Nationwide assessment of practice variability in the utilization of hysteropexy at laparoscopic apical suspension for uterine prolapse

Kaily R. Cox, MD; Tanaz R. Ferzandi, MD, MBA; Christina E. Dancz, MD, MPH; Rachel S. Mandelbaum, MD; Maximilian Klar, MD, MPH; Jason D. Wright, MD; Koji Matsuo, MD, PhD

BACKGROUND: Although hysteropexy has been used to preserve the uterus during uterine prolapse surgery for a long time, there is a scarcity of data that describe the nationwide patterns of use of this surgical procedure.

OBJECTIVE: This study aimed to examine the national-level use and characteristics of hysteropexy at the time of laparoscopic apical suspension surgery for uterine prolapse in the United States.

STUDY DESIGN: This cross-sectional study used data from the Healthcare Cost and Utilization Project's Nationwide Ambulatory Surgery Sample. The study population included 55,608 patients with a diagnosis of uterine prolapse who underwent laparoscopic apical suspension surgery from 2016 to 2019. Patients who had a hysterectomy were assigned to the hysterectomy group, and those who did not have a hysterectomy were assigned to the hysteropexy group. The main outcome was clinical characteristics associated with hysteropexy, assessed using a multivariable binary logistic regression model. A classification tree was further constructed to assess the use pattern of hysteropexy during laparoscopic apical suspension procedures. The secondary outcome was surgical morbidity, including urinary tract injury, intestinal injury, vascular injury, and hemorrhage.

RESULTS: A hysteropexy was performed in 6500 (11.7%) patients. In a multivariable analysis, characteristics associated with increased use of a hysteropexy included (1) patient factors, such as older age, Medicare coverage, private insurance, self-pay, and medical comorbidity; (2) pelvic floor dysfunction factor of complete uterine prolapse; and (3) hospital factors, including medium bed capacity center and location in the Southern United States (all $P<.05$). Conversely, (1) the patient factor of higher household income; (2) gynecologic factors such as uterine myoma, adenomyosis, and benign ovarian pathology; (3) pelvic floor dysfunction factor with stress urinary incontinence; and (4) hospital factors including Midwest and West United States regions and rural setting center were associated with decreased use of a hysteropexy (all $P<.05$). A classification tree identified a total of 14 use patterns for hysteropexies during laparoscopic apical suspension procedures. The strongest factor that dictated the

From the Division of Gynecologic Oncology, Department of Obstetrics and Gynecology, University of Southern California, Los Angeles, CA (Drs Cox and Matsuo); Division of Urogynecology and Reconstructive Pelvic Surgery, Department of Obstetrics and Gynecology, University of Southern California, Los Angeles, CA (Drs Ferzandi and Dancz); Division of Reproductive Endocrinology & Infertility, Department of Obstetrics and Gynecology, University of Southern California, Los Angeles, CA (Dr Mandelbaum); Department of Obstetrics and Gynecology, University Medical Center Freiburg, University of Freiburg Faculty of Medicine, Freiburg, Germany (Dr Klar); Division of Gynecologic Oncology, Department of Obstetrics and Gynecology, Columbia University College of Physicians and Surgeons, New York, NY (Dr Wright); Norris Comprehensive Cancer Center, University of Southern California, Los Angeles, CA (Dr Matsuo)

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The University of Southern California Institutional Review Board approved this study (HS-16-00481). Patient informed consent was not required.

The data on which this study is based are publicly available upon request at the Healthcare Cost and Utilization Project, Agency for Healthcare Research and Quality https://www.hcup-us.ahrq.gov/nassoverview.jsp

The manuscript's corresponding author (K.M.) affirms that the manuscript is an honest, accurate, and transparent account of the study being reported; that no important aspects of the study have been omitted; and that any discrepancies from the study as planned (and, if relevant, registered) have been explained. The Nationwide Ambulatory Surgery Sample is developed for the Healthcare Cost and Utilization Project that is sponsored by the Agency for Healthcare Research and Quality, and the program was the source of the deidentified data used; and the program has not verified and is not responsible for the statistical validity of the data analysis or the conclusions derived by the study team.

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Corresponding author: Koji Matsuo, MD, PhD. koji.matsuo@med.usc.edu

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use of a hysteropexy was the presence or absence of uterine myomas; the rate of hysteropexy use was decreased to 5.6% if myomas were present in comparison with 15% if there were no myomas ($P<.001$). Second layer factors were adenomyosis and hospital region. Patients who did not have uterine myomas or adenomyosis and who underwent surgery in the Southern United States had the highest rate of undergoing a hysteropexy (22.6%). Across the 14 use patterns, the percentage rate difference between the highest and lowest uptake patterns was 22.0%. Patients who underwent a hysteropexy were less likely to undergo anteroposterior colporrhaphy, posterior colporrhaphy, and sling procedures (all $P<.05$). Hysteropexy was associated with a decreased risk for measured surgical morbidity (3.0 vs 5.4 per 1000 procedures; adjusted odds ratio, 0.57; 95% confidence interval, 0.36−0.90).

CONCLUSION: The results of these current, real-world practice data suggest that hysteropexies are being performed at the time of ambulatory laparoscopic apical suspension surgery for uterine prolapse. There is substantial variability in the application of hysteropexy based on patient, gynecologic, pelvic floor dysfunction, and hospital factors. Developing clinical practice guidelines to address this emerging surgical practice may be of use.

Key words: characteristic, hysteropexy, laparoscopic apical suspension, uterine prolapse, utilization

Introduction

Pelvic organ prolapse is defined as the descent of pelvic organs from the normal anatomic position to or beyond the hymenal remnants owing to loss of support from the connective tissue, muscles, or both.[1−3] With an annual incidence of 1.2 to 1.8 per 1000, this disorder lead to pelvic pressure, vaginal bulge and voiding, and sexual and defecatory dysfunction that can lead to a decreased quality of life.[4] Given the aging population in the United States, it is thought that the number of women who experience pelvic organ prolapse will increase by approximately 50% by 2050.[5]

Although approximately 13% of all hysterectomies in the United States are performed because of prolapse, this condition can be repaired without a hysterectomy.[6−9] There is increasing data to support the theory that the uterus is not the cause of prolapse but may play a passive role and has led to increased support for uterine-sparing procedures for prolapse, including hysteropexy.[10−15] Hysteropexy is a surgical procedure that involves lifting or suspending the uterus.[10,16,17] Hysteropexy was first described in the late nineteenth century to mitigate the high intraoperative risk of bleeding during a hysterectomy.[14] Hysteropexies have additional potential advantages of shorter operative times while demonstrating comparable short-term prolapse outcomes when compared with other prolapse procedures.[17−20]

Although hysteropexies have been performed for several decades, there is a paucity of data on the current national trends in and practice patterns of uterine preserving surgeries.[21] It is important to understand the factors that lead to these trends to better counsel the increasing number of women who desire uterine preservation.[14,22] Previous studies have revealed that 36% to 60% of women would prefer to preserve their uterus if all options presented had equal efficacy.[5,10,23] The current practice patterns are largely unknown; hysteropexy could likely be on the rise, but a standardized approach to the procedure is lacking in the current literature. The objective of this study was to assess the national-level use and characteristics of hysteropexy at the time of laparoscopic apical suspension surgery for uterine prolapse.

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Why was this study conducted?

There are limited nationwide data on the use and characteristics of hysteropexy to preserve the uterus during laparoscopic apical suspension procedures for uterine prolapse.

Key findings

In this cross-sectional study of the National Ambulatory Surgery Sample that examined 55,608 patients who underwent laparoscopic apical suspension for uterine prolapse from 2016 to 2019, hysteropexy was performed in 11.7% of cases. There were 14 use patterns in hysteropexy, ranging from <1% to 22.6% based on gynecologic factors, pelvic floor dysfunction factors, and hospital parameters. Hysteropexy was associated with a decreased risk for surgical morbidity (adjusted odds ratio, 0.57; 95% confidence interval, 0.36−0.90).

What does this add to what is known?

The large variability in the use of hysteropexy during laparoscopic apical suspension procedures for uterine prolapse suggests the benefit of developing clinical practice guidelines.

Materials and Methods

Data

This cross-sectional study used data from the Healthcare Cost and Utilization Project's Nationwide Ambulatory Surgery Sample managed by the Agency for Healthcare Research and Quality. Launched in 2016, this program is the largest all-payer database for ambulatory surgery in the United States.[24] The program collects data from ambulatory surgeries performed in hospital-owned facilities. This data capture schema contains data of approximately 68% of the ambulatory surgeries in US hospital−owned facilities. In 2019, nearly 9 million encounters were collected across 2958 facilities. The University of Southern California Institutional Review Board deemed this study exempt from

review because of the use of publicly available, de-identified data.

Inclusion and exclusion

The study population was patients with a diagnosis of uterine prolapse who underwent laparoscopic apical suspension surgery from 2016 to 2019. The World Health Organization's International Classification of Disease, 10th Revision, Clinical Modification (ICD-10-CM) codes of N81.2, N81.3, and N81.4 were used to identify uterine prolapse (Table S1). Additional diagnoses of pelvic organ prolapse (cystocele, enterocele, and rectocele) served as the study covariates.

The exclusion criteria included gynecologic malignancy or premalignancy, other nongynecologic malignancy, previous hysterectomy, absence of laparoscopic apical suspension, and abdominal hysterectomy. Identification of these data followed the ICD-10-CM codes and the American Medical Association's Current Procedural Terminology (CPT) codes (Table S1). These codes were unchanged during the study period.

Exposure

Exposure was the hysterectomy status at the time of laparoscopic apical suspension surgery. The CPT codes were used to identify the following hysterectomy modalities before analysis: total laparoscopic, laparoscopic supracervical, laparoscopy-assisted vaginal, and total vaginal.[25] Patients who had any of these hysterectomy codes were assigned to the hysterectomy group. Patients who did not have any of these hysterectomy codes were assigned to the hysteropexy group in this study. This approach was used because of the lack of specific surgical procedural codes for hysteropexy.

Outcome measures

The coprimary outcome measures were (1) rate of hysteropexy, (2) clinical characteristics associated with hysteropexy, and (3) hysteropexy use patterns among patients who underwent laparoscopic apical suspension surgery for uterine prolapse.

The secondary outcome measures were concurrent reconstructive surgical procedure and surgical morbidity. Core morbidity indicators that were pertinent for performing a hysterectomy were preselected (Table S1), including urinary tract injury (bladder or ureter), intestinal injury, vascular injury, and hemorrhage.[26]

Study covariates

Among the eligible patients, patient demographics, gynecologic factors, pelvic floor dysfunction characteristics, surgical procedures, and hospital parameters were abstracted from the program data (Table S1).

Patient demographics included age (quarterized), year of surgery (2016, 2017, 2018, and 2019), primary payer (Medicare, Medicaid, private including Health Maintenance Organization, self-pay, no charge, or other), census-level median household income (quartierized), obesity, tobacco use, and Charlson comorbidity index (0, 1, or ≥2).

Gynecologic factors included the presence of uterine myoma, uterine adenomyosis, and benign adnexal pathology. Additional pelvic floor dysfunction characteristics other than uterine prolapse included nonuterine prolapse diagnosis (cystocele, rectocele, or enterocele) and urinary incontinence (stress or other). Surgical procedures other than the hysterectomy types listed previously included colporrhaphy (anterior, posterior, or both), urethral sling procedure, and cystoscopy.

Hospital parameters included in the program data were, among others, relative bed capacity (small, medium, or large), teaching status (rural, urban nonteaching, or teaching), and census-level United States region (Northeast, Midwest, South, or West).

Analytical approach

The first step in the analysis was to estimate the use rates of hysteropexy during laparoscopic apical suspension surgery for uterine prolapse. The rate was computed for 100 cases for the whole cohort and for the different study covariate levels.

The second step in the analysis was to examine the clinical characteristics associated with hysteropexy use. A multivariable binary logistic regression model was fitted in this step analysis, and the baseline study covariates with $P<.05$ in the univariable analysis were entered in the analysis. Multicollinearity was assessed among the entered factors. The effect size for hysteropexy was expressed with adjusted odds ratios and a corresponding 95% confidence intervals.

The third step in the analysis was to assess the use pattern of hysteropexy during laparoscopic apical suspension procedure by constructing a classification tree. A classification tree assigned data to a specific node that was then associated with a class or category label. This allowed the data to be visualized into new unseen instances based on the patterns and relationships. A recursive partitioning analysis with chi-square automatic interaction detector method was used with a stopping rule of maximum 3 layers. The use rate of hysteropexy was computed in each identified pattern.

The last step in the analysis was to evaluate the surgical morbidity associated with hysteropexy. This study used inverse probability of treatment weighting propensity score to mitigate the difference in the exposure groups. Stabilized weight was used, and the threshold was set at 10. In the propensity score −weighted cohort, balance statistics was assessed with standardized difference, and the value of >.20 was interpreted as clinical imbalance and informed analysis.

The analysis was based on the national estimates per the program. Statistical interpretation followed a 2-tailed hypothesis, and a $P<.05$ was considered statistically significant. IBM SPSS Statistics (version 28.0, Armonk, NY) and R version 3.5.3 (R Foundation for Statistical Computing, Vienna, Austria) were used for statistical analysis. This study followed the Strengthening the Reporting of Observational Studies in Epidemiology reporting guidelines to outline the performance of the cross-sectional study.

Results

Study cohort

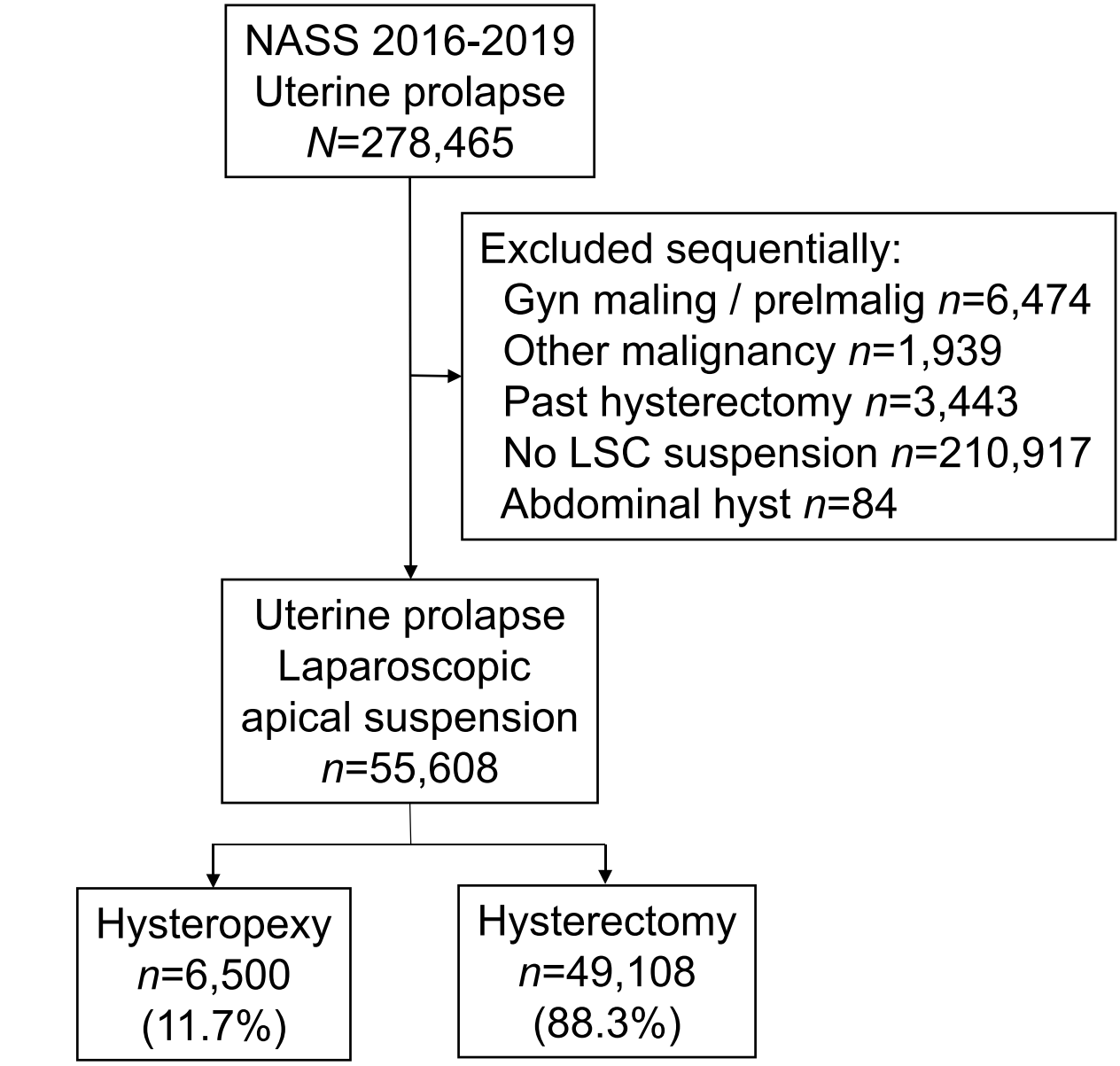
A total of 55,608 patients for national estimates met the study inclusion criteria (Figure 1). At the cohort level, the median age was 61 years (interquartile range, 50−68) (Table 1). The majority of patients were privately insured (56.6%) and underwent surgery at hospitals with a large bed capacity (63.2%) or in an urban teaching setting (73.7%). Complete uterine prolapse and stress urinary incontinence were seen in 24.9% and 37.8% of cases, respectively.

Hysteropexy characteristics

Among the study population, 6500 (11.7%) patients had a hysteropexy and the remaining 49,108 (88.3%) patients had a hysterectomy. In the univariable analysis (Table 1; Table S2), all the measured study covariates except for obesity, tobacco use, and diagnosis of cystocele, rectocele, and enterocele were statistically associated with a hysteropexy with $P<.05$.

In a multivariable analysis (Table 2), characteristics associated with increased use of hysteropexy included (1) patient factors, such as older age, Medicare or private insurance, self-pay, and medical comorbidity; (2) pelvic floor dysfunction factor of complete uterine prolapse;

FIGURE 1
Study selection schema



hyst, hysterectomy; *LSC*, laparoscopic; *malig*, malignancy; *NASS*, Nationwide Ambulatory Surgery Sample; *premalig*, preinvasive malignancy.

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TABLE 1
Hysteropexy use rate

Characteristic	Number[a] (%)	Hysteropexy[b]	*P* value
Whole	55,608 (100)	11.7	
Age (y)			<.001
≤50	14,432 (26.0)	9.9	
51–61	14,932 (26.9)	10.3	
62–68	13,608 (24.5)	11.8	
≥69	12,637 (22.7)	15.3	
Year			<.001[c]
2016	10,767 (19.4)	12.5	
2017	13,464 (24.2)	12.2	
2018	15,004 (27.0)	11.5	
2019	16,372 (29.4)	11.0	
Primary expected payer			<.001
Medicare	18,953 (34.1)	14.5	
Medicaid	3287 (5.9)	9.2	
Private including HMO	31,450 (56.6)	10.2	
Self-pay	513 (0.9)	14.4	
No charge	28 (<0.1)	[d]	
Other	1311 (2.4)	10.4	
Unknown	67 (0.1)	[d]	
Household income[e]			<.001
QT1 (lowest)	9639 (17.3)	14.8	
QT2	13,186 (23.7)	12.1	
QT3	15,925 (28.6)	11.4	
QT4 (highest)	16,227 (29.2)	9.6	
Unknown	630 (1.1)	14.0	
Charlson comorbidity index			<.001
0	41,596 (74.8)	11.3	
1	10,095 (18.2)	12.9	
≥2	3916 (7.0)	12.5	
Obesity			.069
No	50,353 (90.5)	11.8	
Yes	5256 (9.5)	10.9	
Tobacco use			.796
No	53,331 (95.9)	11.7	
Yes	2277 (4.1)	11.9	
Uterine myoma			<.001
No	35,359 (63.6)	15.2	
Yes	20,250 (36.4)	5.6	

Cox. Hysteropexy variability in the United States. Am J Obstet Gynecol Glob Rep 2024. *(continued)*

and (3) hospital factors, including medium bed capacity center and those located in Southern United States (all adjusted $P<.05$).

In contrast, decreased use of hysteropexy was associated with (1) patient factors such as higher census-level household income; (2) gynecologic factors such as uterine myoma, adenomyosis, and ovarian pathology; (3) pelvic floor dysfunction factor of stress urinary incontinence; and (4) hospital factors including location in the Midwest or West United States and rural setting center (all adjusted $P<.05$) (Table 2).

Hysteropexy use patterns

A classification tree identified a total of 14 unique use patterns for hysteropexy during laparoscopic apical suspension procedures (Figure 2). The first and strongest factor that dictated if patients underwent a hysteropexy was the presence or absence of uterine myomas; 5.6% of patients with myomas underwent hysteropexy in comparison with 15% of patients if no myomas were present ($P<.001$). Second-layer factors were adenomyosis and hospital region. Patients with neither uterine myomas nor adenomyosis and surgery in Southern United States had the highest rate of hysteropexy (22.6%). Across the 14 patterns, the percentage rate difference between the highest and lowest patterns was 22.0%.

Concurrent surgical procedure

Patients who underwent a hysteropexy were overall less likely to have concurrent reconstructive surgery for pelvic floor dysfunction (Table 3), including combined anterior-posterior colporrhaphy, posterior colporrhaphy, and sling procedures (all $P<.05$).

Surgical morbidity

The modeled study covariates were well balanced between the hysteropexy and the hysterectomy groups in the propensity score–weighted cohort (Table 4). The measured surgical morbidity was low overall at 5.0 per 1000 cases, including 4.1 per 1000 cases for hemorrhage

TABLE 1
Hysteropexy use rate *(continued)*

Characteristic	Number[a] (%)	Hysteropexy[b]	*P* value
Adenomyosis			<.001
No	40,292 (72.5)	14.0	
Yes	15,317 (27.5)	5.5	
Benign adnexal pathology			<.001
No	35,574 (64.0)	13.8	
Yes	20,034 (36.0)	8.0	
Complete uterine prolapse			<.001
No	41,754 (75.1)	11.0	
Yes	13,853 (24.9)	13.9	
Cystocele			.137
No	53,270 (95.8)	11.6	
Yes	2339 (4.2)	12.7	
Rectocele			.816
No	50,104 (90.1)	11.7	
Yes	5504 (9.9)	11.6	
Enterocele			.349
No	55,335 (99.5)	11.7	
Yes	274 (0.5)	13.5	
Stress urinary incontinence			<.001
No	34,607 (62.2)	12.7	
Yes	21,001 (37.8)	10.0	
Other urinary incontinence			.159
No	48,807 (87.8)	11.8	
Yes	6801 (12.2)	11.2	
Hospital bed capacity			<.001
Small	4137 (7.4)	9.6	
Mid	16,303 (29.3)	13.1	
Large	35,168 (63.2)	11.3	
Hospital location and teaching status			<.001
Rural	2525 (4.5)	9.3	
Urban nonteaching	12,123 (21.8)	11.4	
Urban teaching	40,961 (73.7)	11.9	
Hospital region			<.001
Northeast	9082 (16.3)	12.2	
Midwest	12,005 (21.6)	9.5	
South	23,731 (42.7)	15.1	
West	10,791 (19.4)	6.2	

HMO, Health Maintenance Organization; *NOS*, not otherwise specified; *QT*, quartile.

[a] Number with percentage per column group; [b] Hysteropexy rate (%) per row level; [c] Cochran-Armitage trend test; [d] Small number suppressed per Healthcare Cost and Utilization Project guidelines; [e] Census-level median value. Pearson chi-square test was used to determine the *P* value.

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and <1.0 per 1000 cases for nonhemorrhage morbidity (urinary tract injury, intestinal injury, or vascular injury).

Patients in the hysteropexy group had a lower incidence of measured surgical morbidity than those in the nonhysteropexy group (3.0 vs 5.4 per 1000; adjusted odds ratio, 0.57; 95% confidence interval, 0.36−0.90). Specifically, the incidence of hemorrhage was lower in the hysteropexy group than in the nonhysteropexy group (2.5 vs 4.4 per 1000; adjusted odds ratio, 0.60; 95% confidence interval, 0.37−0.99).

Comments

Principal findings

The key results of this nationwide assessment are as follows. First, at the cohort level, hysteropexy was performed in 1 in 8 to 9 patients with uterine prolapse who underwent ambulatory laparoscopic apical suspension surgery in the United States from 2016 to 2019. Second, the use of hysteropexy varied substantially based on patient, gynecologic, pelvic floor dysfunction, and hospital factors, varying >22.0% across >10 patterns. Lastly, hysteropexy was associated with a decreased risk for hemorrhage and overall bleeding during surgery when compared with hysterectomy.

Insights from the results

Hysteropexy use rate. Population-level use of hysteropexy has been studied rarely. One United States study demonstrated that the number of hysteropexies increased from 2002 to 2012, although the total use rates remained low (1.8%−5.0%).[21] A Taiwan-based study on data collected between 1997 and 2007 demonstrated that the use of uterine suspension procedures increased slightly from a rate of 7.7% to 9.4% to a rate of 9.5% to 13.6% from before 2003 to after 2004.[27] There number of studies exploring the rates and characteristics of apical lift suspension is increasing, but it is hard to infer if the procedure recorded involves the scope of hysteropexy. One study demonstrated that a total of 391 uterosacral suspension

TABLE 2
Multivariable analysis for hysteropexy

Factors	aOR (95% CI)	*P* value
Age (y)		<.001[a]
≤50	1.04 (0.96–1.13)	.304
51–61	1.00 (ref)	
62–68	0.95 (0.87–1.03)	.206
≥69	1.17 (1.05–1.29)	.004
Year		.049[a]
2016	1.00 (ref)	
2017	0.97 (0.90–1.05)	.468
2018	0.94 (0.87–1.02)	.145
2019	0.90 (0.83–0.97)	.009
Primary expected payer		<.001[a]
Medicare	1.49 (1.29–1.73)	<.001
Medicaid	1.00 (ref)	
Private including HMO	1.22 (1.07–1.39)	.003
Self-pay	1.53 (1.15–2.03)	.003
No charge	2.61 (0.99–6.92)	.053
Other	1.14 (0.91–1.42)	.255
Unknown	1.18 (0.59–2.39)	.638
Household income		<.001[a]
QT1 (lowest)	1.23 (1.13–1.33)	<.001
QT2	1.03 (0.95–1.10)	.520
QT3	1.00 (ref)	
QT4 (highest)	0.85 (0.79–0.91)	<.001
Unknown	1.25 (0.98–1.59)	.069
Charlson comorbidity index		.006[a]
0	1.00 (ref)	
1	1.12 (1.05–1.20)	.001
≥2	1.03 (0.93–1.14)	.586
Uterine myoma		
No	1.00 (ref)	
Yes	0.37 (0.35–0.40)	<.001
Adenomyosis		
No	1.00 (ref)	
Yes	0.44 (0.41–0.47)	<.001
Benign adnexal pathology		
No	1.00 (ref)	
Yes	0.65 (0.61–0.69)	<.001
Complete uterine prolapse		
No	1.00 (ref)	
Yes	1.16 (1.10–1.24)	<.001

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procedures were performed at a rate of 14.0%.[28]

These studies highlight a trend of increasing use of uterine suspension procedures with uterine preservation. The studies also demonstrated that there was an issue with delineating the various forms of apical suspension procedures. Our study demonstrated a rate of nearly 12% for hysteropexy among patients who underwent ambulatory laparoscopic surgery for uterine prolapse. This rate seems to be higher than the previously mentioned United States study that examined patient information from inpatient settings from 2002 to 2012 (≤5.0%).[21] This suggests that the use of hysteropexy may have increased in the United States in the past decade. However, during the study period of 2016 to 2019, the use rates hovered between 11.0% and 12.5% without increase. It may be possible that the use of hysteropexy procedures is possibly plateauing in the United States.

Patient factors for hysteropexy use. Older age and medical comorbidities were associated with increased hysteropexy use. These patients may be at a higher risk for surgical complications associated with a hysterectomy, which could explain the increased hysteropexy use. A study that investigated morbidity outcomes for benign hysterectomies demonstrated a correlation between complications and increasing age and this could explain why patients were offered or underwent pelvic organ prolapse repair via a hysteropexy.[28] Hysteropexy has been shown to compare favorably with hysterectomy in comparative studies, demonstrating decreased operative times, complications, and blood loss.[29–31]

Another important factor to consider is the patient's desire to retain their uterus. When considering a hysteropexy, surgeons and patients must consider additional factors, such as the risk for long-term recurrence, onset of de novo pelvic floor dysfunction, technical feasibility, and the future risk for gynecologic pathology and malignancies.

Gynecologic factors for hysteropexy use. One of the strongest predicting

TABLE 2
Multivariable analysis for hysteropexy *(continued)*

Factors	aOR (95% CI)	*P* value
Stress urinary incontinence		
No	1.00 (ref)	
Yes	0.74 (0.70–0.79)	<.001
Hospital bed capacity		<.001[a]
Small	0.94 (0.83–1.06)	.302
Mid	1.45 (1.36–1.55)	<.001
Large	1.00 (ref)	
Hospital location and teaching status		<.001[a]
Rural	0.81 (0.69–0.94)	.007
Urban nonteaching	1.00 (ref)	
Urban teaching	1.20 (1.11–1.29)	<.001
Hospital region		<.001[a]
Northeast	1.00 (ref)	
Midwest	0.69 (0.63–0.76)	<.001
South	1.26 (1.17–1.36)	<.001
West	0.44 (0.40–0.49)	<.001

Binary logistic regression model for multivariable analysis. All the study covariates with $P<.05$ level in Table 1 were entered in the final model.

aOR, adjusted odds ratio; *CI*, confidence interval; *HMO*, Health Maintenance Organization; *NOS*, not otherwise specified; *QT*, quartile.

[a] Overall *P* value.

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factors for hysteropexy was the presence of uterine myomas. Other uterine pathologies, such as adenomyosis, were also associated with decreased hysteropexy use. The presence of uterine pathology may affect if patients and/or surgeons favor uterine removal over preservation because of both the potential for growth of the pathologies and the presence of potential symptoms. Myomas and adenomyosis can both cause abnormal uterine bleeding, which is typically a relative contraindication to hysteropexy.[32,33]

In addition, although the uterus plays a passive role in pelvic organ prolapse, we theorize that a pathologically enlarged uterus could cause a greater effect on the progression of vs masking of pelvic organ prolapse. Few studies have looked specifically at uterine size alone. We found 1 study that reported that regardless of uterine size, there was no effect, but they noted that uterine myoma affected symptoms of incomplete emptying.[34]

Large uterine myomas are associated with bulk symptoms that may affect pelvic floor disorders (urgency incontinence or constipation). There are some studies that examined the effects of uterine myomas on pelvic floor disorders with mixed data; some reported an association between increased pelvic floor disorders, especially urinary disorders (urge and stress incontinence), and uterine myomas.[34–38] There are factors to consider in patients with uterine myomas, because leaving a large uterus in situ would not resolve the secondary effects of pelvic floor dysfunction, making a hysterectomy an appropriate choice.[37,39]

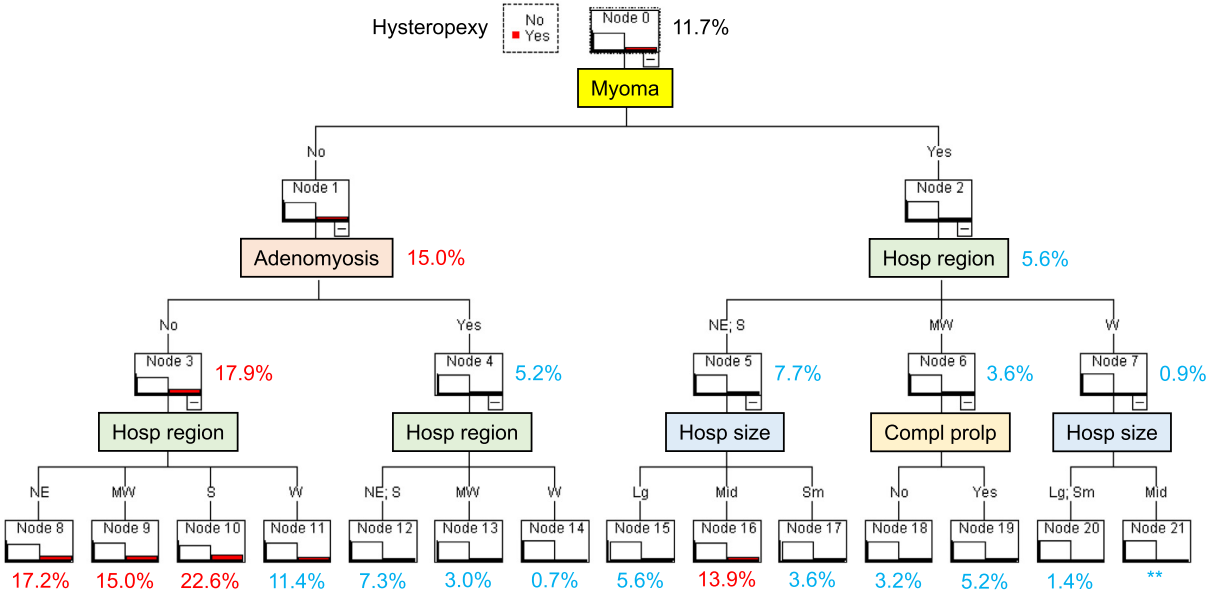
Possible reason to avoid hysteropexy in this setting of adnexal pathology may be a concern for malignancy or recurrence of ovarian pathology. Collectively, gynecologic factors are important to consider when planning surgical repair of prolapse. A thorough understanding of the future risks for benign gynecologic pathology and the true risk of uterine preservation is needed to consider when choosing between hysteropexy and hysterectomy for uterine prolapse.

Pelvic dysfunction factors for hysteropexy use. Complete uterine prolapse was associated with increased use of hysteropexy, which was somewhat unexpected. The observed association suggests that the surgeons who performed the hysteropexy were not deterred by advanced stage prolapse. Concomitant reconstructive surgical procedures were less likely to be performed with a hysteropexy in this study, suggesting a possible effort to reduce surgical invasiveness and morbidity for those who proceeded with a hysteropexy. This may be because of the previously mentioned patient factors, such as older age and medical comorbidity. Further studies to investigate how concomitant pelvic floor disorders affect surgical decision-making and surgical outcomes would be of interest.

Hospital factors for hysteropexy use. The results of this study suggest a possible regional practice variability in the use of hysteropexy. This could be reflective of regional variance in training, comfort with the procedure, or availability of urogynecologists. There is a pattern of lower prevalence of subspecialists in more rural settings.[40] In addition, generalists may be becoming less comfortable with urogynecologic procedures and resident surgical training in urogynecology is decreasing nationally.[41] This suggests that, overall, there may be limited access to providers who offer hysteropexy, which is supported by a recent study showing underuse and lack of access in certain regions.[42] More studies would need to be conducted to further explore the nuances of these differences and limitations.

Surgical morbidity for hysteropexy. This study suggested that hysteropexy had a protective effect in terms of surgical

FIGURE 2
Classification tree for hysteropexy use



Red numbers indicate higher than cohort-level rates (>11.7%), whereas *light blue numbers* indicate lower rates (<11.7%). *Double asterisks* indicate suppressed small numbers per the Healthcare Cost and Utilization Project guidelines.

Compl prolp, complete uterine prolapse; *Hosp*, hospital; *Lg*, large; *MW*, Midwest; *NE*, Northeast; *S*, South; *Sm*, small; *W*, West.

Cox. Hysteropexy variability in the United States. Am J Obstet Gynecol Glob Rep 2024.

TABLE 3
Concurrent surgical procedures

Characteristic	Hysteropexy (-)	Hysteropexy (+)	*P* value
Number of procedures	49,108	6500	
Anterior colporrhaphy alone			.352
No	47,289 (96.3)	6243 (96.1)	
Yes	1820 (3.7)	256 (3.9)	
Posterior colporrhaphy alone			<.001
No	39,798 (81.0)	5773 (88.8)	
Yes	9310 (19.0)	727 (11.2)	
Anterior-posterior colporrhaphy			<.001
No	44,989 (91.6)	6059 (93.2)	
Yes	4120 (8.4)	440 (6.8)	
Sling procedure			<.001
No	27,608 (56.2)	4872 (75.0)	
Yes	21,501 (43.8)	1628 (25.0)	
Cystoscopy			<.001
No	47,959 (97.7)	6401 (98.5)	
Yes	1150 (2.3)	98 (1.5)	

Number with percentage per group is shown. Pearson chi-square tests were used to determine *P* values.

Cox. Hysteropexy variability in the United States. Am J Obstet Gynecol Glob Rep 2024.

TABLE 4
Surgical morbidity

		IPTW[c]		IPTW, adjusted[d]	
Morbidity	Rate[a]	OR (95% CI)	*P* value	OR (95% CI)	*P* value
Any measured[a]					
Hysteropexy (-)	5.4	1.00 (ref)		1.00 (ref)	
Hysteropexy (+)	3.0	0.55 (0.35–0.86)	.008	0.57 (0.36–0.90)	.015
Hemorrhage					
Hysteropexy (-)	4.4	1.00 (ref)		1.00 (ref)	
Hysteropexy (+)	2.5	0.59 (0.36–0.95)	.030	0.60 (0.37–0.99)	.045
Nonhemorrhage					
Hysteropexy (-)	1.1	1.00 (ref)		1.00 (ref)	
Hysteropexy (+)	[b]	0.37 (0.11–1.24)	.107	0.41 (0.12–1.39)	.154

Morbidity rate per 1000 cases is shown in the IPTW cohort.

CI, confidence interval; *IPTW*, inverse probability of treatment weighting; *OR*, odds ratio.

[a] Any measured surgical morbidity (including urinary tract injury, intestinal injury, vascular injury, or hemorrhage); [b] Small number suppressed per the Healthcare Cost and Utilization Project guidelines; [c] IPTW cohort based on the characteristics shown in Table 2; [d] In IPTW cohort, the association was further adjusted for surgical factors that differed between the exposure groups shown in Table 3.

Cox. Hysteropexy variability in the United States. Am J Obstet Gynecol Glob Rep 2024.

blood loss when compared with hysterectomy. This is consistent with previous studies that demonstrated lower odds of experiencing adverse events, decreased blood loss, shorter operating times, and a shorter length of hospital stay.[30,31] The data from this larger sample size when compared with previous investigations reaffirm the findings.[30,31] These factors are important to weigh when counseling patients about the relative risks and benefits of hysteropexy vs hysterectomy.

Strengths and limitations

Our study benefited from a nationwide data capturing schema, recent and updated data, and a larger sample size than previous investigations. Together, this strengthened our ability to interpret the data and improve the external validity.

There are several limitations in this study. First, because of a lack of specific CPT codes for hysteropexy, the exposure assignment for hysteropexy was based on the exclusion of those who had hysterectomy codes and those who had previous hysterectomies. This allocation may potentially lead to misclassification of cases. Lack of a definition for complete uterine prolapse and hemorrhage in the coding schema is another limitation when interpreting the results.

Unmeasured confounders that could have altered the observed exposure-outcome association include preoperative diagnosis, shared decision-making for hysteropexy, surgeon and patient understanding and knowledge of hysteropexy, and detail of surgery information (operative time and blood loss). Data on readmission, patient satisfaction and quality-of-life metrics, and long-term morbidity were not available in the database, and these would have been important outcome measures for this type of study.

Although robotic-assisted surgery is a common practice in pelvic organ prolapse procedures, robot-specific CPT codes are not available. This study examined outpatient-setting surgery only, and thus we are unable to comment on the associations for surgeries conducted in the inpatient setting. The

exposure, outcomes, and study covariables were solely identified from administrative codes, and we are unable to assess the accuracy of data without actual medical record review. Generalizability to other regions was also not assessed.

Clinical and research implications

This study highlights the gap in information on uterus-preserving procedures and points out several important implications. First, given that hysteropexy is a relatively common surgical procedure, developing the specific administrative code for hysteropexy would be useful.

Second, there are no current in-depth clinical practice guidelines on the use of hysteropexy. Upon review of the American Urogynecology Society guidelines on pelvic organ prolapse, the hysteropexy section was limited. For instance, it did not specify the appropriate candidates, details of procedure approach, and contraindications.[1] This may lead to increased heterogeneity in both the patients that receive this procedure and the techniques used to perform it. Developing a detailed clinical practice guideline would assist practitioners in deciding on the appropriate candidates and surgical techniques. Further research is also necessary to validate the findings of this study, especially in the inpatient setting.

Table 4

CRediT authorship contribution statement

Kaily R. Cox: Writing – original draft, Investigation, Conceptualization. **Tanaz R. Ferzandi:** Writing – review & editing, Supervision, Resources, Investigation, Conceptualization. **Christina E. Dancz:** Writing – review & editing, Supervision, Resources, Methodology, Investigation, Conceptualization. **Rachel S. Mandelbaum:** Writing – review & editing, Software, Resources, Investigation, Data curation. **Maximilian Klar:** Writing – review & editing, Supervision, Resources, Investigation. **Jason D. Wright:** Writing – review & editing, Supervision, Investigation. **Koji Matsuo:** Writing – original draft, Validation, Supervision, Software, Resources, Project administration, Methodology, Investigation, Funding acquisition, Formal analysis.

Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.xagr.2024.100322.

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