AOGS ORIGINAL RESEARCH ARTICLE

Trends in readmission rate by route of hysterectomy – a single-center experience

JENNIFER A. KREUNINGER[1,2] iD, SARAH L. COHEN[1], ELSEMIEKE A.I.M. MEURS[1], MARY COX[1] iD, ALLISON VITONIS[3], FRANK W. JANSEN[2] & JON I. EINARSSON[1]

[1]Division of Minimally Invasive Gynecologic Surgery, Brigham and Women's Hospital, Boston, MA, USA, [2]Division of Minimally Invasive Gynecologic Surgery, Leiden University Medical Center, Leiden, the Netherlands, and [3]Department of Obstetrics and Gynecology Epidemiology Center, Brigham and Women's Hospital, Boston, MA, USA

Abstract

Introduction. The aim of this study was to assess the 60-day readmission rates after hysterectomy according to route of surgery and analyze risk factors for postoperative readmission. *Material and methods.* This retrospective study included all women who underwent hysterectomy due to benign conditions from 2009 to 2015 at a large academic center in Boston. Readmission rates were compared among the following four types of hysterectomies: abdominal, laparoscopic, robotic and vaginal. *Results.* There were 3981 hysterectomy cases over the study period (628 abdominal hysterectomy, 2500 laparoscopic hysterectomy, 155 robotic hysterectomy and 698 vaginal hysterectomy). Intraoperative complications occurred more frequently in women undergoing abdominal hysterectomy (4.8%), followed by robotic hysterectomy (3.9%), vaginal hysterectomy (1.9%) and laparoscopic hysterectomy (1.6%) ($p < 0.0001$). Readmission rates were not significantly different among the groups; women receiving abdominal hysterectomy had an overall readmission rate of 3.5%, compared with 3.2% after robotic hysterectomy, 2.9% after vaginal hysterectomy and 1.9% after laparoscopic hysterectomy ($p = 0.06$). When stratifying for relevant variables, women who had an laparoscopic hysterectomy had a twofold reduction of readmission compared with abdominal hysterectomy (odds ratio 0.52, 95% confidence interval 0.31–0.87; $p = 0.01$). There was no significant difference in readmission when robotic hysterectomy or vaginal hysterectomy were compared individually with abdominal hysterectomy. Regarding risk factors related to readmission it was observed that perioperative complications were the largest driver of readmissions (odds ratio 667, 95% confidence interval 158–99; $p < 0.0001$). *Conclusion.* The laparoscopic approach to hysterectomy was associated with fewer hospital readmissions compared with the abdominal route; vaginal, robotic and abdominal approaches had a similar risk of readmission. Perioperative complications represent the main driver of readmissions. After adjusting for perioperative factors such as surgeon type and complications, no difference in readmissions between the different routes of hysterectomy were found.

Abbreviations: AH, abdominal hysterectomy; BMI, body mass index; CI, confidence interval; LH, laparoscopic hysterectomy; OR, odds ratio; RH, robotic hysterectomy; VH, vaginal hysterectomy.

Introduction

Hysterectomy is one of the most commonly performed gynecological procedures in the USA (1) and may be accomplished using an abdominal, laparoscopic, vaginal or robot-assisted approach. In addition to traditional concerns such as perioperative complications or recovery, another pertinent factor when contemplating the route of hysterectomy is the difference in postoperative readmission rate. Hospital readmissions are associated with increased healthcare costs (2) and may reflect patient morbidity. As such, readmission rates have been used as a metric for healthcare quality (3). It has been estimated that the cost of hospital readmissions in the USA totals more than 12–17 billion US dollars annually, with approximately 12% of these readmissions being preventable (3).

The overall risk of readmission for benign gynecological surgery seems low; the incidence of readmission after hysterectomy as described in prior studies varies from 1.1 to 6.7% (4–8). It is important to understand the causes of readmission after surgery in order to design effective interventions, particularly for high-risk patients (4). Patient characteristics, teaching hospital status and surgical volume have been strongly associated with postoperative events requiring readmission, including wound complications, infections and pulmonary emboli (9–11). However, many prior case series examining the cause of readmission following hysterectomy have been relatively small, which may preclude a meaningful conclusion (10,12,13). One large retrospective study of outcome measures following hysterectomy found that the overall readmission rate and sum of readmission costs following robotic surgery were significantly lower than in laparoscopic, vaginal and abdominal hysterectomy groups (14). In contrast, the American College of Obstetricains and Gynecologists recommends that the vaginal approach to hysterectomy is the preferred method when feasible (15). The objective of this study is to compare the risk of readmission following various modes of hysterectomy at a large tertiary care academic hospital. Secondly, we aim to identify potential risk factors associated with readmission after any hysterectomy.

Material and methods

This retrospective cohort study includes all women who underwent a hysterectomy from 2009 to 2015 at Brigham and Women's Hospital (Boston, MA, USA) for benign indications. The mode of hysterectomy was defined as follows: abdominal hysterectomy (AH), laparoscopic hysterectomy (LH), vaginal hysterectomy (VH) and robot-assisted laparoscopic hysterectomy (RH). Patients with a known or suspected gynecological malignancy prior to surgery were excluded, although cases with a premalignant lesion as a surgical indication were included for analysis. Additionally, patients younger than 18 years old were excluded from the study population.

Women meeting the inclusion criteria were identified from a hospital database using the Research Patient Data Registry (RPDR) and billing records. Baseline patient characteristics and surgical data were abstracted from the medical records. The primary outcome of our study was 60-day readmission after hysterectomy, defined as an urgent clinical hospitalization after being discharged from a prior hospital stay. A window of 60-day readmission was used to be sure all the related readmissions were included, as some postoperative complications may be delayed. Only readmissions linked to the hysterectomy were included; other types of readmissions were not considered. Other variables that were obtained included: patient's age, body mass index (BMI), race, parity, indications for hysterectomy (pain/endometriosis, abnormal bleeding, fibroids, urogynecology; not mutually exclusive), type of hysterectomy, operative time (defined as time from first incision to closure), estimated blood loss (by surgeon estimate in operative report), specimen weight, final pathology, length of hospital stay, type of surgeon (fellowship-trained vs. generalist), intraoperative complications (injuries to the urinary tract, nerves, vessels or bowel), postoperative complications [classified according to the Clavien-Dindo classification (16)], history of previous abdominal surgeries (laparoscopy or laparotomy), reoperation and number of days from discharge to readmission. Performance of additional procedures was not an exclusion criterion. Additional procedures such as adnexal surgery or prolapse repair, were not separately analyzed as regards their association with readmission.

Statistical analysis

Patient characteristics and perioperative outcomes between the hysterectomy groups were compared using chi-square, Fisher's exact and ANOVA tests. Multivariable logistic regression was used to detect an association between type of hysterectomy and readmission rates, and

Key Message

The 60-day readmission rates were assessed after hysterectomy. Laparoscopic hysterectomy was associated with fewer readmissions compared with the abdominal route; vaginal robotic and abdominal approaches had similar readmissions.

Table 1. Baseline characteristics.

	Abdominal	Laparoscopic	Robotic	Vaginal	*p*-value
Year					
2009	172 (27.4%)	352 (14.1%)	14 (9.0%)	145 (20.8%)	<0.0001
2010	108 (17.2%)	368 (14.7%)	21 (13.5%)	116 (16.6%)	
2011	66 (10.5%)	423 (16.9%)	23 (14.8%)	55 (7.9%)	
2012	66 (10.5%)	399 (16.0%)	36 (23.2%)	97 (13.9%)	
2013	71 (11.3%)	395 (15.8%)	19 (12.3%)	107 (15.3%)	
2014	70 (11.1%)	296 (11.8%)	25 (16.1%)	93 (13.3%)	
2015	75 (11.9%)	267 (10.7%)	17 (11.0%)	85 (12.2%)	
Age					
n	628	2500	155	698	<0.0001
Mean (SD)	50.10 (9.77)	47.26 (8.26)	49.11 (10.43)	58.28 (12.70)	
Median (min–max)	48.0 (21–87)	47.0 (18–86)	47.0 (27–74)	59.0 (27–90)	
Race					
White	412 (67.0%)	1760 (73.3%)	119 (78.3%)	542 (79.6%)	<0.0001
Black	124 (20.2%)	348 (14.5%)	21 (13.8%)	42 (6.2%)	
Asian	37 (6.0%)	75 (3.1%)	5 (3.3%)	9 (1.3%)	
Hispanic or Latino	37 (6.0%)	179 (7.5%)	3 (2.0%)	80 (11.7%)	
Other	2 (0.3%)	25 (1.0%)	2 (1.3%)	6 (0.9%)	
Native American	3 (0.5%)	14 (0.6%)	2 (1.3%)	2 (0.3%)	
Body mass index					
n	619	2463	154	685	<0.0001
Mean (SD)	29.32 (7.36)	28.81 (6.94)	36.73 (11.61)	27.34 (5.66)	
Median (min–max)	27.7 (15–63)	27.4 (15–68)	33.7 (16–66)	26.6 (16–62)	
Parity					
Nulliparous	176 (31.4%)	580 (24.1%)	43 (30.7%)	20 (3.5%)	<0.0001
1 livebirth	98 (17.5%)	397 (16.5%)	33 (23.6%)	56 (9.7%)	
2 livebirths	161 (28.8%)	838 (34.9%)	36 (25.7%)	221 (38.2%)	
3 livebirths	72 (12.9%)	407 (16.9%)	19 (13.6%)	153 (26.5%)	
4+ livebirths	53 (9.5%)	182 (7.6%)	9 (6.4%)	128 (22.1%)	
Prior laparoscopy					
No	471 (75.7%)	1677 (67.5%)	84 (54.5%)	514 (75.1%)	<0.0001
Yes	151 (24.3%)	807 (32.5%)	70 (45.5%)	170 (24.9%)	
Prior laparotomy					
No	347 (55.8%)	1488 (59.9%)	87 (56.5%)	487 (71.3%)	<0.0001
Yes	275 (44.2%)	996 (40.1%)	67 (43.5%)	196 (28.7%)	
Type of surgeon					
Generalist (24)	254 (40.5%)	418 (16.7%)	21 (13.5%)	369 (52.9%)	<0.0001
Oncology (5)	244 (38.9%)	444 (17.8%)	65 (41.9%)	2 (0.3%)	
MIGS (7)	7 (1.1%)	1078 (43.1%)	33 (21.3%)	2 (0.3%)	
Urogynecology (7)	18 (2.9%)	14 (0.6%)	0 (0%)	320 (45.8%)	
Reproductive endo (5)	104 (16.6%)	546 (21.8%)	36 (23.2%)	5 (0.7%)	
Indication for surgery[a]					
Pain/endometriosis					
No	549 (87.4%)	1870 (74.8%)	118 (76.1%)	657 (94.1%)	<0.0001
Yes	79 (12.6%)	630 (25.2%)	37 (23.9%)	41 (5.9%)	
Abnormal bleeding					
No	509 (81.1%)	1625 (65.0%)	108 (69.7%)	565 (80.9%)	<0.0001
Yes	119 (18.9%)	875 (35.0%)	47 (30.3%)	133 (19.1%)	
Fibroids					
No	223 (35.5%)	1196 (47.8%)	100 (64.5%)	596 (85.4%)	<0.0001
Yes	405 (64.5%)	1304 (52.2%)	55 (35.5%)	102 (14.6%)	
Urogynecology					
No	611 (97.3%)	2355 (94.2%)	154 (99.4%)	143 (20.5%)	<0.0001
Yes	17 (2.7%)	145 (5.8%)	1 (0.6%)	555 (79.5%)	

Table 1. Continued.

	Abdominal	Laparoscopic	Robotic	Vaginal	*p*-value
Other indications					
No	443 (70.5%)	2003 (80.1%)	98 (63.2%)	650 (93.1%)	<0.0001
Yes	185 (29.5%)	497 (19.9%)	57 (36.8%)	48 (6.9%)	

All the values are *n* (%) unless otherwise specified.

p-values from Chi-square tests or Fisher's exact tests for categorical variables and ANOVA for continuous variables.

[a]Subjects can have more than one indication for surgery. (Categories are not mutually exclusive).

Table 2. Perioperative outcomes.

	Abdominal	Laparoscopic	Robotic	Vaginal	*p*-value
Intraoperative complication					
No	598 (95.2%)	2459 (98.4%)	149 (96.1%)	685 (98.1%)	<0.0001
Yes	30 (4.8%)	41 (1.6%)	6 (3.9%)	13 (1.9%)	
Any postoperative complication					
No	512 (88.6%)	2158 (90.9%)	131 (91.0%)	506 (87.7%)	0.07
Yes	66 (11.4%)	215 (9.1%)	13 (9.0%)	71 (12.3%)	
CD-Postoperative complication rating					
0	512 (88.6%)	2158 (90.9%)	131 (91.0%)	506 (87.7%)	0.02
1	12 (2.1%)	71 (3.0%)	1 (0.7%)	13 (2.3%)	
2	40 (6.9%)	105 (4.4%)	7 (4.9%)	44 (7.6%)	
3a	5 (0.9%)	11 (0.5%)	2 (1.4%)	3 (0.5%)	
3b	8 (1.4%)	27 (1.1%)	3 (2.1%)	11 (1.9%)	
4a	0 (0%)	1 (0.0%)	0 (0%)	0 (0%)	
5	1 (0.2%)	0 (0%)	0 (0%)	0 (0%)	
60-day readmission					
No	606 (96.5%)	2453 (98.1%)	150 (96.8%)	678 (97.1%)	0.06
Yes	22 (3.5%)	47 (1.9%)	5 (3.2%)	20 (2.9%)	
Operation time (minutes) incision to close					
n	624	2487	154	696	<0.0001
Mean (SD)	163.5 (58.61)	140.8 (65.58)	194.9 (69.31)	145.6 (65.90)	
Estimated blood loss (mL)					
n	622	2496	155	698	<0.0001
Mean (SD)	317.2 (369.4)	94.87 (159.5)	105.0 (197.7)	137.4 (152.6)	
Uterine weight by pathology (g)					
n	622	2468	155	692	<0.0001
Mean (SD)	591.9 (644.2)	281.5 (327.4)	251.0 (268.8)	96.92 (79.47)	
Length of stay (days)					
n	628	2500	155	698	<0.0001
Mean (SD)	2.86 (1.86)	0.60 (0.84)	0.65 (0.93)	1.12 (1.10)	

p-values from Chi-square tests or Fisher's exact tests for categorical variables and ANOVA tests for continuous variables.

CD, Clavien Dindo complication scale.

to identify possible risk factors associated with a higher chance of readmission postoperatively. The abdominal hysterectomy group served as the reference group in the regression models. Readmissions rates were adjusted for year of procedure, age, race, BMI, parity and prior laparoscopy or laparotomy. The association between surgery type and readmission was initially adjusted for year of procedure, age, race, BMI, parity and prior laparoscopy or laparotomy and additionally adjusted for type of surgeon, supracervical hysterectomy (yes/no), indication for surgery, peri- or postoperative complications, final pathology, operation time, estimated blood loss, uterine weight and length of hospital stay. Due to the large number of surgeons listed in the dataset, it was not possible to adjust the analysis by surgeon. The *p*-values that were ≤0.05 were considered significant for all variables. Statistical analysis was performed with SAS software version 9.3 (SAS Institute, Cary, NC, USA).

Ethical approval

On 30 December 2014 this study was approved by the Partners Institutional Review Board with protocol number 2014P0026897.

Results

A total of 3981 patients underwent hysterectomy for benign indications during the study period: 628 AH cases (15.8%), 2500 LH cases (62.8%), 155 RH (3.9%) cases and 698 VH (17.5%) cases (Table 1). There were 94 readmissions, for an overall incidence of 2.4%. The risk of readmission was not significantly different by mode of surgery on univariate analysis (Table 2); AH cases were associated with 22 readmissions (3.5% of cases), compared with 47 (1.9%) after LH, five (3.2%) after RH and 20 (2.9%) after VH ($p = 0.06$).

Overall baseline characteristics differed significantly between the groups (Table 1). Women undergoing VH were older and more parous, with fewer prior laparotomies. The majority of women in all groups were white and the highest mean BMI was found in the robotic approach group. Both the vaginal and abdominal approaches were more commonly performed by generalists as opposed to fellowship-trained surgeons.

The most common indications for hysterectomy were fibroids, followed by abnormal bleeding; the other indication category generally included premalignant lesions.

Perioperative outcomes are shown in Table 2. Intraoperative complications occurred more often in women undergoing AH (4.8%), followed by RH (3.9%), VH (1.9%) and LH (1.6%) ($p < 0.0001$). Postoperative complications did not differ between the groups. The laparoscopic approach was associated with the shortest operative time and lowest estimated blood loss. Uterine weight was highest in the AH group [mean (SD) 591.9 g $\pm$ 644.2] compared with the LH (281.5 g $\pm$ 327.4), RH (251.0 g $\pm$ 268.8) and VH groups (96.92 g $\pm$ 79.49) ($p < 0.0001$). Of note, there were 33 conversions to laparotomy in the laparoscopic group (1.3% of LH cases) and three in the vaginal group (0.4% of VH cases); no conversions were observed in the robot-assisted cases. Readmission occurred between 0 and 50 days postoperatively. There was no significant difference between the number of days from discharge to readmission, with a median of 4 days for AH, 10 days for LH, 4 days for RH and 7.5 days for VH ($p = 0.30$). The average time to readmission was less than 14 days. Causes of readmission included: ileus, cuff cellulitis, abdominal wound infections with or without dehiscence, abscess formation, fever, vaginal bleeding, pulmonary embolism, deep venous thrombosis, urinary tract infection, urosepsis, hydronephrosis, vesicovaginal fistula, abdominal wall hematoma, hernia and unrecognized urinary tract injury. Table 3 shows a breakdown of indication for readmission by route of surgery.

Readmission risk adjusted for year of procedure, age, race, BMI, parity and prior laparoscopy or laparotomy are displayed in Table 4. When compared with the reference group AH, women who had an LH had twofold reduced odds of readmission (OR 0.52, 95% CI 0.31–0.87; $p = 0.01$). However, the difference between groups disappeared when additionally adjusting for type of surgeon, supracervical hysterectomy (yes/no) and indication for surgery, and when additionally adjusting for peri- or postoperative complications, final pathology, operative time, estimated blood loss, uterine weight and length of

Table 3. Indications for readmission by route of hysterectomy.

	Abdominal		Laparoscopic		Robot		Vaginal	
	n	%	*n*	%	*n*	%	*n*	%
Pain	0	0.0	4	8.5	1	20.0	1	5.0
Fever	0	0.0	2	4.3	0	0.0	1	5.0
Hematoma	0	0.0	0	0.0	0	0.0	2	10.0
Vaginal bleeding	2	9.1	6	12.8	1	20.0	2	10.0
Wound infection	3	13.6	2	4.3	0	0.0	0	0.0
Cellulitis	1	4.5	0	0.0	0	0.0	1	5.0
Abscess formation	4	18.2	10	21.3	1	20.0	4	20.0
Urinary tract infection/urosepsis	2	9.1	2	4.3	0	0.0	5	25.0
Vaginal cuff dehiscence	0	0.0	3	6.4	1	20.0	0	0.0
Hernia	0	0.0	1	2.1	0	0.0	0	0.0
Urinary tract injury	0	0.0	1	2.1	1	20.0	0	0.0
Hydronephrosis	0	0.0	3	6.4	0	0.0	0	0.0
Vesicovaginal fistula	1	4.5	2	4.3	0	0.0	0	0.0
Ileus	6	27.3	4	8.5	0	0.0	3	15.0
Pulmonary embolism/deep venous thrombosis	3	13.6	3	6.4	0	0.0	1	5.0
Nausea	0	0.0	4	0.0	0	0.0	0	0.0
Total	22		47		5		20	

Table 4. Adjusted risk of readmission according to route of surgery.

	No readmisson		Readmission		Crude		Adjusted 1		Adjusted 2		Adjusted 3	
	n	%	n	%	OR (95% CI)	p	OR (95% CI)	p	OR (95% CI)	p	OR (95% CI)	p
Abdominal	606	15.6	22	23.4	1.00		1.00		1.00		1.00	
Vaginal	678	17.4	20	21.3	0.81 (0.44, 1.50)	0.51	0.86 (0.45, 1.67)	0.66	0.41 (0.16, 1.10)	0.08	0.64 (0.18, 2.31)	0.49
Laparoscopic	2453	63.1	47	50.0	0.53 (0.32, 0.88)	0.01	0.52 (0.31, 0.87)	0.01	0.63 (0.35, 1.12)	0.11	0.55 (0.23, 1.32)	0.18
Robotic	150	3.9	5	5.3	0.92 (0.34, 2.46)	0.86	1.08 (0.39, 2.98)	0.89	1.08 (0.38, 3.05)	0.89	1.09 (0.28, 4.32)	0.90

1 – Adjusted for year, age, non-white race, body mass index, parity, prior laparoscopy or laparotomy.
2 – Additionally adjusted for type of surgeon, supracervical hysterectomy, and indication (pain, bleeding, fibroids, uro/gyn).
3 – Additionally adjusted for peri- or postoperative complication, pathology, operative time, estimated blood loss, uterine weight, and length of stay.

hospital stay. There were no differences found when comparing AH with either RH or VH. The risk factors related to readmission are presented in Table 5. Cases with a BMI between 25 and 30 showed a twofold reduction in readmission rates (OR 0.48, 95% CI 0.24–0.95; $p = 0.03$). More parous patients and those with a urogynecological indication for surgery were found to have higher risk of readmissions; however, complications were by far the largest driver of readmissions (OR 667, 95% CI 158–999; $p < 0.0001$). Surgeries performed by either minimally invasive gynecological or urogynecological surgeons, demonstrated a lower number of readmissions compared with generalist gynecologic surgeons: OR 0.35, 95% CI 0.14–0.84 ($p = 0.02$) vs. OR 0.20, 95% CI 0.06–0.70 ($p = 0.01$). Postoperative diagnosis of malignant pathology was also associated with an increased readmission rate (OR 5.18, 95% CI 1.45–18.5; $p = 0.01$). Estimated blood loss, prior laparotomy or laparoscopy and uterine weight did not affect the risk of readmission.

Discussion

This retrospective study demonstrates an overall low rate of readmission among all modes of hysterectomy at this institution. We identified a twofold reduction of readmission in the LH group compared with the AH group; however, these differences did not remain significant after adjusting for multiple patient and surgical characteristics. No difference was found in readmission rate between RH and VH compared with AH. These outcomes are noteworthy, since other clinical outcomes after hysterectomy clearly display the advantage of minimally invasive surgery (17).

When analyzing possible risk factors related to hospital readmission after hysterectomy, we found that having a procedure by a specialized surgeon reduces the risk of readmissions. We also demonstrate a strong correlation between complications and the risk of hospital readmission. The findings in this study are largely in concordance with a retrospective cohort study of over 1600 women undergoing hysterectomy for either a benign or a malignant indication (12). Lee et al. reported perioperative complications as a strong predictor of readmissions, with a twofold rise in odds (12). Based on the findings of our studies, it is advisable carefully to monitor patients who suffered a complication in the postoperative period to avoid preventable readmissions. Furthermore, we show that postoperative malignant pathology results increase the risk of readmission, possibly due to additional surgery or treatment for that condition.

Interestingly, we did not find prior surgery or uterine weight to increase the risk of hospital readmission. In the case-mix study of Driessen et al. (18) concerning LH

Table 5. Adjusted risk factors for readmission.

	No readmission		Readmission			
	n	%	*n*	%	Adjusted OR (95% CI)	*p*-value
Mode of surgery						
Abdominal	606	15.6	22	23.4	1.00	
Vaginal	677	17.4	20	21.3	0.62 (0.17, 2.27)	0.47
Laparoscopic	2453	63.1	47	50.0	0.56 (0.23, 1.34)	0.19
Robotic	150	3.9	5	5.3	1.13 (0.28, 4.48)	0.86
Year						
2009	670	17.2	13	13.8	1.00	
2010	589	15.2	24	25.5	1.79 (0.74, 4.34)	0.20
2011	559	14.4	7	7.4	0.39 (0.13, 1.20)	0.10
2012	586	15.1	12	12.8	0.68 (0.25, 1.84)	0.44
2013	581	15.0	11	11.7	0.45 (0.17, 1.22)	0.12
2014	469	12.1	15	16.0	1.59 (0.59, 4.31)	0.36
2015	432	11.1	12	12.8	0.71 (0.26, 1.91)	0.49
Age						
<44	1010	26.0	27	28.7	1.00	
44–48	1072	27.6	30	31.9	1.21 (0.62, 2.37)	0.57
49–54	858	22.1	20	21.3	1.14 (0.55, 2.34)	0.73
>54	946	24.3	17	18.1	0.59 (0.25, 1.42)	0.24
Race						
White	2785	74.1	48	52.2	1.00	
Non white	971	25.9	44	47.8	1.65 (0.94, 2.90)	0.08
Body mass index						
<25	1272	33.2	34	37.4	1.00	
25–29.9	1189	31.1	18	19.8	0.48 (0.24, 0.95)	0.03
≥30	1368	35.7	39	42.9	1.05 (0.58, 1.92)	0.87
Parity						
0	802	22.3	17	18.9	1.00	
1	572	15.9	12	13.3	1.09 (0.45, 2.61)	0.86
2	1228	34.2	28	31.1	1.24 (0.59, 2.61)	0.58
3	635	17.7	16	17.8	1.20 (0.52, 2.80)	0.69
≥4	354	9.9	17	18.9	2.54 (1.01, 6.38)	0.05
Prior laparotomy or laparoscopy						
0	1687	43.4	39	41.5	1.00	
1	2199	56.6	55	58.5	0.78 (0.46, 1.34)	0.37
Type of surgeon						
Generalist	1031	26.5	31	33.0	1.00	
Oncology	734	18.9	21	22.3	0.83 (0.33, 2.10)	0.69
MIGS	1103	28.4	17	18.1	0.35 (0.14, 0.84)	0.02
Uro	339	8.7	12	12.8	0.20 (0.06, 0.70)	0.01
Reproductive endo	678	17.5	13	13.8	0.69 (0.27, 1.79)	0.45
Supracervical						
No	2853	73.4	82	87.2	1.00	
Yes	1033	26.6	12	12.8	0.79 (0.35, 1.78)	0.57
Pain/endometriosis						
No	3119	80.3	74	78.7	1.00	
Yes	767	19.7	20	21.3	1.24 (0.63, 2.44)	0.53
Abnormal bleeding						
No	2745	70.6	61	64.9	1.00	
Yes	1141	29.4	33	35.1	1.18 (0.65, 2.12)	0.59
Fibroids						
No	2061	53.0	53	56.4	1.00	
Yes	1825	47.0	41	43.6	0.93 (0.46, 1.89)	0.85
Urogynecology						
No	3191	82.1	72	76.6	1.00	

Table 5. Continued.

	No readmission		Readmission			
	n	%	n	%	Adjusted OR (95% CI)	p-value
Yes	695	17.9	22	23.4	3.89 (1.43, 10.6)	0.008
Complications						
No	3540	91.1	2	2.1	1.00	
Yes	346	8.9	92	97.9	667 (158, >999)	<0.0001
Conversion to open						
No	3854	99.2	90	95.7	1.00	
Yes	32	0.8	4	4.3	1.21 (0.30, 4.92)	0.79
Pathology						
Benign	3778	97.2	88	93.6	1.00	
Malignant	108	2.8	6	6.4	5.18 (1.45, 18.5)	0.01
Operation time						
≤90	988	25.5	20	21.5	1.00	
91–124	982	25.4	14	15.1	0.51 (0.21, 1.23)	0.14
125–166	952	24.6	17	18.3	0.37 (0.15, 0.89)	0.03
>166	947	24.5	42	45.2	0.88 (0.36, 2.17)	0.78
Estimated blood loss, mL						
≤30	1051	27.1	17	18.3	1.00	
31–75	945	24.4	15	16.1	0.88 (0.38, 2.04)	0.76
76–150	1009	26.0	29	31.2	1.24 (0.56, 2.73)	0.60
>150	872	22.5	32	34.4	0.68 (0.27, 1.70)	0.41
Uterine weight, g						
<88	968	25.2	18	19.4	1.00	
88–156	965	25.1	21	22.6	0.91 (0.41, 2.02)	0.82
157–346	954	24.8	25	26.9	1.40 (0.58, 3.39)	0.46
>346	954	24.8	29	31.2	1.60 (0.58, 4.45)	0.37
Length of stay						
0	1487	38.3	25	26.6	1.00	
1	1539	39.6	33	35.1	1.02 (0.50, 2.08)	0.96
2	477	12.3	12	12.8	0.60 (0.23, 1.56)	0.29
3	227	5.8	9	9.6	0.72 (0.21, 2.43)	0.60
>3	156	4.0	15	16.0	0.92 (0.31, 2.69)	0.87

Each variable is adjusted for all others shown in the table.

procedures, the authors suggest that those two factors, together with BMI, help in predicting surgical outcome. Lee et al. also suggests that previous laparotomy increases the risk of readmission after any type of hysterectomy (12).

In Martino et al. (14), readmission rates in the robotic cohort were significantly lower than in non-robotic cohorts. Estimated blood loss, length of stay and readmission costs were also significantly less in the robotic cohort compared with the laparoscopic, abdominal or vaginal cohort. In our study, there was no statistically significant difference in readmissions between the robotic cohort and the other cohorts; however, the relatively low percentage of RH limits the interpretation of these results. Additionally, there may be an experience bias related to the overall preference for the traditional laparoscopic approach at our institution.

Limiting the analysis to benign indication cases only, reduces possible confounding factors. The choice to

report readmissions up to 60 days may have also allowed for more thorough capture and assessment of adverse events. A limitation of this study is the retrospective design, which may lead to misclassification or missing data; however, this was assumed to be non-differential. An additional flaw of the retrospective design is the uneven distribution of cases among varying surgical modalities; the small percentage of cases completed robotically limits applicability of these findings to centers that have higher robotic case volume and may experience alternate outcomes. A further limitation might be that only readmissions that occurred at our institution were included, a potential under-registration. Additionally, the fact that AH might involve more complicated cases creates a possible selection bias regarding mode of surgery. A possible confounding factor in our study is the fact that women undergoing LH are more often treated in the ambulatory setting than women receiving an AH, therefore LH patients may be more likely to develop an

adverse event at home. However, a study by Jennings et al. (5) found no difference in readmission between inpatient and outpatient treatment after LH. Another possible confounding factor is that additional statistical adjustments for surgeon volume were not made. However, previous work on this topic and observations of the number of cases contributed to this cohort per individual surgeon reveal that at our institution, fellowship training is in fact a proxy for high volume surgical practice. Additionally, residents and fellows are involved in the majority of cases at our institution. Finally, as a high volume tertiary referral hospital, our findings may not be universally generalizable.

A strength of this study is the large cohort, with a large amount of variables and the use of multivariate analysis. In addition, we are the first to report readmissions up to 60 days, which ascertains the inclusion of potential late readmissions. The existing literature on the subject reported readmissions up to 30 days.

Conclusion

In conclusion, the laparoscopic approach to hysterectomy for benign disease is associated with fewer hospital readmissions in our cohort compared with the abdominal route. Vaginal and robotic hysterectomies had similar rates of readmission to abdominal hysterectomies. Controlling for baseline characteristics, twice as many readmissions occurred with abdominal hysterectomy than with laparoscopic hysterectomy, although differences did not remain significant when controlling for perioperative factors such as surgeon type and complications. Perioperative complications represent the main driver of readmissions.

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