odds ratios and adjusted odds ratios (aORs) and 95% CIs for binary outcomes. The variables shown in Table 1 were tested as potential confounders in our analysis and the fully adjusted models controlled for year of surgery, patient age, income, previous C-sections, previous gynecologic surgeries (Supplemental Table 1, available online), and live births. Because of the low number of events, all perioperative outcomes were grouped as a composite outcome. Total infections and other complications were also grouped as a composite for postoperative outcomes. As the rates of OS increased over time, we also performed an analysis stratified by study period (from 2008 to 2014 and from 2015 to 2021). All analyses were performed using the statistical software R and RStudio Version 1.3.1093.

RESULTS

Main Analysis

A total of 19,774 patients underwent surgical permanent contraception during a live birth in the same hospital stay in British Columbia between January 1, 2008, and March 31, 2021. We excluded patients who were not of female sex (n = 212) because of the possibility of data error; those who did not undergo OS or tubal ligation for permanent contraception purposes (n = 543); those who were not registered for universal health insurance in British Columbia for at least 275 days in the year of their surgery (n = 420), because we could not be certain that we had complete data capture for nonresidents; those with stillbirths (n = 15); and those without 6 complete weeks of follow-up (n = 151). Because of the small number of procedures performed after a vaginal birth (n = 249), we also excluded those with vaginal birth surgeries. It appeared that interval sterilization occurred more frequently after vaginal delivery. The final cohort included 18,184 patients, of whom 8,440 underwent OS and 9,744 had tubal ligation.

Table 1 shows the characteristics of patients who underwent OS and tubal ligation in our cohort. Patients who underwent OS were slightly older (34.5 [standard deviation {SD}, 4.65] vs. 33.6 [SD, 5.03] years; SMD, 0.186). The largest age category for both groups was 35–39 years (37.3% vs. 33.9%, $P<.001$). There were slightly more patients who underwent tubal ligation in the lower-income quintiles ($P<.001$). Opportunistic salpingectomy became more common over time, whereas tubal ligation became less common (OS, 25.0%, vs. tubal ligation, 79.0%, in 2008–2014 and OS, 75.0%, vs. tubal ligation, 21.0%, in 2008–2010; $P<.001$; SMD, 1.284). Both groups of patients who underwent tubal sterilization were comparable with regard to the mean number of pregnancies (3.5 for both groups; SMD, 0.005), mean total live births (2.7 for both groups; SMD, 0.030), and mean number of previous C-sections (1.2 for both groups [SD, 0.80]; SMD, 0.030). On average, patients in the tubal ligation group had more previous gynecologic surgeries (0.18 [SD, 0.45] vs. 0.11 [SD, 0.37] for OS; SMD, 0.165). Although we could not determine whether oophorectomies were intentional or not, there were only 12 unilateral oophorectomies in the OS group and ≤5 in the tubal ligation; therefore, these were not a common complication. No bilateral oophorectomies were noted in either group.

With respect to the crude rates of perioperative outcomes, Table 2 shows that the mean LOS was slightly lower in the OS group (2.48 [SD, 1.86] vs. 2.70 [SD, 1.55] days for tubal ligation; SMD, 0.128). Patients who underwent tubal ligation had shorter OR times, by a mean of approximately 8 minutes (75.1 [SD, 27.3] vs. 83.3 [SD, 26.7] minutes; SMD, 0.304). The rates of perioperative complications (infections, anemia, incision complications, pelvic organ injury, OR returns, and other complications during hospital stay) were low (up to 1.0% maximum) and similar between the groups.

In the 6 weeks after hospital discharge, no differences were noted between patients who underwent tubal ligation and those who underwent OS with respect to hospital readmissions, ultrasound examinations, laboratory tests, infections, or other complications. In addition, no difference in the number of physician visits was observed between the groups. Among antibiotic users, no differences in the number of days of antibiotics dispensed were noted between both groups. Among NSAID users, a significant difference in the number of days of drugs dispensed was observed between the groups (11.5 [SD, 6.47] days for OS vs. 10.2 [SD, 6.62] for tubal ligation; SMD, 0.199). No differences in the number of days of opioids dispensed were noted between both groups.

Table 3 shows the odds ratios (unadjusted, adjusted for age, and fully adjusted) of the outcomes. Patients who underwent OS were less likely to experience perioperative complications, which were a composite outcome of surgical infection, anemia, incision complications, pelvic organ injury, OR returns, and other complications during hospital stay (aOR, 0.77; 95% CI, 0.61–0.99). For postoperative outcomes, patients who underwent OS were significantly less likely to have ultrasound and laboratory visits (aOR, 0.79 [95% CI, 0.68–0.92] and 0.81 [95% CI, 0.72–0.91], respectively). However, patients who underwent OS were more likely to fill prescriptions for NSAIDs (aOR, 1.18; 95% CI, 1.07–1.28) and opioids (aOR, 1.23; 95% CI, 1.12–1.35) than those who underwent tubal ligation. No differences in the likelihood of hospital readmission, infection, antibiotic use, and other complications combined were noted between the groups.

Stratified Analysis

Supplemental Tables 2 and 3 (available online) show the results from the time-period stratified analyses. In the multivariate analysis stratified by study period (Supplemental Table 3), the odds of perioperative complications were significantly lower in patients who underwent OS than in those who underwent tubal ligation only in 2008–2014 (aOR, 0.60; 95% CI, 0.41–0.86). The OS group was less likely to have an ultrasound visit in the first study period (aOR, 0.72; 95% CI, 0.56–0.93) and less likely to have a laboratory visit in both

TABLE 2

Crude rates of operative/perioperative and postoperative outcomes for patients who underwent tubal ligation and opportunistic salpingectomy.

Variables	Ligation (N = 9,744)	Opportunistic salpingectomy (N = 8,440)	*P* value	Standardized mean difference
Length of stay, mean days (standard deviation)	2.70 (1.55)	2.48 (1.86)	<.001	0.128
Operating room times, minutes, mean (standard deviation)	75.1 (27.3)	83.3 (26.7)	<.001	0.304
Missing	3,045 (31.2%)	1,526 (18.1%)		
Perioperative complications				
Infections	90 (0.9%)	35 (0.4%)	<.001	0.062
Other complications during stay	49 (0.5%)	37 (0.4%)	.600	0.009
Anemia	48 (0.5%)	44 (0.5%)	.867	0.004
Incision complications	67 (0.7%)	47 (0.6%)	.308	0.017
Pelvic organ injury	68 (0.7%)	82 (1.0%)	.051	0.030
Operating room returns	15 (0.2%)	24 (0.3%)	.083	0.028
Postoperative outcomes				
Total readmissions	382 (3.9%)	294 (3.5%)	.130	0.023
Total ultrasound visits	678 (7.0%)	586 (6.9%)	.992	0.001
Total laboratory visits	1,445 (14.8%)	1,180 (14.0%)	.109	0.024
Total infections	28 (0.3%)	32 (0.4%)	.344	0.016
Other complications	47 (0.5%)	52 (0.6%)	.262	0.018
No. of physician visits, mean (standard deviation)	8.49 (5.58)	8.77 (5.60)	.140	0.051
Missing	7,858 (80.6%)	6,892 (81.7%)	.085	0.026
Antibiotics dispensed	2,030 (20.8%)	1,452 (17.2%)	<.001	0.093
No. of days of antibiotics dispensed among users, mean (standard deviation)	7.00 (1.00–90.0)	7.00 (1.00–100)	.537	0.021
Nonsteroidal anti-inflammatory drugs dispensed	2,476 (25.4%)	2,394 (28.4%)	<.001	0.067
No. of days of nonsteroidal anti-inflammatory drugs dispensed among users, mean (standard deviation)	10.2 (6.62)	11.5 (6.47)	<.001	0.199
Opioids dispensed	2,620 (26.9%)	2,051 (24.3%)	<.001	0.059
No. of days of opioids dispensed among users, mean (standard deviation)	6.54 (8.69)	6.11 (8.06)	.086	0.050
Missing	344 (3.5%)	313 (3.7%)		

Rufin. OS vs. tubal ligation after C-section. Fertil Steril 2023.

study periods (aOR, 0.75 [95% CI, 0.63–0.90] and 0.85 [95% CI, 0.73–0.99], respectively). Regarding prescription-level analgesics, patients who underwent OS were more likely to fill NSAID prescription in 2008–2014 (aOR, 1.31; 95% CI, 1.15–1.49) but not in 2015–2021. Patients who underwent OS were more likely to fill opioid prescription in both study periods (aOR, 1.30 [95% CI, 1.14–1.48] and 1.22 [95% CI, 1.06–1.40], respectively).

DISCUSSION

Principle Findings

Our results reveal decreased odds of perioperative complications among patients who underwent OS compared with those among patients who underwent tubal ligation after a C-section. We also observed a decreased likelihood of ultrasound and laboratory visits for patients who underwent OS but an increased likelihood of filling prescriptions for NSAIDs and opioids. The mean difference in the LOS was not clinically meaningful between the study groups. Patients who underwent tubal ligation had shorter OR times by approximately 8 minutes for the overall study period. This difference decreased over time to approximately 5 minutes from 2015 to 2021. With respect to postoperative complications, no differences in the number of physician visits, hospital readmissions, infections, and other complications were observed.

Results in the Context of What Is Known

Historically, there have been important concerns regarding OS at the time of C-section primarily because of the vascular anatomy during pregnancy compared with a uterus in a nonpregnant state at the time of benign hysterectomy or during a permanent contraception procedure when not immediately after delivery. An increased blood flow to the uterus and fallopian tubes during pregnancy introduces a potential increased risk of vascular injury, increased OR time, and blood loss during a C-section. Our study, which is, to our knowledge, the largest to date, supports the findings of a previous small randomized controlled trial (RCT) that compared blood loss and

TABLE 3

Unadjusted, adjusted for age, and fully adjusted odds ratios of complications after tubal ligation and opportunistic salpingectomy during cesarean section.

	Unadjusted and adjusted odds ratios (95% confidence intervals)			
	Tubal ligation (n = 9,744)	Opportunistic salpingectomy (n = 8,440)		
Variable	Reference	Odds ratio	Odds ratio adjusted for age	Adjusted odds ratio: full model[a]
Perioperative complications	1.00	0.82 (0.68–0.97)	0.80 (0.67–0.95)	0.77 (0.61–0.99)
Postoperative outcomes				
Total readmissions	1.00	0.88 (0.76–1.03)	0.91 (0.78–1.06)	0.86 (0.70–1.06)
Ultrasound visits	1.00	0.99 (0.89–1.12)	0.99 (0.88–1.12)	0.79 (0.68–0.92)
Laboratory visits	1.00	0.93 (0.86–1.01)	0.94 (0.86–1.02)	0.81 (0.72–0.91)
Total infections/other complications combined	1.00	1.27 (0.92–.76)	1.29 (0.93–1.79)	1.17 (0.76–1.85)
Antibiotic use	1.00	0.79 (0.73–0.85)	0.80 (0.75–0.87)	1.08 (0.98–1.20)
Prescription analgesic use: nonsteroidal anti-inflammatory drugs	1.00	1.16 (1.09–1.24)	1.15 (1.08–1.23)	1.18 (1.07–1.28)
Prescription analgesic use: opioids	1.00	0.87 (0.82–0.93)	0.88 (0.83–0.94)	1.23 (1.12–1.35)

Perioperative complications represented a composite outcome of infections, anemia, incision complications, pelvic organ injury, operating room returns, and other complications during stay. Postoperative complications included readmissions, ultrasound visits, laboratory visits, and a composite outcome of postoperative infections and other complications during the 6 weeks after hospital discharge.

[a] The fully adjusted models controlled for year of surgery, patient age, income, previous cesarean sections, previous gynecologic surgeries, and parity.

Rufin. OS vs. tubal ligation after C-section. Fertil Steril 2023.

OR time in patients who underwent OS (n = 19) with those in patients who underwent tubal ligation (n = 18). They found no difference in the total OR time (60 vs. 68 minutes, $P = .34$) or estimated blood loss (600 vs. 700 mL, $P = .09$) between the groups (29). However, the 8-minute difference in the OR time reported herein was statistically significant.

Our findings are consistent with other studies showing that OS during C-section is feasible and safe with minimally increased OR times compared with tubal ligation (29–34, 40). A small RCT that compared OS with tubal ligation found that the total estimated blood loss and safety outcomes were similar at 6 weeks postpartum for both groups (41). In another study, Powell et al. (42) compared the short-term intraoperative and postoperative complication rates of bilateral OS (n = 50) vs. partial OS (n = 99) during C-section and found no significant differences in the rates of postpartum fever, wound infection, relaparotomy, hospitalization length, estimated blood loss, transfusions, and readmissions within 1 month postpartum. These findings are consistent with the studies from British Columbia, Canada (27), and the United States (41–44) that have shown no differences in the estimated blood loss, blood transfusions, readmissions, reoperations, and intraoperative, perioperative, and postoperative complications between patients who underwent OS and tubal ligation. Our findings regarding more NSAID and opioid use among those in the OS group is also consistent with another safety study from British Columbia in which patients who underwent OS had a slightly increased likelihood of filling a prescription for analgesics in the immediate 2 weeks after discharge, which disappeared by 1 month after discharge (27).

Clinical Implications

Our results suggest that OS at the time of C-section is safe and does not increase the risk of perioperative or postoperative complications. Although a slightly increased risk of filling an analgesic prescription was observed, this was not associated with longer hospital stay or the necessity of further investigation with ultrasound or laboratory in the postoperative period.

Research Implications

Uptake of OS at the time of C-section has been considerably lower than at the time of hysterectomy (19). Although we expect that this is partly driven by safety concerns, we also hypothesize that it may reflect physician concerns around reducing the age of onset of menopause (45). There have been several reassuring observational studies, including those examining ovarian sonographic parameters and hormonal assays, and a small RCT that have reported no differences in hormonal assays (46–48) and no significant differences in the pregnancy and postpartum antimüllerian hormone levels between the groups for the RCT (48). Although the evidence that exists is reassuring, more evidence regarding the age of onset of menopause is needed to ensure that there is no difference.

Furthermore, several patients who undergo OS at the time of C-section have a history of C-sections, which can result in an increased risk of adhesive disease, making surgery more challenging (49). In a study of successful completion of total and partial OS at the time of C-section, 7 patients underwent bilateral partial OS because of adhesions, engorged vasculature, or unspecified reasons, and 1 patient was unable to have any procedure because of significant adhesive disease. As a result, this

study found that among individuals who planned a bilateral OS, having ≥3 C-sections was associated with needing an alternative procedure (40). Although we did not observe increased risks in our OS group despite some included patients having a high number of previous C-sections, we did not directly address the likelihood of needing an alternative procedure in our study. Further research in this area is required.

Strengths and Limitations

Our study is strengthened by its population-based nature. To our knowledge, this is the first study to examine an entire population of patients who underwent OS during the same hospital stay as a live birth. This study included all hospital stays where both a live birth and tubal ligation or bilateral OS for permanent contraception occurred in British Columbia; therefore, there were no biases resulting from focusing on a single hospital or center. However, this study has limitations common to retrospective and observational study designs. There is a risk of physician coding inaccuracy in the databases. However, this imprecision is unlikely to be related to OS status and, thus, would not be a source of significant bias. Although outcomes may have varied across different centers, we did not have information on where procedures were performed and, thus, were unable to examine the effect of center. We were also missing data on the indication for the C-section and on the planned procedure for permanent contraception, meaning that we do not have data on failed attempts because of surgical limitations. Finally, we are limited by the fact that the BC PharmaNet does not include over-the-counter medications; thus, many of the NSAIDs used in this cohort were likely not captured. This makes the significant difference in NSAID use less reliable because patients in both groups may have purchased NSAIDs over the counter. We also cannot accurately assess whether patients took the medications. Our data simply indicate that they were filled through the BC PharmaNet. The likelihood of not taking or not completing a prescription for analgesics is high because these are generally used as needed. Finally, we cannot directly assess whether patients who underwent OS experienced a higher degree of pain because no patient-reported outcomes were available in the population-based administrative database. We recommend that future research on patient-reported outcomes be performed to better understand pain after OS compared with that after tubal ligation.

CONCLUSION

We report the decreased odds of perioperative complications and no differences in postoperative complications between patients who underwent OS and tubal ligation during the same hospital stay as a live birth after a C-section. We observed an increased risk of filling a prescription for NSAIDs and opioids in the 6 weeks after discharge. This finding should be interpreted with caution because we did not have access to the over-the-counter NSAID use and actual patient medication intake. Given the recent preliminary evidence showing fewer observed than expected ovarian cancers in patients who underwent OS, particularly HGSCs, and the growing body of evidence around safety (28), with equal or better efficacy for contraception, OS after C-section should be offered to patients. Patients should also be counseled that choosing OS will reduce their risk of ovarian cancer. Opportunistic salpingectomy is a feasible option that is also an effective and safe ovarian cancer prevention strategy.

CREDIT AUTHORSHIP CONTRIBUTION STATEMENT

Khaye Gerazel A. Rufin: Writing – review & editing, Writing – original draft, Methodology, Formal analysis, Conceptualization. **Helena Abreu do Valle:** Writing – review & editing, Writing – original draft, Methodology, Formal analysis. **Jessica N. McAlpine:** Writing – review & editing, Writing – original draft, Methodology, Conceptualization. **Chelsea Elwood:** Writing – review & editing, Writing – original draft, Methodology, Conceptualization. **Gillian E. Hanley:** Writing – review & editing, Writing – original draft, Supervision, Methodology, Formal analysis, Conceptualization.

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