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ORIGINAL ARTICLE

Surgical trends and patient factors associated with the treatment of apical pelvic organ prolapse from a national sample

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Abstract

Introduction and hypothesis Prolapse of the vaginal apex can be treated using multiple surgical modalities. We describe national trends and patient characteristics associated with the surgical approach and compare perioperative outcomes of abdominal versus vaginal repair of apical pelvic organ prolapse (POP).

Methods The 2006–2012 National Surgical Quality Improvement Program Database was queried for abdominal sacrocolpopexy (ASC) and vaginal apical suspensions. Patients were stratified by whether or not concomitant hysterectomy (CH) was performed or whether or not they were post-hysterectomy (PH). Multivariate logistic regressions were adjusted for confounding variables.

Results A total of 6,147 patients underwent apical POP repair: 33.9% (2,085) ASCs, 66.1% (4,062) vaginal suspensions. 60.0% (3,689) underwent CH. In all cohorts, older patients were less likely to have ASC (CH: OR 0.48, CI 0.28–0.83, $p = 0.008$ for age ≥ 60; PH: OR 0.28, CI 0.18–0.43, $p < 0.001$). Over time, the proportion of all vaginal and abdominal repairs remained relatively stable. Use of minimally invasive ASC, however, increased over the study period (trend $p < 0.001$), and use of mesh for vaginal suspensions decreased ($p < 0.001$). ASC had a longer median operative time (PH 174 vs 95 min, $p < 0.001$; CH 192 vs 127 min, $p < 0.001$). Complication rates were the same for vaginal repairs and ASC, overall and when sub-stratified by hysterectomy status.

Conclusions Nationally, most apical POP repairs are performed via a vaginal route. Older age was predictive of the vaginal route for both CH and PH groups. ASCs had longer operative times. There has been increased utilization of minimally invasive ASC and decreased use of mesh-augmented vaginal suspensions over time.

Keywords Pelvic organ prolapse · Outcome assessment (health care) · Gynecologic surgical procedures · Urologic surgical procedures

Introduction

Pelvic organ prolapse (POP) is an increasingly prevalent women's health concern, with over 40% of women over age 50 being affected [1, 2]. The number of women experiencing symptomatic POP is predicted to increase as the population of women over age 65 is expected to double by year 2050 [3, 4]. Prolapse significantly affects quality of life, with 50% of women reporting significant distress related to POP [5, 6]. Up to 10% of women will undergo surgery for POP before age 80, and approximately 220,000 POP surgeries are performed annually in the USA [7].

The preferred treatment for apical POP varies depending on the severity of bothersome symptoms, sexual activity, comorbidities, and previous pelvic floor surgery. Management options include observation, pessary insertion, and surgery. Surgical treatments are divided into vaginal or abdominal approaches and use of mesh augmentation and native tissue repair. Preoperative decision-making is also impacted by whether or not hysterectomy needs to be performed. At the time of vaginal hysterectomy for POP, 26–43.6% of surgeons perform a concurrent vaginal vault suspension [8, 9].

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Abdominal sacrocolpopexy (ASC) is considered the most durable surgical approach for apical POP and is associated with lower rates of recurrence than vaginal approaches [10]. However, ASC is associated with higher rates of complications including ileus, mesh or suture complications, and thromboembolic events [11]. There are multiple approaches for the surgical repair of apical POP, and surgical preferences are ever evolving based on current literature, technology, and patient characteristics. No previous studies have characterized national practice patterns for the surgical treatment of apical POP. The objective of this study is to evaluate national surgical trends in and patient characteristics associated with vaginal versus abdominal apical POP repair and compare the perioperative outcomes of surgical modalities.

Materials and methods

This is an IRB-exempt study that utilized the 2006 to 2012 American College of Surgeons National Surgical Quality Improvement Program database (NSQIP). The NSQIP offers HIPAA-compliant, patient level, aggregate perioperative data reported from the medical charts of randomly selected patients on over 240 preoperative through 30-day postoperative variables. Data were collected from 374 participating institutions with over 500,000 patients included in 2012 [12].

The NSQIP was queried for Current Procedural Technology (CPT) codes for open ASC (57280), laparoscopic ASC (57425), uterosacral ligament suspension (57283), and sacrospinous ligament fixation (57282). Uterosacral and sacrospinous suspensions were categorized as vaginal repairs; open and laparoscopic ASC were pooled as abdominal repairs. A total of 387 patients who underwent colpocleisis (CPT 57120) and 12 uterine suspensions (CPT 58400, 58,410) were excluded. This search yielded a study cohort of 6,147 patients who were sub-stratified into whether or not a hysterectomy had been performed at the time of apical prolapse repair: concomitant hysterectomy (CH) at the time of POP repair or post-hysterectomy (PH; see Appendix Table 4). All patients who did not have a concurrent hysterectomy code listed were assumed to have undergone previous hysterectomy.

The primary outcomes were temporal trends and patient factors associated with a vaginal versus an abdominal surgical approach to apical POP repair. Secondary outcomes included postoperative length of stay (LOS), the occurrence of at least one complication, unplanned readmission, or unplanned reoperation in the 30-day postoperative period. Complications captured by NSQIP have been previously described [13].

Statistical analysis was performed using Stata version 11.2 (StataCorp LP, College Station, TX, USA). Covariates included in the analysis were patient-specific demographic characteristics (Table 1) and surgeon specialty (gynecology or urology). All medical and surgical comorbidities recorded in NSQIP were included in the analysis [14]. A modified Charlson Comorbidity Index (mCCI) was used to measure patient comorbidities [15]. Previous studies have demonstrated the feasibility and validation of modified Charlson scores using administrative databases, including the NSQIP [16]. Data were assessed for normality of distribution. Continuous variables were analyzed using Student's t test for normally distributed variables and the Mann–Whitney U test for non-normally distributed variables. Categorical variables were analyzed using the Chi-squared test. Multivariate logistic regression analysis was used to adjust for confounding variables. All results yielding $p < 0.05$ were deemed statistically significant.

Results

A total of 6,147 patients who underwent apical POP repair during the study period were identified: 33.9% of the cohort (2,085) underwent ASC (888 open and 1,197 minimally invasive) and 66.1% (4,062) had a vaginal suspension (1,908 uterosacral and 2,154 sacrospinous ligament fixations). Of vaginal repairs, 22.1% (898) were augmented with vaginal mesh. In the entire cohort, 60.0% (3,689) had CH at the time of POP repair. Overall median age was 46 years: 42 years with CH and 51 years with PH. Urologists performed 15.4% (379 out of 2,458) of PH repairs and 0.6% (23 out of 3,689) with CH, and the remainder were performed by gynecological surgeons. Overall, women undergoing apical POP repairs were healthy, with mCCI 0 in 83.3% of patients, and not obese (70.1%; Table 1).

Although the proportion of ASC to vaginal apical surgeries remained stable over time, the use of minimally invasive (MIS) ASC became increasingly prevalent from 2010 to 2012 ($p < 0.001$ for trend, Fig. 1). Over this time period, mesh-augmented apical POP repairs become less common, decreasing from 32.3% of apical vaginal suspensions in 2010 to 16.0% in 2012 ($p < 0.001$ for trend). Patients who underwent any ASC were younger (median age 44 years) than patients having vaginal surgery (median age 48 years; $p < 0.001$). On multivariate logistic regression analysis, undergoing ASC was associated only with younger age (50–59 years, OR 0.73, CI 0.58–0.90, $p = 0.004$, and ≥ 60 years, OR 0.37, CI 0.26–0.51, $p < 0.001$, compared with <50 years (Table 2). Although surgery by a urologist ($p < 0.001$), PH status ($p < 0.001$) and non-obese BMI ($p = 0.039$) were associated with ASC on univariate Chi-squared analysis, these relationships were lost on logistic regression.

Among patients undergoing CH at the time of apical prolapse repair, a vaginal suspension was more likely than ASC (60.2%, 2,220 out of 3,689, Fig. 2). When adjusting for comorbidities, surgeon specialty and smoking status in the

Table 1 Demographic characteristics of patients who underwent apical pelvic organ prolapse repair

Variables	Total ($N = 6,147$) *n* (%)	Vaginal repair ($N = 4,062$) *n* (%)	ASC ($N = 2,085$) *n* (%)	*p* value
Age (years)				<0.001
18–39	1,956 (32.1)	1,208 (30.0)	748 (36.2)	
40–49	1,680 (27.6)	1,031 (25.6)	649 (31.4)	
50–59	1,704 (28.0)	1,176 (29.2)	528 (25.6)	
≥60	759 (12.4)	619 (15.3)	140 (6.8)	
BMI				0.039
<30	4,307 (70.1)	2,811 (69.2)	1,496 (71.8)	
≥30	1,840 (29.9)	1,251 (30.8)	589 (28.2)	
mCCI				0.279
0	2,743 (83.3)	2,065 (82.9)	678 (84.5)	
≥1	550 (16.7)	426 (17.1)	124 (15.5)	
Surgeon specialty				<0.001
Gynecology	5,745 (93.5)	3,763 (92.6)	1,982 (95.1)	
Urology	402 (6.5)	299 (7.4)	103 (4.9)	
Hysterectomy status				<0.001
CH	3,689 (60.0)	2,220 (54.7)	1,469 (70.5)	
PH	2,458 (40.0)	1,842 (45.4)	616 (29.5)	
Resident in OR				<0.001
Yes	1,627 (48.0)	1,161 (45.1)	466 (57.1)	
No	1,764 (52.0)	1,414 (54.9)	350 (42.9)	

mCCI modified Charlson Comorbidity Index, *CH* concomitant hysterectomy, *PH* partial hysterectomy, *ASC* abdominal sacrocolpopexy

CH cohort, age ≥60 years (OR 0.48, CI 0.28–0.83, $p = 0.008$) and BMI ≥30 (OR 0.77, CI 0.60–0.99, $p = 0.045$) were associated with a lower likelihood of ASC on multivariate logistic regression (Table 2). Post-hysterectomy, 75.9% (1,842 of 2,458) of apical POP repairs were performed via a vaginal route. In PH patients, ASC was associated with younger age (compared with <50 years, age 50–59 years OR 0.57, CI 0.41–0.78, $p = 0.001$ and ≥60 years OR 0.28, CI 0.18–0.43, $p < 0.001$), adjusting for patient comorbidities, obesity, and surgeon specialty (Table 2).

Abdominal repairs, both open and MIS, had significantly longer operative times than vaginal suspensions (open: median 164 min vs 110 min, $p < 0.001$; MIS 200 min vs 110 min, $p < 0.001$). Abdominal repairs consistently had longer operative times in both CH (ASC 190 min, vaginal 129 min, $p < 0.001$) and PH (ASC 172 min, vaginal 97 min, $p < 0.001$) repairs. LOS was longest after open ASC, with 83.4% of patients in this cohort admitted for ≥2 days. 34.4% of patients undergoing vaginal suspensions and only 22.2% in the MIS ASC group were admitted for ≥2 days ($p < 0.001$ among all groups).

Overall, 7.5% (462) of patients experienced a complication with equivalent rates among vaginal, open, and laparoscopic repairs ($p = 0.151$) and hysterectomy status ($p = 0.943$; Table 3). Superficial surgical site infections (SSIs) were most likely after open ASC (2.1% vs MIS ASC 0.8% and vaginal 0.5%, $p < 0.001$). The incidence of urinary tract infection was slightly higher after vaginal suspension than MIS ASC (4.8% vs 3.4%, $p = 0.047$), but equivalent to open ASC (3.7%, $p = 0.171$). Although uncommon overall, rates of deep vein thrombosis ($p = 0.642$), pulmonary embolism ($p = 0.821$), pneumonia ($p = 0.749$), and failure to wean ventilatory support ($p = 0.075$) were equivalent between abdominal and vaginal surgical modalities. In subgroup analysis by hysterectomy status, complication rates were again similar between surgical approach (CH: vaginal 7.7% vs ASC 6.3%, $p = 0.106$; PH: vaginal 7.5% vs ASC 7.5%, $p = 0.943$; Table 3).

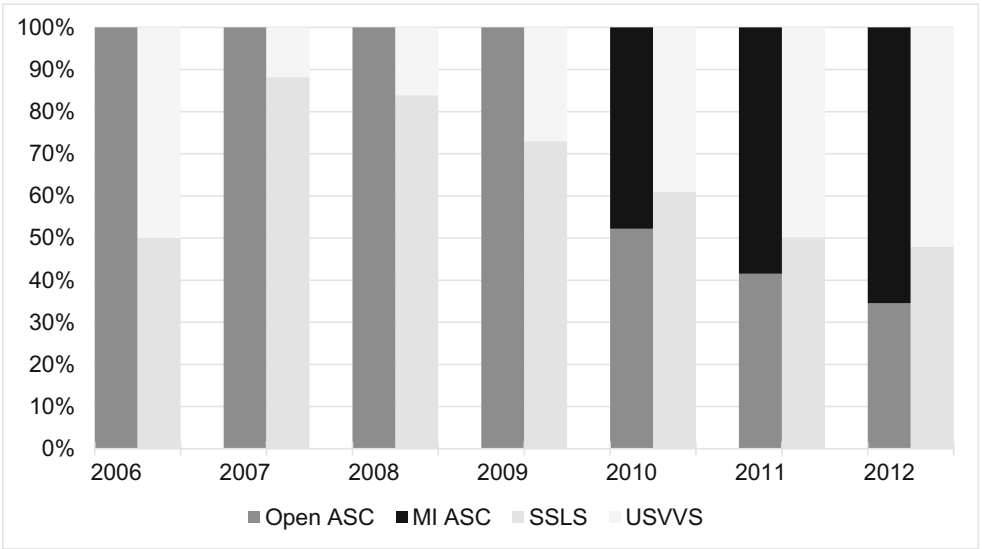

Fig. 1 Proportion of type of apical pelvic organ prolapse (POP) repair, by year ($p < 0.001$ for all trends). *ASC* abdominal sacrocolpopexy, *MI* minimally invasive, *SSLS* sacrospinous ligament suspension, *USVVS* uterosacral vaginal vault suspension

Table 2 Multinomial logistic regression analysis of factors associated with ASC

	Total		Concomitant hysterectomy		Post-hysterectomy	
Variable (Referent)	OR (95% CI)	*p* value	OR (95% CI)	*p* value	OR (95% CI)	*p* value
Age (years; 18–39)						
40–49	1.07 (0.87–1.32)	0.515	1.19 (0.91–1.56)	0.213	0.84 (0.61–1.16)	0.283
50–59	0.73 (0.58–0.90)	0.004	0.84 (0.61–1.16)	0.324	0.57 (0.41–0.78)	0.001
≥ 60	0.37 (0.26–0.51)	<0.001	0.48 (0.28–0.83)	0.008	0.28 (0.18–0.43)	<0.001
mCCI (0)						
≥ 1	1.02 (0.81–1.28)	0.88	1.01 (0.71–1.44)	0.951	1.04 (0.77–1.40)	0.796
BMI (<30)						
≥ 30	0.88 (0.74–1.06)	0.173	0.77 (0.60–0.99)	0.045	1.02 (0.80–1.30)	0.906
Surgeon specialty (gynecology)						
Urology	1.13 (0.83–1.53)	0.451	0.83 (0.23–3.04)	0.781	1.18 (0.86–1.63)	0.309
Hysterectomy status (PH)						
CH	0.99 (0.83–1.18)	0.886				

Unplanned readmission was required for 2.0% of patients overall (94) and 1.1% (67) underwent reoperation within 30 days postoperatively, with no difference with regard to surgical approach (readmissions $p = 0.438$, reoperations $p = 0.396$) or hysterectomy status (readmissions $p = 0.550$, reoperations $p = 0.342$; Table 3). The type of reoperation was only available for half of these cases, the most common reoperations being exploratory abdominal surgery in 21 patients: repair of a surgical wound (CPT 13160), exploration and repair of abdominal post-surgical bleeding (CPT 35221, 35,840), intestinal repair (CPT 44005, 44,120, 44,604), and repair of incisional hernia (CPT 49561). Operative repair of vaginal or urethral complications was reported in 11 patients, including five cases of removal or revision of a urethral sling (CPT 57287).

Discussion

In this large national patient cohort, the majority of apical POP repairs were performed vaginally. Patients undergoing a vaginal approach were older than patients who had ASC, whereas covariates including patient comorbidity index, hysterectomy status, obesity, and surgeon specialty did not differ between surgical approach on multivariate analysis. With CH, obesity was also associated with a vaginal suspension. The median operative time of any ASC was 75 min longer than vaginal repairs. Patients were most likely to be hospitalized for 2 or more days after open ASC, whereas MIS ASC had the shortest LOS. These differences in surgical modality suggest that patient selection may be critical for minimizing surgical

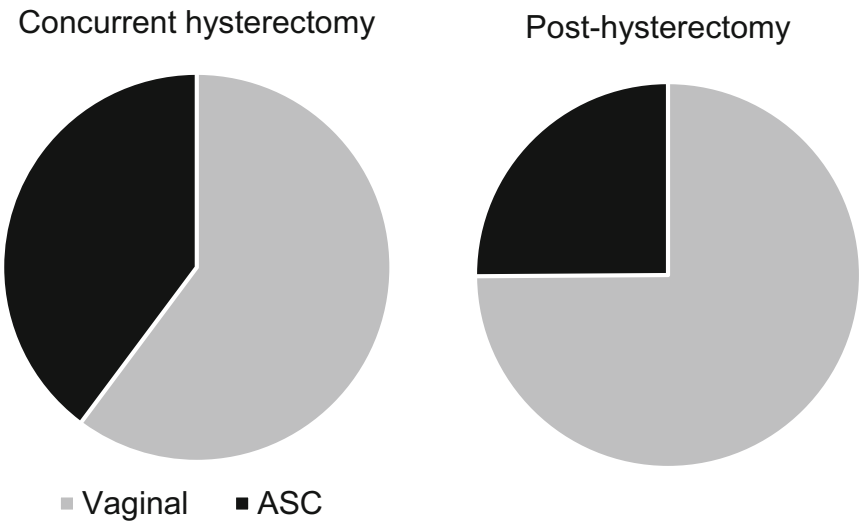

Fig. 2 Proportion of vaginal and abdominal surgeries for concurrent hysterectomy (CH) and partial hysterectomy (PH) POP repair

Table 3 Thirty-day perioperative outcomes after apical POP repair

	Total ($n = 6,147$) n (%)	Vaginal ($n = 4,062$) n (%)	Open ASC ($n = 888$) n (%)	MIS ASC ($n = 1,197$) n (%)	p value
Median LOS (days)	1	1	2	1	
Any complication	462 (7.5)	306 (7.5)	78 (8.8)	78 (6.5)	0.151
Urinary tract infection	268 (4.4)	194 (4.8)	33 (3.7)	41 (3.4	0.079
Superficial SSI	50 (0.8)	22 (0.5)	19 (2.1)	9 (0.8)	<0.001
Reintubation	9 (0.2)	2 (0.1)	3 (0.3)	4 (0.3)	0.021
Blood transfusion	88 (1.4)	57 (1.4)	12 (1.4)	19 (1.6)	0.941
Unplanned readmission	94 (2.0)	55 (1.9)	17 (2.6)	22 (2.0)	0.513
Unplanned reoperation	67 (1.1)	41 (1.0)	13 (1.5)	13 (1.1)	0.497

morbidity after apical POP repair and influence surgical route. In general, longer duration of anesthesia and extended time in Trendelenburg surgical positioning with pneumoperitoneum are associated with higher rates of postoperative events such as DVT and pulmonary complications, particularly for patients with comorbidities such as obesity or pulmonary disease [17, 18]. Among our patient cohort, open ASC is associated with higher rates of SSI than both MIS ASC and vaginal repairs ($p < 0.001$), which is already a greater concern for obese patients [19]. Open ASC is falling out of favor, however, as a result of the increasing popularity of MIS ASC. Meta-analysis has demonstrated greater durability of abdominal prolapse repair overall [10]. However, shorter operative time and decreased incidence of certain adverse events may increase consideration for a vaginal suspension in some older and more complicated patients. Although patient comorbidity indices were not associated with surgical route, patient age may act as a surrogate for perceived patient frailty or fitness for surgery during preoperative planning. The greater prevalence of vaginal prolapse repair overall may therefore be reflective of the complicated patient populations with symptomatic apical POP undergoing surgical repair.

Vaginal POP repair remained the most common surgical modality over the study period. The utilization of MIS ASC, however, rose significantly from 2010 to 2012 (Fig. 1) after NSQIP began reporting laparoscopic and robotics-assisted ASC in 2010. Robotic surgery has facilitated the widespread utilization of MIS abdominal and pelvic surgery across disciplines. According to data from the National Inpatient Sample, robotic surgical case volume across disciplines has doubled from 2008 to 2013, with urology and gynecology accounting for the highest proportions of robotic-assisted laparoscopic procedures [20]. The increased use of ASC may be a reflection of the shorter learning curve than traditional laparoscopy and the relative ease of pelvic suturing and knot tying with robotic surgery [20]. Surgical trainees graduate with increasing experience with robotic techniques; thus, practice patterns are likely to reflect surgeons' comfort with this approach. However, costs and operative times are greater with robotic assistance [21, 22]. Another consideration for the rise in ASC rates is evidence-based surgical decision-making. In appropriate patients, ASC has lower rates of prolapse recurrence than vaginal repairs [10]. Perhaps the publication of literature supporting ASC has influenced surgical trends. Finally, low complication rates and LOS after MIS, as demonstrated in this study for open vs MIS ASC, may have affected trends, making an abdominal approach a safer option than traditional open ASC. The decreased utilization of vaginal mesh for apical POP also suggests that minimizing complications might be a an important consideration in surgical planning, in addition to the probability of success.

Hysterectomy status introduced unique practice patterns and risks for POP repair in this national sample. Vaginal suspensions were more common in both the CH and the PH groups, and increasing age was associated with vaginal surgery. In CH surgery, obesity was associated with vaginal repair in addition to older age. The International Federation of Gynecology and Obstetrics (FIGO) working group recently published a report recommending ASC as the gold standard for vaginal vault prolapse, particularly if preservation of vaginal length and sexual function are important. Sacrospinous and uterosacral ligament fixations were also noted to be safe and cost-effective repairs with high success rates, although recent prospective data from the OPTIMAL 5 trial revealed high long-term failure rates after vaginal suspension [23, 24]. Among International Urogynecological Association (IUGA) members, 60% prefer to repair apical POP via a vaginal approach [25]. In the UK, however, ASC is the procedure of choice [26]. Although the motives behind surgical decision-making are multifactorial, both vaginal and abdominal repairs were low risk in our large national patient cohort. There were

no differences in readmissions, reoperations or overall complication rates within 30 days between surgical modalities, reflecting the safety of both surgical approaches in the appropriate patient. Ultimately, the decision regarding surgical modality for CH and PH apical POP needs to be individualized, taking into account patient history, comorbidities, personal goals, and the risks and benefits of the surgical modality of choice.

The main limitation of our study is the use of a retrospective de-identified database. Many factors that may be important drivers or barriers to selecting a surgical approach were not available, including the indication for current or past hysterectomy, hospital descriptors, and surgeon training or experience. Complications rates may be falsely low compared with previous studies, as NSQIP data are only reported through 30 days postoperatively. Any postoperative complications after 30 days, including mesh exposures, are missed. Additionally, we were unable to evaluate long-term outcomes of prolapse repair. In our methods, we assumed that patients not undergoing CH had a history of hysterectomy, as we excluded uterine suspensions; however, this may not be accurate because of variations in coding practices. The CPT code 57282 used for sacrospinous ligament fixation may also be used for sacrospinous hysteropexy without additional appropriate coding for uterine suspension, which was excluded in our study (CPT 58400, 58,410). CPT 57282 is also inclusive of the less common iliococcygeus fascia suspension; thus, we were unable to differentiate between these surgical modalities. Despite these limitations, the retrospective nature of the data did reveal important recent trends in POP repair, such as a trend toward equal utilization of abdominal and vaginal techniques.

In this national sample, most apical POP repairs are performed via the vaginal approach by gynecological surgeons. Vaginal suspensions were more common among both the CH and the PH groups, and older age was predictive of the vaginal route for both groups. ASC was more likely in patients who are younger, and use of MIS ASC has increased over time. ASC had a longer operative time, but there were no differences in readmissions, reoperations or overall complication rates within 30 days between surgical modalities. Further research is needed to determine the gold standard approach for PH and CH POP repair.

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Compliance with ethical standards

Conflicts of interest Dr Adonis K. Hijaz is a member of the Astellas, Inc. Speaker's Bureau. The remaining authors declare that they have no conflicts of interest.

Appendix

Table 4 Hysterectomy Current Procedural Technology (CPT) codes included in the concurrent hysterectomy cohort

Procedure	Code
Total abdominal hysterectomy	58150
	58152
Supracervical abdominal hysterectomy	58180
Vaginal hysterectomy	58260
	58262
	58263
	58267
	58270
	58275
	58280
	58285
	58290
	58291
	58292
	58293
	58294
Laparoscopic supracervical hysterectomy	58541
	58542
	58543
	58544
	58545
	58546
	58548
Laparoscopy-assisted vaginal hysterectomy	58550
	58552
	58553
	58554
Total laparoscopic hysterectomy	58570
	58571
	58572
	58573

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