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Original Research

Pelvic organ prolapse surgery after different hysterectomy methods: a population-based cohort study

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Summary

Background: Pelvic floor disorders are expected to greatly increase in the coming years. Many factors have been implicated in the development of pelvic organ prolapse (POP). In the last decade, the route of hysterectomy performed has shifted more towards robotic/laparoscopic techniques, and the role that the hysterectomy route plays in the need for future POP repair remains uncertain. Here the authors investigate the association of POP repair following robotic/laparoscopic hysterectomies, as well as vaginal, supracervical, and abdominal modalities. *Results:* Patients living in the West were more likely to have a prolapse repair post- hysterectomy than those living in the Midwest (HR 1.39; 95% CI: 1.01–1.93). Patients with hospital stays ≥4 days following hysterectomies were more likely to require future prolapse repairs than those with ≤ 1-day stays (HR 1.71; 95% CI: 1.10–2.65). Compared to abdominal procedures, robotic/laparoscopic modalities were more likely to be associated with prolapse within 18 months of hysterectomies (HR 1.72, 95% CI: 1.13–2.61). However, between 18 and 36 months, both supracervical and vaginal hysterectomies were more likely to be associated with prolapse surgeries (HR 1.96, 95% CI: 1.15–3.34 and HR 1.94; 95% CI: 1.02–3.70, respectively). *Conclusions:* Region and length of hospital stay significantly impacted the need for future prolapse repair. Among modalities, the association with prolapse repair changes with time.

Key words: Pelvic organ prolapse; Hysterectomy; Prolapse repair.

Information

The US Census Bureau projects that the number of American women with at least one pelvic floor disorder will increase from 28.1 million in 2010 to 43.8 million in 2050 [1]. Considering yearly surgical costs in the US have been consistently greater than one billion USD since 1997, it is safe to project that the surgical healthcare expense for pelvic organ prolapse (POP) will be exponentially increased by 2050 [2]. Hysterectomy, among other factors, has been associated with an increased risk for subsequent POP [3-7]. Altman *et al.* studied the risk for POP surgery attributed to hysterectomy until the year 2003 [4]. However, since 2003, rapidly developing technology has created a shift towards laparoscopic and robotic techniques for uterine removal as opposed to the open laparotomy method [8, 9].

Although the benefits of laparoscopic/robotic modalities are well known, their association with future risk for prolapse, compared to vaginal or open abdominal hysterectomy, remains unclear. The present authors utilized a large-scale patient population to examine the association of future prolapse repair with different types of hysterectomy.

The aim of this study was to estimate the incidence of POP surgery after abdominal hysterectomies compared to laparoscopic/robotic-assisted, vaginal, and supracervical hysterectomies for benign cases in the US.

Materials and Methods

The present authors conducted a retrospective cohort study using health insurance claims from the Clinformatics Data Mart (CDM) Database. This de-identified database contains insurance claims for medical services and drug prescriptions for over 56 million enrollees in the US. This study was determined to be exempt by the institutional review board of the University of Texas Medical Branch at Galveston.

The study cohort consisted of women aged 18–64 who received hysterectomies between January 2005 and September 2014 (Table 1) with any of the following modalities: robotic or laparoscopic, supracervical, open abdominal, or vaginal procedures (Table 2). The authors included women who had continuous insurance enrollment 12 months before and three months after the hysterectomies (Figure 1). The authors excluded women with prolapse procedure or diagnosis (Table 3) in the 12 months prior to hysterectomy because they are more likely to have a prolapse compared to those without history regardless of the hysterectomy modality. The authors also excluded any concomitant prolapse procedures or diagnoses, as well as prolapse procedures or diagnoses in the immediate three months following hysterectomy (Figure 1). That is, the authors excluded POP that was not identified

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Table 1. — *Patient characteristics of the study cohort, overall and stratified by hysterectomy modality.*

Patient characteristics	Overall n = 122404	Total abdominal n = 45863	Robotic/laparoscopic n = 44428	Supracervical n = 21150	Vaginal n = 10963
			N (column %)		
Age at hysterectomy (years)					
18-44	60870 (49.7)	21304 (46.5)	22658 (51.0)	10440 (49.4)	6468 (59.0)
45-54	52141 (42.6)	20483 (44.7)	18082 (40.7)	9602 (45.4)	3974 (36.2)
55-64	9393 (7.7)	4076 (8.9)	3688 (8.3)	1108 (5.2)	521 (4.8)
Region					
Midwest	32130 (26.2)	12229 (26.7)	11863 (26.7)	4641 (21.9)	3397 (31.0)
Northeast	7087 (5.8)	2758 (6.0)	1812 (4.1)	2175 (10.3)	342 (3.1)
South	66561 (54.4)	25422 (55.4)	24905 (56.1)	11198 (52.9)	5036 (45.9)
West	16626 (13.6)	5454 (11.9)	5848 (13.2)	3136 (14.8)	2188 (20.0)
Year of hysterectomy					
2005	11498 (9.4)	6602 (14.4)	2122 (4.8)	1418 (6.7)	1356 (12.4)
2006	12330 (10.1)	6622 (14.4)	2622 (5.9)	1584 (7.5)	1502 (13.7)
2007	12906 (10.5)	6309 (13.8)	2745 (6.2)	2438 (11.5)	1414 (12.9)
2008	13634 (11.1)	5987 (13.1)	3588 (8.1)	2715 (12.8)	1344 (12.3)
2009	13741 (11.2)	5321 (11.6)	4550 (10.2)	2652 (12.5)	1218 (11.1)
2010	13437 (11.0)	4461 (9.7)	5296 (11.9)	2585 (12.2)	1095 (10.0)
2011	12892 (10.5)	3569 (7.8)	5907 (13.3)	2436 (11.5)	980 (8.9)
2012	12695 (10.4)	2967 (6.5)	6592 (14.8)	2274 (10.8)	862 (7.9)
2013	11852 (9.7)	2471 (5.4)	6548 (14.7)	2073 (9.8)	760 (6.9)
2014 Jan-Sep	7419 (6.1)	1554 (3.4)	4458 (10.0)	975 (4.6)	432 (3.9)
Length of stay for hysterectomy					
Outpatient	48343 (39.5)	1794 (3.9)	30716 (69.1)	10442 (49.4)	5391 (49.2)
1	16590 (13.6)	1477 (3.2)	8377 (18.9)	3469 (16.4)	3267 (29.8)
2	32785 (26.8)	22882 (49.9)	4061 (9.1)	3940 (18.6)	1902 (17.3)
3	16691 (13.6)	13529 (29.5)	750 (1.7)	2135 (10.1)	277 (2.5)
4+	7995 (6.5)	6181 (13.5)	524 (1.2)	1164 (5.5)	126 (1.1)
			Mean ± STD (Median)		
Age at hysterectomy	44.5 ± 7.1 (45.0)	45.0 ± 7.2 (45.0)	44.3 ± 7.3 (44.0)	44.4 ± 6.4 (45.0)	42.9 ± 7.0 (43.0)
Follow-up time in months	30.9 ± 25.2 (23.1)	33.8 ± 27.3 (25.2)	27.2 ± 22.2 (20.5)	31.8 ± 24.9 (24.7)	32.5 ± 26.6 (24.0)

until the surgery day or during immediate postoperative visits. In addition, they excluded patients who had insurance claims for both vaginal and abdominal procedures, or those with cervical or uterine cancer diagnoses (International Classification of Diseases, 9th Revision, Clinical Modification [ICD-9-CM]) code 180.x and 182.x; respectively) in the prior year, and those with unknown residence information (Figure 1).

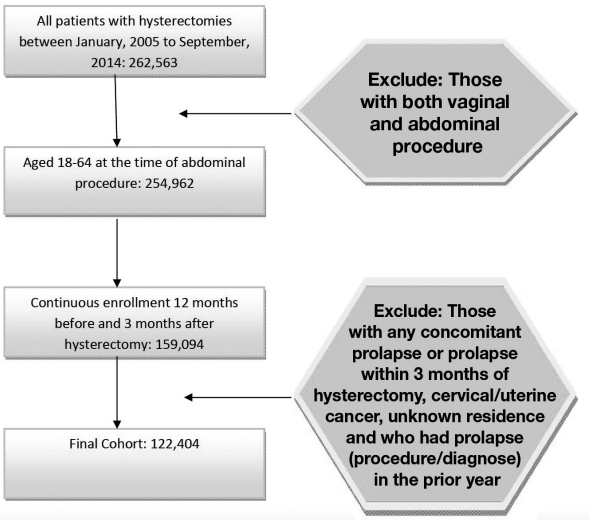


Figure 1. — Cohort selection flowsheet.

Patients were classified into four groups based on the type of hysterectomy: 1) robotic or laparoscopic, 2) supracervical, 3) total abdominal, and 4) vaginal. The supracervical hysterectomy included both laparoscopic and open abdominal procedures since the uterine ligaments remained undisrupted regardless of the route of this type of hysterectomy. Age, region, and the enrollment ending date were obtained from the member file, which contained demographic and enrollment information. The length of hospital stay for hysterectomy was obtained from the claim of hysterectomy.

The outcome of this study is the time to prolapse surgery following hysterectomy. Patients without prolapse surgery were censored at disenrollment, 60 months after hysterectomy, or at the end of study (December 31, 2014), whichever was earliest.

For each hysterectomy group, the authors estimated the incidence of receiving prolapse surgeries by Kaplan-Meier method and presented the result in graphics. The log-rank test was used to identify any difference among the unadjusted prolapse rates from these four hysterectomy groups. They used the proportional hazard regression model to examine which factors were associated with the outcome. When examining the proportional hazard assumption for each covariate in the model, they found the hazards from those four hysterectomy groups were not proportional. Therefore, a time-dependent hazard model with the effect of hysterectomy groups on prolapse surgeries at three time periods (<18 months, 18–36 months, and 37–60 months) was built. All statis-

Table 2. — *The current procedural terminology (CPT) and International Classification of Diseases, 9th Revision, Clinical Modification (ICD-9-CM) codes for identifying insurance claims of hysterectomy.*

CPT	CPT description	ICD-9-CM	ICD-9-CM description
Total Abdominal			
58150	Total abdominal hysterectomy (corpus and cervix)	68.49	Other and unspecified total abdominal hysterectomy
Robotic + laparoscopic			
58550	Laparoscopy, surgical, with vaginal hysterectomy, for uterus 250 g or less	68.41	Laparoscopic total abdominal hysterectomy
58552	Laparoscopy, surgical, with vaginal hysterectomy, for uterus 250 g or less; with removal of tube(s) and/or ovary(s)	68.51	Laparoscopically assisted vaginal hysterectomy
58553	Laparoscopy, surgical, with vaginal hysterectomy, for uterus greater than 250 g		
58554	Laparoscopy, surgical, with vaginal hysterectomy, for uterus greater than 250 g; with removal of tube(s) and/or ovary(s)		
58570	Laparoscopy, surgical, with total hysterectomy, for uterus 250 g or less		
58571	Laparoscopy, surgical, with total hysterectomy, for uterus 250 g or less; with removal of tube(s) and/or ovary(s)		
58572	Laparoscopy, surgical, with total hysterectomy, for uterus greater than 250 g		
58573	Laparoscopy, surgical, with total hysterectomy, for uterus greater than 250 g; with removal of tube(s) and/or ovary(s)		
Vaginal			
58260	Vaginal hysterectomy, for uterus 250 g or less	68.59	Other and unspecified vaginal hysterectomy
58262	Vaginal hysterectomy, for uterus 250 g or less; with removal of tube(s), and/or ovary(s)		
58290	Vaginal hysterectomy, for uterus greater than 250 g		
58291	Vaginal hysterectomy, for uterus greater than 250 g; with removal of tube(s) and/or ovary(s)		
Supracervical hysterectomy			
58180	Supracervical abdominal hysterectomy (subtotal hysterectomy)	68.31	Laparoscopic supracervical hysterectomy
58541	Laparoscopy, surgical, supracervical hysterectomy, for uterus 250 g or less	68.39	Other and unspecified subtotal abdominal hysterectomy
58542	Laparoscopy, surgical, supracervical hysterectomy, for uterus 250 g or less; with removal of tube(s) and/or ovary(s)		
58543	Laparoscopy, surgical, supracervical hysterectomy, for uterus greater than 250 g		
58544	Laparoscopy, surgical, supracervical hysterectomy, for uterus greater than 250 g; with removal of tube(s) and/or ovary(s)		

tical analyses were performed using SAS version 9.4.

Results

The present total cohort had 122,404 women hysterectomized for benign indications during the time period of 2005–2014. Baseline characteristics of cohort subjects overall, as well as stratified by hysterectomy modality, are presented in Table 1. The Kaplan-Meier method was used to evaluate the rate of subsequent POP repair. At year 5 post-hysterectomy, 0.64% of these women received POP repairs, regardless of the modality. For the women with total abdominal hysterectomies, 0.48% had undergone prolapse surgeries at year 5. For women with laparoscopic/robotic, supracervical, and vaginal hysterectomies, the event rates at year 5 were 0.68%, 0.85%, and 0.76%, respectively. There was a significant difference in event rates among these 4 groups of women with various modalities (Figure 2, log-rank test, $p = 0.0012$). The overall mean follow-up time for all modalities was 30.9 months. The authors performed a proportional hazards regression to identify factors associated with the likelihood of having a prolapse surgery post-hysterectomy (Table 4). They observed an increase in the likelihood of having a prolapse surgery in older women. However, this increase was not significant. The year that the hysterectomy was performed was not associated with the likelihood of having a prolapse surgery.

Patients who stayed ≥4 days in the hospital following hysterectomies were more likely to require future prolapse repairs than those who stayed ≤1 day (HR 1.71; 95% CI: 1.10–2.65). Geographically, compared to those living in the Midwest, patients living in the West had a significant association with POP after their hysterectomy procedures.

As demonstrated in Figure 2, in terms of the probability that a patient developed prolapse after hysterectomy, the relationship between various modalities changed with time. To reflect this fact, the five-year follow-up was divided into three time periods: <18 months, 18–36 months,

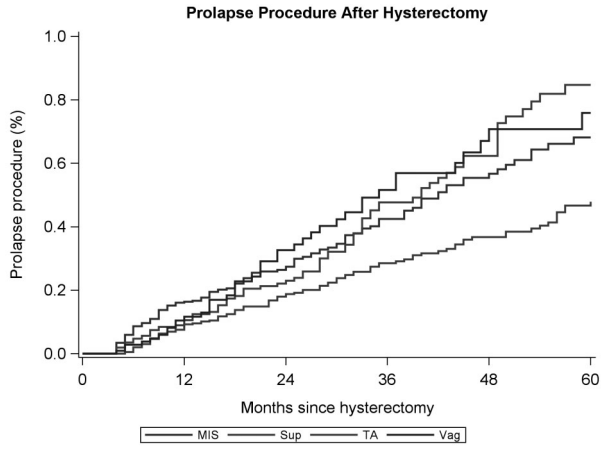
Table 3. — *The current procedural terminology (CPT) and International Classification of Diseases, 9th Revision, Clinical Modification (ICD-9-CM) codes for identifying insurance claims with prolapse diagnosis or procedure.*

Code	Code description
ICD-9-CM diagnosis	
618.0	Prolapse of vaginal walls without mention of uterine prolapse
618.1	Uterine prolapse without mention of vaginal wall prolapse
618.2	Uterovaginal prolapse, incomplete
618.3	Uterovaginal prolapse, complete
618.4	Uterovaginal prolapse, incomplete
618.5	Prolapse of vaginal vault after hysterectomy
618.6	Vaginal enterocele, congenital or acquired
618.7	Old laceration of muscles of pelvic floor
618.8	Other specified genital prolapse
ICD-9-CM procedure	
70.51	Repair of cystocele, urethrocele
70.50	Repair of cystocele and rectocele
70.52	Repair of rectocele
70.61, 70.62	Vaginal construction and reconstruction
70.77, 70.92	Vaginal suspension and fixation/other operations cul-de-sac
70.8	Obliteration of the vaginal vault (LeFort operation)
70.79	Colpoperineoplasty
CPT	
45560	Repair of rectocele
57120	Colpocleisis (Le Fort type)
57240	Anterior colporrhaphy, repair of cystocele with or without repair of urethrocele
57250	Posterior colporrhaphy, repair of rectocele with or without perineorrhaphy
57260	Combined anteroposterior colporrhaphy
57265	Combined anteroposterior colporrhaphy ,With enterocele repair
57267	Insertion of mesh or other prosthesis for repair of pelvic floor defect, each site (anterior, posterior compartment), vaginal approach
57268	Repair of enterocele (vaginal)
57270	Repair of enterocele (abdominal)
57280	Apical repair, abdominal open
57282	Apical repair, vaginal extra-peritoneal
57283	Apical repair, vaginal Intra-peritoneal
57284	Paravaginal defect repair (including repair of cystocele, if performed); open abdominal approach
57285	Paravaginal defect repair (including repair of cystocele, if performed); vaginal approach
57289	Pereyra procedure, including anterior colporrhaphy
57423	Paravaginal defect repair (including repair of cystocele, if performed); laparoscopic approach
57425	Apical repair, abdominal laparoscopic
58400	Uterine suspension
58410	Uterine suspension with presacral sympathectomy

and 37–60 months. As shown in Table 4, in the early period (within 18 months of hysterectomy), patients who had robotic or laparoscopic procedures were more likely to develop prolapses compared to those with total abdominal procedures (HR 1.72, 95% CI: 1.13–2.61); however, no significant difference existed between these two modalities in later periods. No difference was found between supracervical and total abdominal hysterectomies within 18 months. The difference appeared later, showing that patients who received supracervical procedures were more likely to have prolapse surgeries (HR 1.96, 95% CI: 1.15–3.34). The risk was even higher in the late period, between 37 and 60 months post-hysterectomy. Similarly, women who underwent vaginal hysterectomies were more likely to need prolapse repairs compared to abdominal hysterectomies after the initial 18-month postoperative period (HR 1.94; 95% CI: 1.02–3.70).

Discussion

Vaginal hysterectomy is a commonly recommended hysterectomy method due to a quicker return to normal activities, faster operating time, and shorter hospital stay compared with open hysterectomy [10]. However, the present study agrees with the rest of the literature that prolapse repair more frequently follows vaginal hysterectomies than other modalities [4]. Surgeons typically select women with more uterine decent for vaginal modalities, which potentiates a selection bias and may offer a rationale for higher subsequent prolapse repair [11]. When a hysterectomy is



Year	MIS		Supracervical		Total abdominal		Vaginal	
	Prolapse repair %	Number at risk	Prolapse repair %	Number at risk	Prolapse repair %	Number at risk	Prolapse repair %	Numb er at risk
1	0.16	32255	0.11	16304	0.09	35195	0.12	8349
2	0.27	20106	0.23	11137	0.19	24474	0.33	5622
3	0.42	12382	0.48	7504	0.29	17427	0.52	3912
4	0.57	7557	0.62	5013	0.37	12232	0.71	2703
5	0.68	4414	0.85	3225	0.48	8402	0.76	1854

Figure 2. — Prolapse procedure after hysterectomy.
Time to the first prolapse repair procedure within five years of hysterectomy, by the type of hysterectomy. $p = 0.0012$, Log-rank test. MIS = robotic/laparoscopic; Sup = supracervical hysterectomy; TA = total abdominal hysterectomy; Vag= vaginal hysterectomy.

Table 4. — *The effect of hysterectomy type and other patient characteristics on the likelihood for having a prolapse surgery within five years of hysterectomy.*

Patient characteristics	Hazard ratio (95% CI)
Type of hysterectomy	
< 18 months	
Total abdominal	Ref
MIS (robotic/laparoscopic)	1.72 (1.13, 2.61)
Supracervical hysterectomy	1.28 (0.79, 2.07)
Vaginal	1.49 (0.85, 2.62)
18-36 months	
Total abdominal	Ref
MIS (robotic/laparoscopic)	1.42 (0.84, 2.41)
Supracervical hysterectomy	1.96 (1.15, 3.34)
Vaginal	1.94 (1.02, 3.70)
37-60 months	
Total abdominal	Ref
MIS (robotic/laparoscopic)	1.22 (0.52, 2.89)
Supracervical hysterectomy	3.15 (1.25, 7.92)
Vaginal	1.72 (0.52, 5.62)
Age at hysterectomy (years)	
18-44	Ref
45-54	1.03 (0.83, 1.28)
55-64	1.14 (0.77, 1.67)
Region	
Midwest	Ref
Northeast	0.60 (0.33, 1.11)
South	1.12 (0.87, 1.44)
West	1.39 (1.01, 1.93)
Year of hysterectomy, per year	0.98 (0.93, 1.02)
Length of stay for hysterectomy	
Outpatient	Ref
1	1.11 (0.82, 1.50)
2	1.03 (0.75, 1.43)
3	0.76 (0.49, 1.19)
4+	1.71 (1.10, 2.65)

not feasible to perform vaginally, the next recommended option is most often a laparoscopic method [12].

Gynecologists have increasingly adopted laparoscopic and robotic approaches into their practices since 2003 [9]. Since laparoscopic/robotic surgeries have entered the surgical repertoire, few studies have evaluated their outcomes on the subsequent need for prolapse repair. In this study, the hazard ratio for laparoscopic/robotic hysterectomy was highest in the first 18 months following surgery. Naturally, there is a learning curve for surgeons to acquire this new skill set, which might influence early incidence of POP. In this learning curve period, surgeons might select patients with more serious prolapse because surgery is easier when the uterus has descended farther, and patients with more serious conditions may be more prone to prolapse. Even though the present authors excluded those patients who had a claim for prolapse in the year prior to hysterectomy, some patients with less severe prolapse conditions may have remained in the study cohort. Such patients were not captured by the claims data because they did not feel the need to see a medical professional. Another explanation for the higher rate of POP repair after laparoscopic/robotic hysterectomies is that various energy sources are used instead of sharp transection and ligation as in open or vaginal cases. Thermal spread may cause tissue destruction, potentially increasing tissue necrosis and leading to poor healing that ultimately has an effect on pelvic support as seen in increased cuff dehiscence incidence after laparoscopic hysterectomy [13].

A common thought is that hysterectomy may cause prolapse by disrupting the uterine ligamentous supports [14, 15]. One of the outcomes of using uterine manipulators during laparoscopic/robotic cases is the preservation of major parts of the uterosacral and cardinal ligaments. This procedure is thought to help prevent prolapse, especially apical prolapse [16, 17]. However, when Lykke *et al.* looked at POP rates after radical hysterectomy versus simple total abdominal hysterectomy, they found more POP repairs took place following simple hysterectomies [18]. Considering that more supporting ligaments are removed in radical hysterectomies, these data do not agree with the idea that disrupting these supports leads to more POP. Furthermore, in supracervical hysterectomies, whether they are performed as open or minimally invasive procedures, these ligaments are spared, suggesting that this modality should have decreased rates of prolapse compared to other routes of hys-

terectomies. However, Rhan *et al.* demonstrated that total abdominal and supracervical hysterectomies had similar resistance when force was applied to the vaginal apex on cadavers [19]. Data from the present study is in accordance with Rhan *et al.*'s findings, demonstrating that supracervical hysterectomies were similarly likely to require POP repair compared to abdominal hysterectomies and suggesting that the etiology of POP is likely more complex and multifactorial than just ligamentous support.

In the present study, only two characteristics were significantly associated with future prolapse repair. The first was length of hospital stay. Patients are typically kept in the hospital longer due to postoperative complications [20]. Perhaps a more difficult uterine extraction ultimately leads to a longer stay. Thus, some authors suggest that postoperative complications lead to prolapse [20].

Region was also significantly associated with future prolapse repair. Data from the Centers for Disease Control and Prevention show that total fertility rates are higher in the Western states compared to those of the Midwest [21], which corresponds to higher parity rates among Western than Midwestern women. Parity, specifically number of vaginal deliveries, is the most commonly cited risk factor for prolapse [22-24].

The strength of the present study is the large number of hysterectomies included and their fairly equal distribution among each modality. Another major strength of the present study is that the authors excluded cases with prolapse diagnosis or procedure in the year prior to hysterectomy or in the three months immediately following hysterectomy. They also excluded patients who had concomitant prolapse repair, which is important, as women who have existing POPs are at increased risk for future prolapses [25, 26]. By excluding these patients, they were able to focus more on the incidence of prolapse repairs following hysterectomy rather than the preexisting risk for POP.

A limitation of the present study was that the authors did not evaluate how BMI, race, menopause, vaginal parity, or smoking affect prolapse repair after hysterectomy because the information on those factors was either not available or was under-coded in claims databases. Additionally, several studies have shown that the prevalence of pelvic floor disorders increases with age [23, 27], and more than 90% of our study population was younger than 55-years-old at the time of hysterectomy. This limitation can be overcome by further randomized clinical trials aiming for an older population. The present study was conducted using a private insurance claims database. Uninsured patients are less likely than those with insurance to be able to afford prolapse repair surgeries. Therefore, it is questionable whether these findings can be applied to an uninsured population. Lastly, given that gynecologists have varying skill levels and may prefer one route over the others, practitioners may be confounders for the present results. Future studies accounting for provider effect should be conducted to alleviate this concern.

In conclusion, of the characteristics explored, only region and length of hospital stay showed statistically significant associations with the need for future prolapse repair. When comparing the different modalities, the probability of a patient having post-hysterectomy prolapse repair changes with time. Early follow-up shows prolapse repair is more likely to follow laparoscopic/robotic modalities compared to abdominal. Long-term follow-up demonstrates that supracervical procedures and vaginal approaches are more likely to lead to prolapse repairs than abdominal procedures. Supracervical procedures had the highest probability of subsequent prolapse repair 36 months post-hysterectomy. Patients should be educated on the risk of post-hysterectomy prolapse repair following their designated modalities while understanding that the overall incidence of POP following any route of hysterectomy remains low.

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