Original Article

Postoperative complications after abdominal, laparoscopic, and vaginal hysterectomy for uteri weighing 250 grams or less

Tsung Mou[1]^, Oluwateniola Brown[2], Deepanjana Das[2], Margaret G. Mueller[3], Kimberly S. Kenton[3], Carol Emi Bretschneider[2]

[1]Division of Urogynecology and Pelvic Reconstructive Surgery, Department of Obstetrics and Gynecology, Tufts Medical Center, Boston, Massachusetts, USA; [2]Division of Female Pelvic Medicine and Reconstructive Surgery, Department of Obstetrics and Gynecology, Northwestern University Feinberg School of Medicine, Chicago, Illinois, USA; [3]Section of Urogynecology and Reconstructive Pelvic Surgery, Department of Obstetrics and Gynecology, University of Chicago Pritzker School of Medicine, Chicago, Illinois, USA

Contributions: (I) Conception and design: T Mou, CE Bretschneider; (II) Administrative support: None; (III) Provision of study materials or patients: CE Bretschneider; (IV) Collection and assembly of data: T Mou, CE Bretschneider; (V) Data analysis and interpretation: All authors; (VI) Manuscript writing: All authors; (VII) Final approval of manuscript: All authors.

Correspondence to: Tsung Mou, MD. Division of Urogynecology and Pelvic Reconstructive Surgery, Department of Obstetrics and Gynecology, Tufts Medical Center, 800 Washington Street, Box #232, Boston, MA 02111, USA. Email: tsung.p.mou@gmail.com.

Background: The objective of this study is to assess if route of hysterectomy impacts 30-day postoperative complications in patients with uterus weighing 250 grams or less for benign indications.

Methods: This was a retrospective cohort study of the American College of Surgeons National Surgical Quality Improvement Program (NSQIP) database from 2014 to 2018. Women who underwent hysterectomy for benign disease with uterus weight 250 grams or less were selected. Patients were stratified into three groups: abdominal hysterectomy (AH; via laparotomy), laparoscopic hysterectomy (LH; either conventional or robotic-assisted laparoscopy), and vaginal hysterectomy (VH; vaginal approach without laparotomy or laparoscopy). The primary outcomes were the rates of composite 30-day postoperative complications for each group. We compared patient demographics, clinical, and surgical characteristics using ANOVA for continuous variables, Kruskal Wallis for nonparametric variables, and chi-square for categorical variables across all three groups. We then used multivariate regression to identify independent factors associated with increased 30-day postoperative complications in this total cohort.

Results: From 2014 to 2018, a total of 38,429 cases were identified. There were 5,585 (14.5%) AH, 27,196 (70.8%) LH, and 5,648 (14.7%) VH. LH and AH had similar operative time [113 minutes (IQR, 85–150 minutes) and 111 (IQR, 83–154 minutes), respectively, P=0.870) while VH has the shortest when compared to LH (96 minutes (IQR, 68–137 minutes), P<0.001]. AH had the most composite complications when compared to LH and VH (10.1% versus 5.3% and 6.4%, respectively, P<0.001). After multivariable logistic regression, black race (aOR 1.13, 95% CI: 1.01–1.26), ASA class 2 (aOR 1.25, 95% CI: 1.06–1.49), ASA class 3 (aOR 1.79, 95% CI: 1.48–2.17), smoker (aOR 1.20, 95% CI: 1.08–1.33), vaginal hysterectomy (aOR 1.38, 95% CI: 1.22–1.55), abdominal hysterectomy (aOR 1.96, 95% CI: 1.771–2.18), and uterine weight 201–250 g (aOR 1.35, 95% CI: 1.09–1.68) were associated with increased odds of 30-day postoperative complications.

Conclusions: In a modern cohort of women undergoing hysterectomies for benign indications, laparoscopic hysterectomy has lower rates of complications than vaginal hysterectomy for uteri weighing 250 grams or less. This finding challenges the older analyses and confers laparoscopic hysterectomy with lower odds of 30-day postoperative complications.

Keywords: Postoperative complication; laparoscopic hysterectomy; vaginal hysterectomy; abdominal hysterectomy

^ ORCID: 0000-0003-0445-6868.

Received: 19 November 2022; Accepted: 13 April 2023; Published online: 04 May 2023.
doi: 10.21037/gpm-22-44
View this article at: https://dx.doi.org/10.21037/gpm-22-44

Introduction

The benefits of minimally invasive approaches to hysterectomy have been well described (1-4). For uterine weight less than 280 grams, vaginal hysterectomy has historically been the preferred route given superior patient outcomes when compared to abdominal hysterectomy (5). In early 2000, Chang *et al.* argued that vaginal hysterectomy is the preferred route over laparoscopic hysterectomy for uteri weighing less than 350 g due to its shorter operative time based on their retrospective study; however, they did not demonstrate any difference in clinical outcomes or perioperative complications between the two approaches (6). The current committee opinion published by the American College of Obstetricians and Gynecologists (ACOG) states that vaginal hysterectomy is preferred based on size of the uterus along with other factors (2). But recently, data emerged to challenge this stance. For instance, Luchristt *et al.* in 2020 reported that vaginal hysterectomy had greater odds of complications when compared to laparoscopic or laparoscopic-assisted vaginal hysterectomy after controlling for several clinically important factors including uterine weight greater than 250 grams (7). However, it is unclear if laparoscopic hysterectomy would still be associated with lower complications than vaginal hysterectomy for smaller uteri less than 250 grams. As a result, the objective of this study is to assess if there is an association between 30-day postoperative complications and route of hysterectomy—abdominal, vaginal, and laparoscopic-for benign gynecologic conditions with uterus weighing 250 grams or less. We present this article in accordance with the STROBE reporting checklist (available at https://gpm.amegroups.com/article/view/10.21037/gpm-22-44/rc) (8).

Highlight box

Key findings

- In hysterectomy for uterus weighing 250 grams or less, abdominal and vaginal hysterectomies were independently associated with an increased odds of 30-day postoperative complications when compared to laparoscopic hysterectomy.

What is known and what is new?

- Abdominal hysterectomy has been associated with increased 30-day complications risks.
- We found vaginal hysterectomy has increased 30-day complication risks than laparoscopic hysterectomy.

What is the implication, and what should change now?

- There is a role for laparoscopic hysterectomy for patient safety particularly among surgeons who are most comfortable with this approach.

Methods

This was a retrospective cohort study using data from the National Surgical Quality Improvement Program (NSQIP) database from 2014 through 2018. Women undergoing a hysterectomy for benign condition were included. The NSQIP database is a rigorously maintained with more than 600 participating hospitals that captures data on perioperative variables, including preoperative comorbidities, intraoperative variables, and 30-day mortality and morbidity outcomes for multiple surgical procedures (9). Studies using the NSQIP database are considered exempt by our institutional review board. The study was conducted in accordance with the Declaration of Helsinki (as revised in 2013). Publication of this manuscript was waived from patient consent according to the Northwestern University ethics committee/institutional review board.

We used Current Procedural Terminology (CPT) codes for the primary surgery to identify patients who underwent hysterectomy and pathology reports to select cases with uterine weight less than or equal to 250 grams. Then, we categorized patients based on the routes of hysterectomy: abdominal hysterectomy (AH), vaginal hysterectomy (VH), and laparoscopic hysterectomy (LH) (see *Table 1* for CPT codes used). Of note, there was no specific CPT code to differentiate traditional versus robotic-assisted laparoscopy; as a result, these are combined into one analysis group under LH. Furthermore, LH and AH groups both included total and supracervical hysterectomies in this analysis. We did not include laparoscopic assisted vaginal hysterectomy (LAVH) in this analysis as our aim is to determine perioperative outcomes from uniquely distinctive routes of hysterectomy. Exclusion criteria included cancer diagnoses and concomitant surgeries except for cystoscopy, as well as subjects with American Society of Anesthesiologists

Table 1 CPT codes identified

Surgical approach	CPT codes
Laparoscopic hysterectomy	58570
	58571
	58572
	58573
	58541
	58542
	58543
	58544
Vaginal hysterectomy	58260
	58262
	58263
	58267
	58270
	58275
	58280
	58290
	58291
	58292
	58293
	58294
Abdominal hysterectomy	58150
	58152
	58180
	58200

CPT, Current Procedural Terminology.

(ASA; a classification system to predict risks of perioperative morbidity and mortality in surgical patients) classes 4 or 5 (severe systemic disease that is a constant threat to life or moribund), missing height, weight, or unknown/not reported race, and cases with missing operative time. Finally, we excluded patients with supplementary CPT codes indicating "Other." Salpingectomy or salpingo-oophorectomy were inconsistently captured in CPT codes, but we assumed comparable distribution of these procedures in all routes of hysterectomy (10).

Once the subjects were identified, we queried the database for patient characteristics, including age, body mass index (BMI), race (defined as White, Black, or other), ASA classification, smoking status, and presence of major medical comorbidities 1 to 6 months before surgery as defined by NSQIP. Race was further classified into White, Black, and others. Others included Asian American, American Indian, Alaskan Native, Native Hawaiian and Pacific Islander. Operative characteristics such as uterine weight (grams per pathology reports), total operating time (minutes), 30-day postoperative complications, readmission, and reoperation data were also collected.

The primary outcome was the presence or absence of one or more of the predefined 30-day postoperative adverse events, which included blood transfusion, superficial, deep, and organ space surgical site infection (SSI), wound disruption, unplanned intubation, stroke/cardiovascular accident (CVA), sepsis, shock, cardiac arrest, myocardial infarction, venous thromboembolism (either deep vein thrombosis and/or pulmonary embolism), pneumonia, progressive renal insufficiency or failure. We also performed a sub-analysis, excluding urinary tract infections (UTI) from the composite complication list as hysterectomy is a known risk factor for developing UTI postoperatively (11).

Descriptive statistics were reported as n (%) for categorical variables and mean ± standard deviation (SD) or median with interquartile range (IQR) for all continuous variables. Comparison of demographic and clinical variables were performed between the three groups (AH, LH, and VH) using ANOVA for continuous variables, Kruskal Wallis for nonparametric variables, and Chi-squared for categorical variables where appropriate. We also selectively performed bivariate analysis between LH and AH as well as LH and VH on operative times and composite complication rates using Mann-Whitney U tests. Multivariable logistic regression models were used to control for potential confounding from sociodemographic factors and medical comorbidities while assessing differences in operative time as well as odds of complications in the 30-day postoperative period. Potential confounders were chosen a priori based on clinical expertise and established literature (7,12). A P value of less than .05 was considered significant. All analyses were conducted using R version 3.6.1.

Results

From 2014 to 2018, a total of 38,429 cases were identified (see flow diagram in *Figure 1*). There were 5,585 (14.5%) abdominal hysterectomies, 27,196 (70.8%) laparoscopic hysterectomies, and 5,648 (14.7%) vaginal hysterectomies

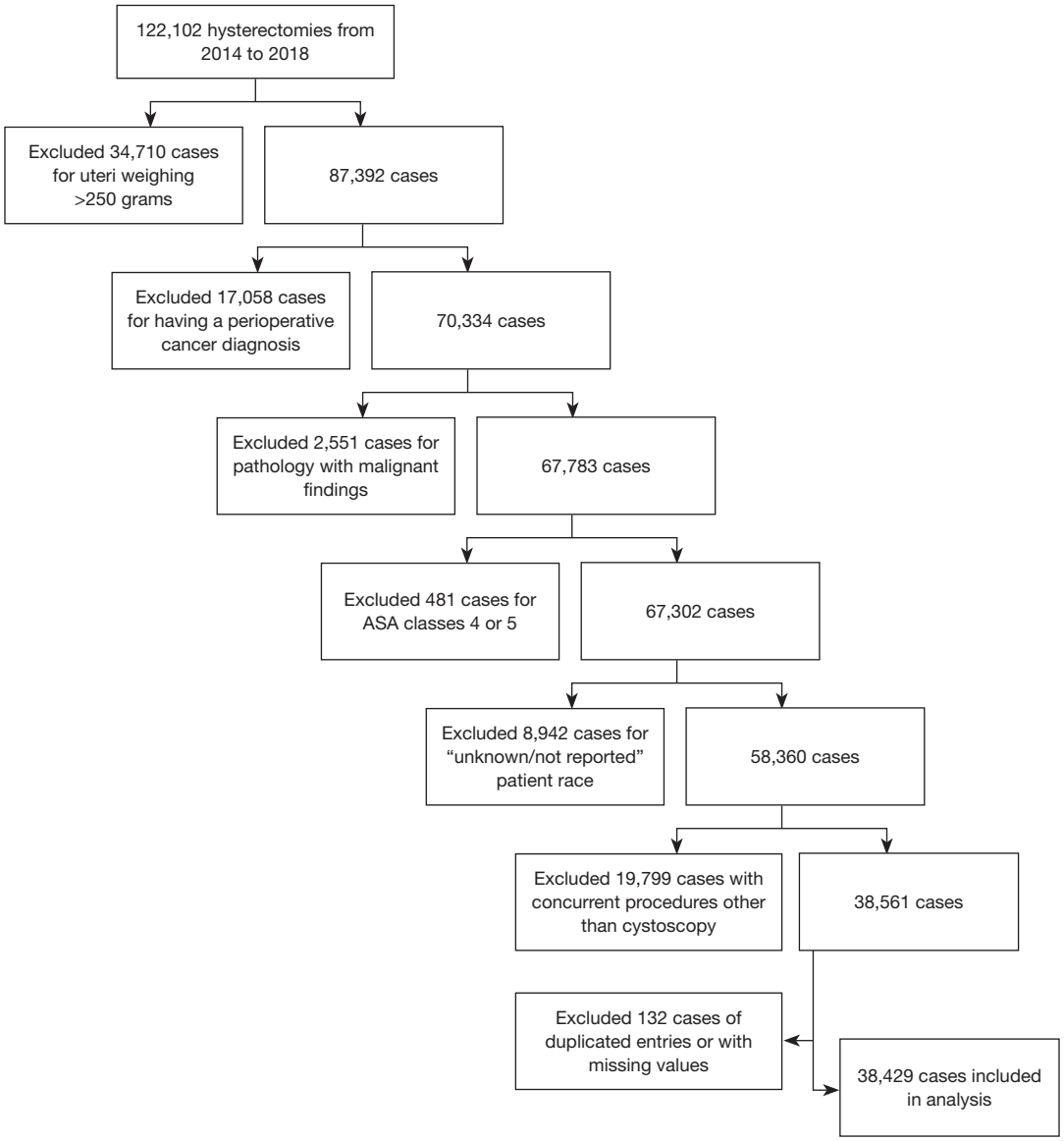

Figure 1 Flow diagram of case selection for analysis. ASA, American Society of Anesthesiologists.

performed where the uterus weighed 250 grams or less. The mean age of the cohort was 46±11 years with a median BMI of 30.6 kg/m^2 (IQR, 25.9–36.5 kg/m^2). Of the total population, 6,813 (17.7%) patients were smokers, and most of the cohort had an ASA classification of 2 (64.4%). Less than 30% of cohort had one or more major medical comorbidities. Clinical data stratified by route of hysterectomy is shown in *Table 2*. Route of hysterectomy differed across race, with a higher proportion of Black women undergoing AH than LH and VH (23.7% versus 13.8% and 16.3%, respectively, P<0.001).

Table 3 shows uterine weights among the three routes of hysterectomy. Over half of the hysterectomies were performed on uterine weights between 51 and 150 g (24,078, 62.6%). Compared to LH, AH had similar median operative times [LH 113 minutes (IQR, 85–150 minutes) and AH 111 minutes (IQR, 83–154 minutes), P=0.87] while VH had the shortest [96 minutes (IQR, 68–137 minutes), P<0.001]. *Table 4* describes the top five most common indications for hysterectomy, with the most common being "Null" (or no documented postoperative diagnosis) across all three routes. In Table S1, we displayed a breakdown of

Table 2 Patient characteristics stratified by route of hysterectomy

Variables	AH (N=5,585)	LH (N=27,196)	VH (N=5,648)	P value
Age (year)	48.0±11.1	45.8±10.6	47.1±11.6	<0.001
BMI (kg/m^2)	31.2 (26.6–36.6)	30.8 (25.9–36.9)	29.8 (25.5–35.0)	<0.001
Race				<0.001
White	4,002 (71.9)	22,347 (82.4)	4,418 (78.6)	
Black	1,318 (23.7)	3,744 (13.8)	918 (16.3)	
Other	249 (4.5)	1,033 (3.8)	287 (5.1)	
Current smoker	1,012 (18.2)	4,790 (17.7)	988 (17.6)	0.63
ASA classification				<0.001
ASA class 1	409 (7.3)	2,555 (9.4)	647 (11.5)	
ASA class 2	3,598 (64.6)	18,336 (67.6)	3,893 (69.2)	
ASA class 3	1,562 (28.0)	6,233 (23.0)	1,083 (19.3)	
Major medical comorbidity	1,872 (33.6)	7,147 (26.3)	1,496 (26.6)	<0.001

Data shown as n (%), mean ± SD, and median (interquartile range). AH, abdominal hysterectomy; LH, laparoscopic hysterectomy; VH, vaginal hysterectomy; SD, standard deviation; ASA, American Society of Anesthesiologists.

Table 3 Uterine weight and operative time

Variables	AH (N=5,585)	LH (N=27,196)	VH (N=5,648)	P value
Uterine weight (g)	121 (79 to 171)	118 (84 to 160)	109 (75 to 150)	<0.001
Uterine weight subgroups				<0.001
≤50 g	511 (9.2)	1,811 (6.7)	647 (11.5)	
51–100 g	1,611 (28.9)	8,321 (30.7)	1,805 (32.1)	
101–150 g	1,540 (27.7)	8,948 (33.0)	1,781 (31.7)	
151–200 g	1,113 (20.0)	5,130 (18.9)	981 (17.4)	
201–250 g	794 (14.3)	2,914 (10.7)	409 (7.3)	
Total operating time (min)	111 (83 to 154)	113 (85 to 150)	96 (68 to 137)	<0.001

Data shown as n (%) and median (interquartile range). AH, abdominal hysterectomy; LH, laparoscopic hysterectomy; VH, vaginal hysterectomy; min, minutes.

perioperative complications by routes of hysterectomy. The overall rate of 30-day postoperative complications was 6.2%. AH had the most composite complications (AH 10.3%, LH 5.3%, VH 6.8%, P<0.001). When comparing LH and VH directly on bivariate analysis, the composite complication rate for LH was significantly lower than VH's (P<0.001).

In a multivariable logistic regression model controlling for age, BMI, race, ASA class, medical comorbidity, smoking status, route of hysterectomy, uterine weight, and operative time, we found VH (aOR 1.38, 95% CI: 1.22–1.55) and AH (aOR 1.96, 95% CI: 1.771–2.18) both had higher odds of any 30-day postoperative complication when compared to LH in women undergoing benign hysterectomy for uteri <250 grams (*Table 5*). Other factors independently associated with 30–day postoperative complications included the following: Black race (aOR 1.13, 95% CI: 1.01–1.26), ASA class 2 (aOR 1.25, 95% CI: 1.06–1.49), ASA class 3 (aOR 1.79, 95% CI: 1.48–2.17), smoking (aOR 1.20, 95% CI: 1.08–1.33), and increased uterine weight from 201 to 250 grams (aOR 1.35, 95% CI: 1.09–1.68).

We subsequently performed a sub-analysis to determine if route of hysterectomy was associated with non-UTI

Table 4 Postoperative diagnoses by routes of hysterectomy

Postoperative diagnosis	Value, n (%)
AH (N=5,585)	
Null	3,729 (66.8)
Leiomyoma of uterus	428 (7.7)
Excessive or frequent menstruation	236 (4.2)
Benign neoplasm of ovary	164 (2.9)
Endometriosis of uterus	74 (1.3)
LH (N=27,196)	
Null	20,599 (75.7)
Excessive or frequent menstruation	1,315 (4.8)
Leiomyoma of uterus	1,020 (3.8)
Endometriosis of uterus	352 (1.3)
Dysmenorrhea	328 (1.2)
VH (N=5,648)	
Null	4,055 (71.8)
Excessive or frequent menstruation	389 (6.9)
Uterovaginal prolapse	202 (3.6)
Leiomyoma of uterus	186 (3.3)
Unspecified disorders of menstruation and abnormal bleeding from female genital tract	158 (2.8)

AH, abdominal hysterectomy; LH, laparoscopic hysterectomy; VH, vaginal hysterectomy.

Table 5 Logistic regression model for all 30-day postoperative complications

Variables	Adjusted OR (95% CI)
Age	0.98 (0.97–0.98)
Race (Ref: White)	
Black	1.13 (1.01–1.26)
Other	1.37 (1.13–1.66)
BMI (kg/m^2)	1.00 (1.00–1.01)
ASA class (Ref: ASA class 1)	
ASA class 2	1.25 (1.06–1.49)
ASA class 3	1.79 (1.48–2.17)
Medical comorbidities (Ref: no)	1.10 (0.99–1.21)
Current smoker (Ref: no)	1.20 (1.08–1.33)
Route of hysterectomy (Ref: laparoscopic)	
Vaginal	1.38 (1.22–1.55)
Abdominal	1.96 (1.77–2.18)
Uterine weight (Ref: ≤50 g)	
51–100 g	1.16 (0.96–1.41)
101–150 g	1.93 (0.99–1.45)
151–200 g	1.14 (0.93–1.40)
201–250 g	1.35 (1.09–1.68)
Operative time	1.00 (1.00–1.00)

OR, odds ratio; CI, confidence interval; Ref, referent category; ASA, American Society of Anesthesiologists.

complications (*Table 6*). VH (aOR 1.37, 95% CI: 1.17–1.59) and AH (aOR 2.78, 95% CI: 2.47–3.12) remained to be associated with higher odds of non-UTI complications. Other factors independently associated with non-UTI complication included Black race (aOR 1.32, 95% CI: 1.17–1.50), ASA class 3 (aOR 1.79, 95% CI: 1.42–2.27) and smoking (aOR 1.25, 95% CI: 1.10–1.42). We also observed that incremental 50-gram increases in uterine weights were associated with increasing odds of non-UTI complications.

Discussion

We found a low complication rate among women undergoing hysterectomy for benign conditions with uteri weighing 250 grams or less in a contemporary cohort. We also found AH was associated with a nearly 2-fold increased odds of any 30-day postoperative complication and a nearly 3-fold increased odds of a non-UTI complication, while VH was associated with 40% increased odds of both any and non-UTI complications when compared to LH. Our finding of AH being associated with more postoperative complications than minimally invasive hysterectomy is consistent with the literature (7). However, current dogma recommending VH over LH in patients with smaller uterus (<250 grams) may no longer be applicable due to VH's increased odds of complications as compared to LH. Furthermore, Ghezzi *et al.* also found LH was associated with less postoperative pain, need for rescue analgesia, and shorter hospital stay when compared to VH for uteri under 14-week gestation size in a recent randomized trial (13). These modern patient-centered outcomes continue to challenge the historical recommendations for VH. While residency training in VH has remained relatively stable over time, the numbers of LH has increased dramatically (7). The increasing numbers of LH likely lead to the lower complication rate,

Table 6 Logistic regression model for all non-UTI postoperative complications

Variables	Adjusted OR (95% CI)
Age	0.98 (0.97–0.98)
Race (Ref: White)	
Black	1.32 (1.17–1.50)
Other	1.51 (1.19–1.88)
BMI (kg/m^2)	1.00 (0.99–1.01)
ASA class (Ref: ASA class 1)	
ASA class 2	1.20 (0.98–1.48)
ASA class 3	1.79 (1.42–2.27)
Medical comorbidities (Ref: no)	1.13 (1.00–1.28)
Current smoker (Ref: no)	1.25 (1.10–1.42)
Route of hysterectomy (Ref: laparoscopic)	
Vaginal	1.37 (1.17–1.59)
Abdominal	2.78 (2.47–3.12)
Uterine weight (Ref: ≤50 g)	
51–100 g	1.28 (1.01–1.66)
101–150 g	1.38 (1.08–1.78)
151–200 g	1.43 (1.11–1.86)
201–250 g	1.63 (1.25–2.15)
Operative time	1.00 (1.00–1.00)

OR, odds ratio; UTI, urinary tract infection; CI, confidence interval; Ref, referent category; ASA, American Society of Anesthesiologists.

which subsequently diminished the overestimation of differences between LH and VH overtime (14-16).

Although we observed a national trend of decreasing AH, our study found Black women are still undergoing a higher proportion of AH than minimally invasive hysterectomy when compared to their white counterparts. Additionally, when controlled for routes of hysterectomy and uterine weight, Black women continue to experience increased odds of all and non-UTI postoperative complications even when uterus weighs 250 grams or less. This study's finding is concordant with prior work that demonstrated disparity in the hysterectomy route and complication rates for Black patients (17-19). These numerous and repeated findings in literature should no longer simply serve to promote awareness or future research ideas of why this is happening. Instead, these numbers are evidence of persistent racial inequities in gynecologic surgical outcomes that are rooted in structural racism (20,21).

A strength of this study is the use of a reliable database that has been utilized to assess postoperative complications from hysterectomy and other surgeries for many studies. The database provided information for a large sample of patients from different hospitals. Specific and detailed patient-level information was collected, particularly actual uterine weights reported by pathology rather than estimated weights used in previous studies (7,14). Limitations of this study are related to its retrospective design of a United States database system. Retrospective studies like this are susceptible to information and data collection biases specific to a geographic location. These may be contributed by inaccurate coding of procedures, diagnoses, perioperative outcomes, and biases from nonresponses or missing data in the United States only. In our study, we excluded hysterectomy with other concurrent procedures except for cystoscopy. This allows us to truly examine how hysterectomy routes may affect patient outcome. However, the exclusivity of having only hysterectomies may make our study not generalizable to hysterectomies with common concomitant procedures. Due to the inherent limitation of NSQIP database, we were unable to analyze differences between conventional and robotic-assisted LH because of their shared CPT codes. However, large studies have demonstrated similar clinical outcomes between conventional and robotic-assisted LH (22,23). Moreover, we a priori decided "Null" postoperative diagnosis as benign indication and excluded postoperative diagnoses as a variable in our multivariable logistic regression analysis due to most patients had undefined postoperative diagnosis (i.e., "Null"). Lastly, the predictability of uterine size preoperatively may be inconsistent thus limiting the applicability of this study for preoperative planning (24,25).

Conclusions

In conclusion, we found LH the safest route of hysterectomy with the fewest complications in patients with small uteri weighing 250 grams. This challenges traditional dogma that VH is the preferred route of hysterectomy for benign disease. The findings of this study highlight the role of LH in optimizing patient outcomes particularly for surgeons most comfortable with LH, including for those with uteri under 250 grams. More prospective and comparative studies are needed on perioperative complications in patients undergoing minimally invasive hysterectomy with smaller uteri to confirm LH's advantage

in patient outcome over VH.

Acknowledgments

Funding: None.

Footnote

Reporting Checklist: The authors have completed the STROBE reporting checklist. Available at https://gpm.amegroups.com/article/view/10.21037/gpm-22-44/rc

Data Sharing Statement: Available at https://gpm.amegroups.com/article/view/10.21037/gpm-22-44/dss

Conflicts of Interest: All authors have completed the ICMJE uniform disclosure form (available at https://gpm.amegroups.com/article/view/10.21037/gpm-22-44/coif). KK serves as an expert witness for Ethicon and receives grant funding from Axonics. MGM serves in the capacity of a board member in the American Urogynecology Society and as an expert witness for Ethicon. The authors have no other conflicts of interest to declare.

Ethical Statement: The authors are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. Studies using the NSQIP database are considered exempt by our institutional review board. The study was conducted in accordance with the Declaration of Helsinki (as revised in 2013). Publication of this manuscript was waived from patient consent according to the Northwestern University ethics committee/institutional review board.

References

1. AAGL position statement: route of hysterectomy to treat benign uterine disease. J Minim Invasive Gynecol 2011;18:1-3.
2. Committee Opinion No 701: Choosing the Route of Hysterectomy for Benign Disease. Obstet Gynecol 2017;129:e155-9.
3. Wright JD, Herzog TJ, Tsui J, et al. Nationwide trends in the performance of inpatient hysterectomy in the United States. Obstet Gynecol 2013;122:233-41.
4. Lee J, Jennings K, Borahay MA, et al. Trends in the national distribution of laparoscopic hysterectomies from 2003 to 2010. J Minim Invasive Gynecol 2014;21:656-61.
5. Kovac SR. Hysterectomy outcomes in patients with similar indications. Obstet Gynecol 2000;95:787-93.
6. Chang WC, Huang SC, Sheu BC, et al. Transvaginal hysterectomy or laparoscopically assisted vaginal hysterectomy for nonprolapsed uteri. Obstet Gynecol 2005;106:321-6.
7. Luchristt D, Brown O, Kenton K, et al. Trends in operative time and outcomes in minimally invasive hysterectomy from 2008 to 2018. Am J Obstet Gynecol 2021;224:202.e1-202.e12.
8. von Elm E, Altman DG, Egger M, et al. The Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) Statement: guidelines for reporting observational studies. Int J Surg 2014;12:1495-9.
9. Shiloach M, Frencher SK Jr, Steeger JE, et al. Toward robust information: data quality and inter-rater reliability in the American College of Surgeons National Surgical Quality Improvement Program. J Am Coll Surg 2010;210:6-16.
10. Kovac SR, Barhan S, Lister M, et al. Guidelines for the selection of the route of hysterectomy: application in a resident clinic population. Am J Obstet Gynecol 2002;187:1521-7.
11. Maudsley RF, Robertson EM. Common complications of hysterectomy. Can Med Assoc J 1965;92:908-11.
12. Vree FE, Cohen SL, Chavan N, et al. The impact of surgeon volume on perioperative outcomes in hysterectomy. JSLS 2014;18:174-81.
13. Ghezzi F, Uccella S, Cromi A, et al.. Postoperative pain after laparoscopic and vaginal hysterectomy for benign gynecologic disease: a randomized trial. Am J Obstet Gynecol 2010;203:118.e1-8.
14. Mowat A, Maher C, Ballard E. Surgical outcomes for low-volume vs high-volume surgeons in gynecology surgery: a systematic review and meta-analysis. Am J Obstet Gynecol 2016;215:21-33.
15. Dedden SJ, Geomini PMAJ, Huirne JAF, et al. Vaginal and

Laparoscopic hysterectomy as an outpatient procedure: A systematic review. Eur J Obstet Gynecol Reprod Biol 2017;216:212-23.
16. Drahonovsky J, Haakova L, Otcenasek M, et al. A prospective randomized comparison of vaginal hysterectomy, laparoscopically assisted vaginal hysterectomy, and total laparoscopic hysterectomy in women with benign uterine disease. Eur J Obstet Gynecol Reprod Biol 2010;148:172-6.
17. Ranjit A, Sharma M, Romano A, et al. Does Universal Insurance Mitigate Racial Differences in Minimally Invasive Hysterectomy? J Minim Invasive Gynecol 2017;24:790-6.
18. Alexander AL, Strohl AE, Rieder S, et al. Examining Disparities in Route of Surgery and Postoperative Complications in Black Race and Hysterectomy. Obstet Gynecol 2019;133:6-12.
19. Pollack LM, Olsen MA, Gehlert SJ, et al. Racial/Ethnic Disparities/Differences in Hysterectomy Route in Women Likely Eligible for Minimally Invasive Surgery. J Minim Invasive Gynecol 2020;27:1167-1177.e2.
20. The American College of Obstetricians and Gynecologists. Joint statement: collective action addressing racism. Available online: https://www.acog.org/news/news-articles/2020/08/joint-statement-obstetrics-and-gynecology-collective-action-addressing-racism. Accessed March 9, 2021.
21. Alson JG, Robinson WR, Pittman L, et al. Incorporating Measures of Structural Racism into Population Studies of Reproductive Health in the United States: A Narrative Review. Health Equity 2021;5:49-58.
22. Rosero EB, Kho KA, Joshi GP, et al. Comparison of robotic and laparoscopic hysterectomy for benign gynecologic disease. Obstet Gynecol 2013;122:778-86.
23. Pasic RP, Rizzo JA, Fang H, et al. Comparing robot-assisted with conventional laparoscopic hysterectomy: impact on cost and clinical outcomes. J Minim Invasive Gynecol 2010;17:730-8.
24. Hattiangadi RV, Dahlman M, Szydlo DW. Accuracy of preoperative ultrasound in predicting uterine weight across varying uterine pathologies. J Minim Invasive Gynecol 2020;27:S49-50.
25. Condous G, Van Calster B, Van Huffel S, et al. What is the value of preoperative bimanual pelvic examination in women undergoing laparoscopic total hysterectomy? J Minim Invasive Gynecol 2007;14:334-8.

doi: 10.21037/gpm-22-44
Cite this article as: Mou T, Brown O, Das D, Mueller MG, Kenton KS, Bretschneider CE. Postoperative complications after abdominal, laparoscopic, and vaginal hysterectomy for uteri weighing 250 grams or less. Gynecol Pelvic Med 2023;6:3.

Supplementary

Table S1 30-day postoperative complications by route of hysterectomy

Complications	AH (N=5,585)	LH (N=27,196)	VH (N=5,648)
Any complication	578 (10.3%)	1439 (5.3%)	386 (6.8%)
Blood transfusion	248 (4.4%)	168 (<1%)	97 (1.7%)
Superficial SSI	126 (2.3%)	245 (<1%)	21 (<1%)
UTI	87 (1.6%)	607 (2.2%)	151 (2.7%)
Organ space SSI	62 (1.1%)	274 (1.0%)	86 (1.5%)
Deep incisional SSI	20 (<1%)	43 (<1%)	18 (<1%)
Wound disruption	25 (<1%)	57 (<1%)	2 (<1%)
Pneumonia	20 (<1%)	24 (<1%)	6 (<1%)
Pulmonary embolism	22 (<1%)	49 (<1%)	3 (<1%)
Sepsis	35 (<1%)	78 (<1%)	25 (<1%)
Septic shock	5 (<1%)	9 (<1%)	2 (<1%)
Unplanned intubation	7 (<1%)	13 (<1%)	2 (<1%)
DVT	11 (<1%)	30 (<1%)	3 (<1%)
Myocardial infarction	3 (<1%)	0 (<1%)	0 (<1%)
Acute renal failure	3 (<1%)	3 (<1%)	1 (<1%)
Renal insufficiency	1 (<1%)	8 (<1%)	1 (<1%)
Stroke	1 (<1%)	1 (<1%)	0 (<1%)
Cardiac arrest	2 (<1%)	2 (<1%)	0 (<1%)
Intubation >48 hours	4 (<1%)	0 (<1%)	0 (<1%)
Reoperation	99 (1.8%)	323 (1.2%)	81 (1.4%)
Readmission	222 (4.0%)	712 (2.6%)	152 (2.7%)

AH, abdominal hysterectomy; LH, laparoscopic hysterectomy; VH, vaginal hysterectomy; SSI, surgical site infection; UTI, urinary tract infection; DVT, deep vein thrombosis; NS, nonsignificant.

https://dx.doi.org/10.21037/gpm-22-44