



# Perioperative complication rates of colpopcleisis performed with or without concomitant hysterectomy: a large population-based study

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## Abstract

**Introduction and hypothesis** We aimed to compare perioperative complications for women who underwent colpopcleisis with and without concomitant hysterectomy, and report the rate of concomitant hysterectomy.

**Methods** We conducted a retrospective study using the Healthcare Cost and Utilization Project (HCUP) – Nationwide Inpatient Sample 2004 to 2014. We used International Classification of Diseases, Ninth Revision (ICD-9) codes to identify women with pelvic organ prolapse (POP) who underwent colpopcleisis with or without concomitant hysterectomy. Trend over time of each procedure type was created. We calculated odds ratios (ORs) to determine the risk of perioperative complications with or without concomitant hysterectomy. ORs were adjusted for age, race, income, insurance plan, and hypertension.

**Results** Of 253,100 adult women who underwent POP repair, 7,431 had colpopcleisis. Colpopcleisis with concomitant hysterectomy was performed in 1,656 (22.2%) and 5,775 (77.7%) underwent colpopcleisis alone (2,469 [33.2%] had a previous hysterectomy). Hysterectomy rates among women with POP undergoing colpopcleisis remained relatively steady, whereas those undergoing colpopcleisis without hysterectomy declined over time. Prevalence of any complications was higher among those with concomitant hysterectomy (11.4% vs 9.5%,  $p=0.023$ ). Adjusted OR showed that concomitant hysterectomy increased the risk of complications (OR 1.93, 95% CI 1.45–2.57,  $p<0.001$ ).

**Conclusions** Our large administrative data analysis suggests an increased risk of complications when performing a hysterectomy at the time of colpopcleisis. A concomitant hysterectomy was performed in 22% of cases. Whether or not to include hysterectomy at the time of colpopcleisis is based on shared decision making, influenced by individual patients' values, comorbidities, and risk of complications.

**Keywords** Colpopcleisis · Hysterectomy · Perioperative complication · Database · Epidemiology · Pelvic organ prolapse

## Introduction

Colpopcleisis procedures have been performed since the 1800s [1]. These obliterative procedures are typically

reserved for advanced stage pelvic organ prolapse (POP), in older individuals no longer wishing to be sexually active through penetrative intercourse. Most women undergoing colpopcleisis are reportedly between 60 and 90 years old [2, 3]. Heterogenous data report the comparative rates of:

1. Partial colpopcleisis with uterus in situ (LeFort colpopcleisis; 18–87%) [3–5]
2. Complete colpopcleisis in individuals with previous hysterectomy (55–70%) [4, 5]
3. Complete colpopcleisis with concomitant hysterectomy (4–27%) [3–5]

As a group, colpopcleisis procedures are associated with high success rates, ranging from 91 to 100%, as well as low complication rates (6–15%) [1, 3, 4, 6, 7]. Postoperative

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regret due to loss of coital function has been reported, with a prevalence between 0 and 9% [1, 8]. This reinforces the need for thorough pre-operative counselling to ensure appropriate patient expectations postoperatively. As noted by Hill et al., there is little literature on the difference in outcomes after colpocleisis with concomitant vaginal hysterectomy compared with LeFort colpocleisis [4]. Concomitant hysterectomy is associated with longer operative time and increased mean blood loss, with conflicting evidence regarding impact on transfusion rates in smaller studies [4, 9, 10]. The largest reported series of patients with colpocleisis ( $N=4,776$ ) did not evaluate the role of concomitant hysterectomy, but found an overall complication rate of 6.82% [6]. In a review of 1,000 cases through the American College of Surgeons National Surgical Quality Improvement Program (ACS-NSQIP) database, vaginal hysterectomy was associated with an increased risk of serious medical complications (overall 1.2%, 12 serious medical complications in the whole cohort) [3].

We aimed to compare the impact on complication rates of three different approaches to colpocleisis for POP (LeFort with uterus in situ, complete colpocleisis in individuals with previous hysterectomy, and complete colpocleisis with concomitant hysterectomy) among a large study population, through an analysis of the Healthcare Cost and Utilization Project (HCUP) – Nationwide Inpatient Sample database.

## Materials and methods

### Study samples and selection criteria

We conducted a retrospective study using the HCUP–NIS from 2004 to 2014. HCUP represents a 20% stratified sample of discharge data from hospitals in the USA. Over 7 million hospital stays are represented in this database. Information does not include long-term or rehabilitation facilities (HCUP, 2019). For our analyses, we extracted all hospital record information based on International Classification of Diseases, Ninth Revision (ICD-9), for women who had POP (diagnostic codes: 618.0–618.8) and prolapse repair (procedural codes: 69.2–69.29, 70.4–70.92 excluding 70.72–70.75) with and without hysterectomy (procedural codes 68.3–68.9).

Women who had urogenital and gastrointestinal cancers (179–184, 188–189, 198–199, 152, 197.4–197.8, 209.00–209.03, 209.10–209.17, 209.24–209.27, 209.74, 236) were excluded. Sociodemographic variables of interest included patient age, race, income, medical insurance plan, and length of stay. Comorbidities considered were tobacco smoking (305.1), obesity (278.00, 278.01, 278.03), hypertension (401.0–401.9), diabetes (250.0–250.9), chronic obstructive pulmonary disease (490.00–496.00), coronary

artery disease (414.01–414.3), and chronic kidney disease (585.9, 586.00).

Adult women with POP who underwent colpocleisis (procedure codes 70.4 and 70.8) were selected. Two groups were then created composed of women who had undergone colpocleisis with and without hysterectomy. Those who did not have hysterectomy were further divided into women who had a uterine prolapse (LeFort colpocleisis; 618.1 to 618.4) or vaginal vault prolapse (complete colpocleisis; 618.5).

We also extracted common complications associated with colpocleisis, namely hemorrhage including receiving blood transfusion (459.0, 998.11, V58.2) procedure codes 990.0–990.9), infection, (998.59), bowel obstruction (560.81, 560.89, 560.9), peritoneal abscess (567.22), accidental puncture (998.2), cystotomy (V44.50), injury to the gastrointestinal tract (863.20, 863.29, 863.30, 863.39, 863.40–59, 863.80, 863.89, 863.90 and 863.99), wound disruptions (998.30, 998.31, 998.32), venous thromboembolism (453.4x, 453.5x, 453.6, 453.7x, 453.8x, 453.9, 415.1x), cardiovascular complications (410.0–410.9; 398.91, 402.x1, 404.x1, 404.x3, 428.x), pelvic abscess/hematoma (614.4, 665.70), pneumonia (480x, 481, 482, 483.0, 483.8, 485, 486), respiratory complications (997.31, 997.39), genitourinary complications (997.5), *C. difficile* colitis (008.45), ischemic stroke (362.3x, 433.x1, 434.x1, 436), hemorrhagic stroke (431), and acute kidney injury (584x). A variable called “accidental organ puncture” was created including codes for accidental puncture, cystotomy, and injury to the gastrointestinal tract owing to the low numbers in each category. A variable called “any complications” was created including any of the complications (hemorrhage, requiring transfusion, infection, bowel obstruction, peritoneal abscess, peritonitis, accidental puncture, cystotomy, gastrointestinal injury, wound disruption, deep vein thrombosis or pulmonary embolus, cardiovascular complications, pelvic abscess/pelvic hematoma, pneumonia, respiratory complications, genitourinary complications, *C. difficile* colitis, ischemic stroke, hemorrhagic stroke, and acute kidney failure. Death was extracted from the variable “Died” in the HCUP database).

### Statistical methods

We conducted an evaluation of the prevalence rates for women with POP who had undergone colpocleisis with and without hysterectomy. We also calculated the percentages among women without hysterectomy who had either uterine prolapse or vaginal vault prolapse. Descriptive analysis using baseline sociodemographic characteristics and co-morbidities was performed for women with POP who underwent repair, including those with and those without hysterectomy.

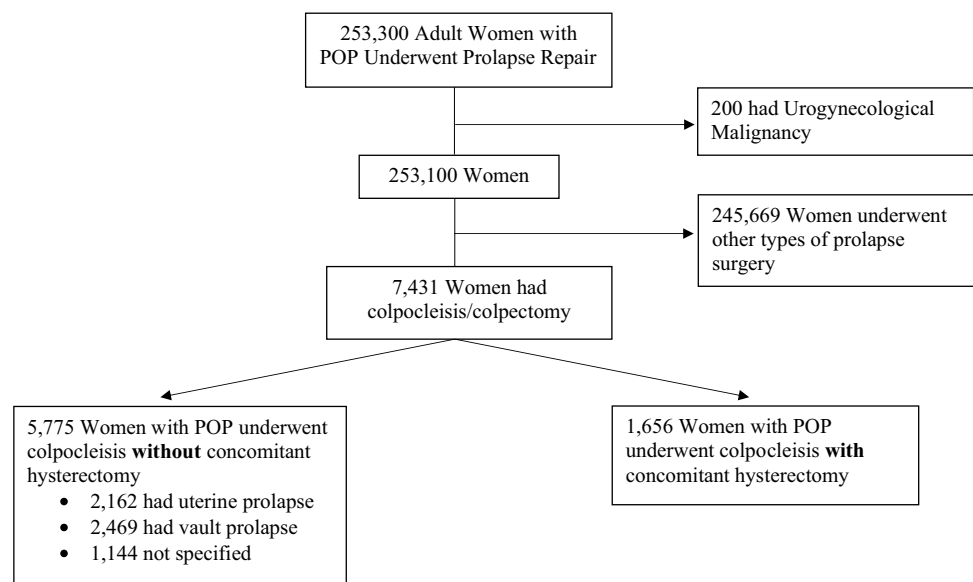
Categorical variables are presented as percentages and compared using Chi-squared test. Continuous variables such as age and length of stay (LOS) are presented as median (interquartile range [IQR]) and compared using Mann–Whitney test based on the normality of the distribution. A comparison was also made among the six most common complications associated with colpocleisis, namely requiring transfusion, hemorrhage, cardiovascular complications, acute renal failure, genitourinary complications, and accidental organ puncture, as well as for any complications. We also examined age distribution among women who underwent colpocleisis with and without complications. Finally, multivariate logistic regression analysis was conducted to estimate odds ratio (OR) and 95% confidence intervals (CI) for the risk of any complications among women undergoing colpocleisis with or without concomitant hysterectomy. Analysis was adjusted for age, race, income, insurance plan, and comorbidities of smoking, obesity, hypertension, diabetes mellitus, chronic obstructive pulmonary disease, coronary artery disease, and chronic kidney disease. After comparing colpocleisis without hysterectomy (reference group) with colpocleisis with concomitant hysterectomy, a second analysis was performed using LeFort colpocleisis as our reference compared with complete colpocleisis for vault prolapse, and with hysterectomy and complete colpocleisis. Statistical significance was set at  $p < 0.05$  and all analyses were performed using SPSS for Windows, version 27.0 (IBM Corp.). As data were anonymized and publicly available, institutional review board approval was not required. As per HCUP-NIS policy, results with less than 20 individuals in a group (which represents 0.3% of our sample of colpocleisis cases) could not be reported.

## Results

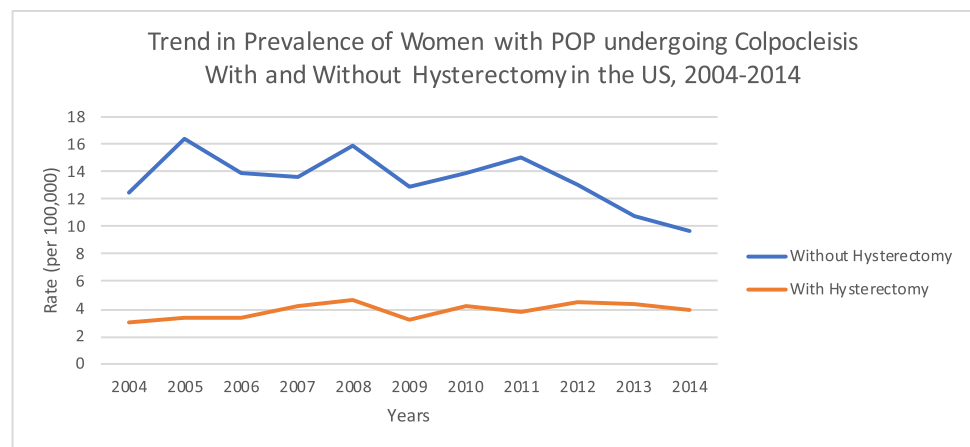
After excluding women with urogenital and gastrointestinal cancers, a total of 253,100 adult women underwent POP repair. Among them, 7,431 women specifically had colpocleisis/colpectomy, whereas the remaining underwent other types of prolapse surgery. 1,656 (22.2%) women had colpocleisis with hysterectomy. Of the 5,775 (77.7%) women without hysterectomy, 2,162 (29.1%) had undergone LeFort colpocleisis and 2,469 (33.2%) had complete colpocleisis for vault prolapse after a remote hysterectomy (Fig. 1). Of individuals with uterine prolapse who underwent colpocleisis, 43.4% underwent a concomitant hysterectomy. The diagnosis (uterine vs vault POP) for the rest of women who underwent colpocleisis without hysterectomy was not clarified in the database ( $N=1,144$ ). Figure 2 shows that hysterectomy rates among women with POP undergoing colpocleisis remain relatively steady, whereas those undergoing colpocleisis without hysterectomy are declining from 2004 to 2014, going from 12.5 to 9.7 per 100,000. Examining trends for women without concomitant hysterectomy who had either uterine prolapse or vaginal vault prolapse show declining rates across the same timeframe (Supplementary Fig. 1).

Based on sociodemographic variables (Table 1), women undergoing colpocleisis were predominantly older than 71 years old, of white race, and had mostly Medicare insurance. Median (IQR) LOS was shorter for women undergoing colpocleisis than those undergoing any POP repairs (1 [1–2] vs 2 [1–2] days). Alternatively, concomitant hysterectomy increased LOS at the time of colpocleisis compared with those without (2 [1–3] vs 1 [1–2] days;

**Fig. 1** Adult women with pelvic organ prolapse (POP) who underwent colpocleisis in the USA derived from the Healthcare Cost and Utilization Project – Nationwide Inpatient Sample database (2004 to 2014)



**Fig. 2** Trend in prevalence of women with pelvic organ prolapse (POP) undergoing colpocleisis with and without concomitant hysterectomy in the USA (2004–2014)



$p < 0.001$ ). Hypertension was significantly more common among women who underwent colpocleisis without hysterectomy compared to those with concomitant hysterectomy, whereas the rate of hypertension was much lower overall among all women undergoing POP repair. Demographic and baseline characteristics of women undergoing LeFort colpocleisis for uterine prolapse vs complete colpocleisis for vault prolapse were similar (Supplementary Table 1).

Table 2 highlights common perioperative complications among women who underwent colpocleisis with or without concomitant hysterectomy. Concomitant hysterectomy at the time of colpocleisis was associated with an increased risk of complication (11.4 vs 9.5%,  $p = 0.023$ ). Need for blood transfusion was the most common complication, occurring in 281 (3.8%) after colpocleisis. Based on HCUP guidelines of individual cells of less than 20 subjects, details of complications other than the six most common (including death) could not be further analyzed individually. Among women undergoing colpocleisis, those who experienced any complications were marginally older (79 [73–84] vs 78 [72–83],  $p < 0.001$ ). This was especially true for women who had hemorrhage or who required transfusion.

Among 245,669 women who underwent other types of POP repair, 4,310 (1.8%) women experienced gastrointestinal injury, cystotomy or accidental organ puncture, followed by 3,892 (1.6%) women needing blood transfusion. Overall, 15,865 (6.5%) women experienced any of the complications listed (Supplementary Table 2). When we examined age distribution, it was noted that overall, complications occurred among women between 50 and 75 years of age. Hemorrhage occurred at a younger age (53 [43–76],  $p < 0.001$ ). Women who experienced pelvic/peritoneal abscess/hematoma or peritonitis were also found to have it at a younger age (53 [43–76],  $p = 0.001$ ). Very few women died perioperatively. Overall complication rate was higher after colpocleisis than after other POP repairs (9.6% vs 6.5%,  $p < 0.001$ ).

Table 3 describes multivariate logistic regression analysis among colpocleisis patients with and without concomitant

hysterectomy and the presence of complications. Upon adjusting for sociodemographic variables, keeping women without hysterectomy as our reference, the odds ratio for women with concomitant hysterectomy for developing any complications was 1.927 (1.445–2.568,  $p < 0.001$ ). When LeFort colpocleisis is the reference group, risk of having any complications among those with complete colpocleisis was not significant (OR 0.945, 95% CI 0.641–1.370,  $p = 0.764$ ), whereas the risk in those with concomitant hysterectomy was significant (OR 1.666, 1.145–2.425,  $p = 0.008$ ).

## Discussion

In this large USA-based database, we found that concomitant hysterectomy was performed in 22% of colpocleisis procedures. Specifically, among women with uterine prolapse, 43.4% underwent a concomitant hysterectomy. Overall perioperative complications occurred in 9.6% of cases, with an increased risk associated with concomitant hysterectomy. Rate of colpocleisis without hysterectomy decreased over time. We reported the respective proportions of colpocleisis that are performed for vault prolapse (39.3%) vs cases of uterine prolapse (60.7%).

We found that patients undergoing colpocleisis without concomitant hysterectomy were older than those undergoing concomitant hysterectomy (median age 78 [73–83] vs 75 [69–80]). This finding is consistent with previous literature. A NSQIP database study of over 1,000 cases showed that mean age at the time of LeFort colpocleisis was  $79.4 \pm 6.9$  years vs  $76.7 \pm 6.6$  years at the time of colpocleisis with concomitant vaginal hysterectomy [3]. Older age was also associated with the risk of any complication in our study ( $p < 0.001$ ). This is consistent with a study by Sung et al. of 264,340 women undergoing urogynecological surgery, although not specific to colpocleisis. In that study, age over 80 was associated with an increased risk of perioperative complications (OR 1.4 [95% CI 1.3–1.5]) and a drastic

**Table 1** Characteristics of women with pelvic organ prolapse (POP) who underwent colpopoiesis with and without concomitant hysterectomy

	Colpopoiesis N (%)			All women undergoing any POP surgical repair N=253,100	p value*
	Without concomitant hysterectomy N=5,775	With concomitant hysterectomy N=1,656	Total N=7,431		
Age (years), median (IQR)	78 (73–83)	75 (69–80)	78 (72–83)	60 (49–69)	
Age groups					
18–50	138 (2.4)	88 (5.3)	226 (3.0)	70,577 (27.9)	<0.001
51–60	117 (2.0)	87 (5.3)	204 (2.7)	59,352 (23.5)	
61–70	711 (12.3)	327 (19.7)	1,038 (14.0)	65,513 (25.9)	
71–80	2,504 (43.4)	765 (46.2)	3,269 (44.0)	45,235 (17.9)	
>80	2,305 (39.9)	389 (23.5)	2,694 (36.3)	12,423 (4.9)	
Race					
White	3,844 (80.7)	997 (70.9)	4,841 (78.5)	162,946 (80.1)	<0.001
Black	239 (5.0)	81 (5.8)	320 (5.2)	8,301 (4.1)	
Hispanic	401 (8.4)	181 (12.9)	582 (9.4)	22,358 (11.0)	
Asian or Pacific islander	114 (2.4)	72 (5.1)	186 (3.0)	2,997 (1.5)	
Native American or other	163 (3.4)	75 (5.3)	238 (3.9)	6,718 (3.3)	
Income quartiles					
1st quartile (lowest income)	670 (19.4)	240 (22.3)	910 (20.1)	29,134 (22.0)	<0.001
2nd quartile	818 (23.7)	220 (20.5)	1,038 (22.9)	34,250 (25.8)	
3rd quartile	945 (27.4)	265 (24.7)	1,210 (26.7)	35,085 (26.4)	
4th quartile (highest income)	1,022 (29.6)	350 (32.6)	1,372 (30.3)	34,250 (25.8)	
Plan type					
Medicare	4,953 (85.9)	1,269 (76.7)	6,222 (83.9)	92,720 (36.7)	<0.001
Medicaid	118 (2.0)	70 (4.2)	188 (2.5)	12,067 (4.8)	
Private	623 (10.8)	267 (16.1)	890 (12.0)	136,761 (54.1)	
Self-pay, no charge, or other	72 (1.2)	49 (3.0)	121 (1.6)	11,138 (4.4)	
Co-morbidities					
Smoking	145 (2.5)	55 (3.3)	200 (2.7)	15,895 (6.3)	<0.001
Obesity	192 (3.3)	82 (5.0)	274 (3.7)	13,036 (5.2)	<0.001
Hypertension	3,513 (60.8)	892 (53.9)	4,405 (59.3)	90,991 (36.0)	<0.001
Diabetes mellitus	953 (16.5)	294 (17.8)	1,247 (16.8)	24,232 (9.6)	<0.001
Chronic obstructive pulmonary disease	733 (12.7)	167 (10.1)	900 (12.1)	24,562 (9.7)	<0.001
Coronary artery disease	531 (9.2)	134 (8.1)	665 (8.9)	7,089 (2.8)	<0.001
Chronic kidney disease	126 (2.2)	37 (2.2)	163 (2.2)	992 (0.4)	<0.001

\*p value refers to women who underwent colpopoiesis with or without concomitant hysterectomy

increased risk of mortality (OR 13.6 [95% CI 5.9–31.4]) compared with women less than 60 years old [11]. Reassuringly, a study of over 100 octogenarians undergoing colpopoiesis found a low rate of serious complications (3.2%) despite an overall high complication rate (28.6%) in that older population [12]. In Sung et al, a lower risk of complication was observed for those undergoing obliterative procedures (17.0%) compared with reconstructive procedures (24.7%) [11]. In our study, the rate of complication was comparatively higher after colpopoiesis with or without hysterectomy than after other prolapse repair procedures (9.6% vs 6.5%,  $p < 0.001$ ). Although obliterative procedures are often

considered less invasive than reconstructive procedures, the increased rate of complications in our study may be related to the higher rate of comorbidities among individuals undergoing colpopoiesis compared with those undergoing other prolapse repairs.

In general, it is recommended that concomitant hysterectomy be performed at the time of colpopoiesis only in cases of abnormal postmenopausal bleeding or in patients with risk factors for endometrial/cervical cancer [10, 13]. With an overall lifetime incidence of endometrial cancer of 3.1% (NIH data 2022), a concomitant finding of endometrial malignancy in hysterectomy specimens at the time of



**Table 2** Types of perioperative complications among women with concomitant hysterectomy, uterine prolapse (without hysterectomy), vaginal vault prolapse (without hysterectomy) who underwent colpocleisis or other types of prolapse repair

Perioperative complications	Procedure type					Other POP repairs N= 245,669	p value <sup>d</sup>
	All colpocleisis N= 7,431	Colpocleisis with concomitant hysterectomy N=1,656	Colpocleisis without hysterectomy		Total N=4,631		
			Uterine prolapse (LeFort colpocleisis) N=2,162	Vaginal vault prolapse (complete colpocleisis) N=2,469			
Six most common complications							
Required transfusion	281 (3.8)	88 (5.3)	81 (3.7)	82 (3.3)	163 (3.5)	3,892 (1.6)	0.056
Hemorrhage	90 (1.2)	26 (1.6)	30 (1.4)	28 (1.1)	58 (1.2)	2,464 (1.0)	0.435
Cardiovascular complications <sup>a</sup>	121 (1.6)	36 (2.2)	38 (1.8)	31 (1.3)	69 (1.5)	1,474 (0.6)	0.197
Acute renal failure	104 (1.4)	29 (1.8)	42 (1.9)	23 (0.9)	65 (1.4)	507 (0.2)	0.057
Genitourinary complications	87 (1.2)	21 (1.3)	23 (1.0)	31 (1.2)	54 (1.2)	3,278 (1.3)	0.557
Accidental puncture	76 (1.0)	Not reported <sup>c</sup>	Not reported <sup>c</sup>	Not reported <sup>c</sup>	Not reported <sup>c</sup>	4,267 (1.7)	0.736
Any of the six most common complications	640 (8.6)	169 (10.2)	191 (8.7)	202 (8.1)	393 (8.4)	14,231 (5.8)	0.031
Any complication <sup>b</sup>	713 (9.6)	189 (11.4)	210 (9.7)	228 (9.2)	438 (9.5)	15,854 (6.5)	0.023

*POP pelvic organ prolapse*

<sup>a</sup>Includes myocardial infarction, hypertensive heart disease

<sup>b</sup>Includes hemorrhage, requiring transfusion, infection, bowel obstruction, peritoneal abscess, peritonitis, accidental puncture, cystotomy, gastrointestinal injury, wound disruption, deep vein thrombosis or pulmonary embolus, cardiovascular complications, pelvic abscess/pelvic hematoma, pneumonia, respiratory complications, genitourinary complications, *C. difficile* colitis, ischemic stroke, hemorrhagic stroke, and acute kidney failure

<sup>c</sup>Exact number could not be reported (some of the cells had numbers <20)

<sup>d</sup>p value refers to women who underwent colpocleisis with or without concomitant hysterectomy

POP repair or colpocleisis is very rare (0.24–0.5%) [14–17]. Risk increases with a history of postmenopausal bleeding. A decision analysis model showed that colpocleisis alone has

the optimal expected overall utility in women 40–90 years old, this being increasingly true with advancing age [13]. However, multiple patient-related factors may play a role

**Table 3** Multivariate association between women who underwent colpocleisis with and without concomitant hysterectomy and the presence of complications

	Any complication <sup>a</sup>		
	OR	95% CI	p value
Adjusted			
Colpocleisis without concomitant hysterectomy	Reference		
Colpocleisis with concomitant hysterectomy	1.927	1.445–2.568	<0.001
Adjusted			
Colpocleisis without concomitant hysterectomy			
Uterine prolapse (LeFort colpocleisis)	Reference		
Vaginal vault prolapse (complete colpocleisis)	0.945	0.651–1.370	0.764
Colpocleisis with concomitant hysterectomy	1.666	1.145–2.425	0.008

CI confidence interval, OR odds ratio

<sup>a</sup>Hemorrhage, requiring transfusion, infection, bowel obstruction, peritoneal abscess, peritonitis, accidental puncture, cystotomy, gastrointestinal injury, wound disruption, deep vein thrombosis or pulmonary embolus, cardiovascular complications, pelvic abscess/pelvic hematoma, pneumonia, respiratory complications, genitourinary complications, *C. difficile* colitis, ischemic stroke, hemorrhagic stroke, and acute kidney failure

<sup>b</sup>Adjusted for age, race, income, insurance plan, and smoking, obesity, hypertension, diabetes mellitus, chronic obstructive pulmonary disease, coronary artery disease, and chronic kidney disease

in the decision to undergo concomitant hysterectomy. The recently published Value of Uterus Instrument (VALUS) may be considered to better understand patient preferences, when discussing the role of hysterectomy at the time of prolapse repair [18]. In our study, the use of a large database did not provide information regarding the reason for performing concomitant hysterectomy. Additionally, we excluded malignancy to ensure reporting of complication rates among benign POP cases.

We found a 2.3% increase in the risk of complications associated with hysterectomy at the time of colpopoiesis, and an overall low risk of complications of 9.6%. Previous studies had reported larger difference in risk between those groups. Up to 35% required a transfusion with concomitant hysterectomy compared with 13% without hysterectomy in a small study by Von Pechmann et al. [9]. In our large sample, transfusion rate was much lower at 3.5% without hysterectomy and 5.3% with hysterectomy. Serious medical complications were associated with concomitant hysterectomy in the NSQIP study of Bochenska et al. (3.7 vs 0.8%) [3]. Multiple studies unsurprisingly reported longer operating room time with concomitant hysterectomy, which was not addressed in our sample [3, 4, 9, 19].

Reassuringly, we found a very low mortality rate, below 0.3%. Previous literature had reported similar or higher rates in smaller studies, likely related to a longer patient follow-up. For LeFort colpopoiesis specifically, an NSQIP surgical complications database of 283 patients found 0.35% mortality [20]. A higher mortality rate of 1.3% was reported by Zebede et al. in a retrospective case series of 325 patients, where the average age was higher (81 years old) [7].

The main strength of our study is its large sample size. To our knowledge, this is the largest reported study of colpopoiesis procedures. The high number of cases allowed us to determine the comparative risk of improbable complications between women who had a concomitant hysterectomy and those who did not. We also reported trends of concomitant hysterectomy rates over time. Limitations of this study are intrinsically related to the use of a cross-sectional public health care database. Coding deficiencies limited our interpretation of the results, as 15% of procedures did not have a specific associated diagnosis (uterine vs vault prolapse). The HCUP-NIS database is the largest inpatient sample database in the USA, which limited our search to inpatient cases. Pre-COVID-19 pandemic, most colpopoiesis cases were performed as inpatient procedures, as is the case in our data set (including up to 2014) [3, 6]. Since the pandemic started, many pelvic floor surgeries were increasingly being performed with same-day discharge [21, 22]. Readmission and complication rates appear similar after pelvic reconstructive surgeries with same-day discharge, but future studies should be performed among older women undergoing colpopoiesis. Those with significant comorbidities may not

be amenable to such an approach. In addition, only data from admission to discharge without a link to future emergency visits or readmissions was available in the NIS database. Hence, we could not account for complications occurring after the surgical admission. In a previous large study, hospital readmission was estimated at 3% [6]. On another note, previous literature demonstrated a possible impact of surgeon specialty (urology, gynecology, urogynecology) and center volume on complication rates [20]. These variables were not assessed in our data. Nor did we assess the role of concomitant incontinence procedures. However, a previous study of 283 women undergoing LeFort colpopoiesis found no difference in perioperative complications with concomitant sling [20].

## Conclusions

We found an overall perioperative complication rate of 9.6% during surgical admission for colpopoiesis. Concomitant hysterectomy was associated with an increased risk. Women undergoing these procedures were generally older and had more comorbidities than women undergoing reconstructive pelvic floor surgeries. Shared decision-making regarding concomitant hysterectomy at the time of colpopoiesis should be explored and studied further, taking into account individual patients' values, comorbidities, future risk of endometrial cancer, and respective complication rates.

**Supplementary information** The online version contains supplementary material available at <https://doi.org/10.1007/s00192-023-05457-w>

**Authors' contributions** J. Raina: protocol development, database management, data analysis, manuscript writing; M.P. Bastrash: literature review, manuscript writing; E. Suarathana: protocol development, data analysis, manuscript writing; M. Larouche: concept and protocol development, manuscript writing.

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## Declarations

**Conflicts of interest** M. Larouche reports a research stipend from the St. Mary's Research Centre.

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