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ORIGINAL RESEARCH ARTICLE

Pelvic organ prolapse after hysterectomy: A 10-year national follow-up study

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Abstract

Introduction: Hysterectomy may have an effect on the pelvic floor. Here, we evaluated the rates and risks for pelvic organ prolapse (POP) surgeries and visits among women with a history of hysterectomy for benign indication excluding POP.

Material and methods: In this retrospective cohort study 3582 women who underwent hysterectomy in 2006 were followed until the end of 2016. The cohort was linked to the Finnish Care Register to catch any prolapse-related diagnoses and operation codes following the hysterectomy. Different hysterectomy approaches were compared according to the risk for a prolapse, including abdominal, laparoscopic, laparoscopic-assisted vaginal and vaginal. The main outcomes were POP surgery and outpatient visit for POP, and Cox regression was used to identify risk factors (hazard ratios [HR]).

Results: During the follow-up, 58 women (1.6%) underwent a POP operation, of which a posterior repair was the most common (n = 39, 1.1%). Outpatient visits for POP symptoms occurred in 92 (2.6%) women of which posterior wall prolapses (n = 58, 1.6%) were the most common. History of laparoscopic-assisted vaginal hysterectomy were associated with risk for POP operation (HR 3.0, p = 0.02), vaginal vault prolapse operation (HR 4.3, p = 0.01) and POP visits (HR 2.2, p < 0.01) as compared to the approach of abdominal hysterectomy. History of vaginal deliveries and concomitant stress urinary continence operation were associated with the risk for a POP operation (HR 4.4 and 11.9) and POP visits (HR 3.9 and 7.2).

Conclusions: Risk for POP operations and outpatient visits for POP symptoms in hysterectomized women without a preceding POP seems to be small at least 10 years after hysterectomy. History of LAVH, vaginal deliveries and concomitant stress urinary incontinence operations increased the risk for POP operations after hysterectomy.

Abbreviations: AH, abdominal hysterectomy; BMI, body mass index; CI, confidence interval; HR, hazard ratio; LAVH, laparoscopic-assisted vaginal hysterectomy; LH, laparoscopic hysterectomy; POP, pelvic organ prolapse; SUI, stress urinary incontinence; UI, urinary incontinence; VH, vaginal hysterectomy.

These data can be utilized in counseling women considering hysterectomy for benign indication.

KEYWORDS
different approaches, hysterectomy, pelvic organ prolapse, POP operation, POP visit

1 | INTRODUCTION

Hysterectomy remains a common gynecological operation, even if the number of hysterectomies has reduced by half in Finland during the last two decades.[1] It is estimated that by the age of 60, more than a third of all women receive a hysterectomy, largely for benign conditions, such as fibroids, abnormal uterine bleeding, endometriosis and uterine prolapse.[2] These main indications as well as hysterectomy approaches have changed over the past decades,[2–5] vaginal and laparoscopic approaches have surpassed the abdominal one.[1,3]

Hysterectomy may contribute to pelvic floor weakness by changing anatomy and nerve supply. It seems to increase the risk for pelvic organ prolapse (POP),[6–8] even if hysterectomy has been generally considered as a treatment for apical prolapse. Suspension of the vaginal vault is crucial in preventing POP, since the lack of the apical support doubles the POP recurrence risk.[9] In addition, several other factors, such as age, obesity, vaginal deliveries, parity, and hysterectomy indication seem to affect the POP risk after hysterectomy.[6–8]

Less is known about the role of hysterectomy approach, intra- or perioperative factors, complications, body mass index (BMI), experience and status of the surgeon, or preceding and concomitant procedures such as ovariectomy and stress urinary incontinence (SUI) operations. In this retrospective cohort study, we report the rates of post-hysterectomy POP operations and outpatient visits over more than 10 years among 3582 women who underwent hysterectomy for benign indication other than prolapse during the year 2006. We also assessed patient and operation related factors for long-term POP risk.

Key message

After benign hysterectomy, the risk of POP operation was reported in only 1.6% patients without prior POP. The risk for POP was associated with the approach of laparoscopic-assisted vaginal hysterectomy, vaginal deliveries and concomitant stress urinary incontinence operations.

2 | MATERIAL AND METHODS

The present data is a sub-analysis of the prospective, large nationwide Finhyst-study of 5279 women who underwent hysterectomy for benign indications and was conducted in 53 Finnish hospitals in 2006. It included 79% of all benign hysterectomies in Finland that year. The study comprised all 46 public hospitals (5 university, 16 central and 23 local) and 7 private clinics. The latter covered only 1.3% of all hysterectomies. Due to the prospective, national study design and volunteer participation also for the surgeons, 21% (n = 1109) of the benign hysterectomies performed in the first study year (2006) was missed. The study was included in the ClinicalTrials.gov protocol and written consent was obtained from each patient. Paper questionnaires covered patient characteristics and surgical data and were completed by the surgeons.[4] The main indications for hysterectomy determined by a gynecological surgeon were: fibroids, menorrhagia, dysmenorrhea, endometriosis, uterine prolapse, adnexal mass or other. Other indications included endometrial hyperplasia (3.1%), cervical malignancy (1.8%), abdominal pain, familial history of cancer, adenomyosis, benign pelvic tumor, endometrial polyposis, pelvic inflammatory disease, transsexualism, prior breast cancer, hematometra, urinary symptoms, dyspareunia and migraine (each only <0.5%).[4] Other patient and operation characteristics were defined as described previously.[4]

The hysterectomy approaches were classified as abdominal (AH, including both total and subtotal hysterectomies and conversions), laparoscopic (LH), laparoscopic-assisted vaginal (LAVH) and vaginal (VH). The hysterectomy approach was chosen by a surgeon according to anatomical findings and an indication, The surgeon provided the diagnosis but not the stage of the prolapse nor the method of the vaginal cuff suture. The difficulty of the operation was classified by a surgeon from one to five (1 = easy, 5 = very difficult) and the operation time was also reported. The experience of the surgeon was classified under 10, 10–30 and over 30 operations.

From this data we identified 3582 (68%) women who underwent hysterectomy for any other benign indication than POP. Women with an operation or diagnosis of POP before the hysterectomy were excluded (n = 1697). Post-hysterectomy operations and outpatient clinical visits for POP were followed up until the end of year 2016. A flow chart of sample collection is shown in Figure 1.

The cohort was subsequently linked to the Finnish Care Register maintained by the Finnish Institute for Health and Welfare. The Care Register contains information on dates of hospital admission and discharge, diagnoses coded according to the International Classification of diseases (ICD) and operation codes based on the Nordic Classification of Surgical Procedures (NSCP) for all clinical in- and outpatient visits in every specialized health care providing institute in Finland. From the Care Register, we identified all POP

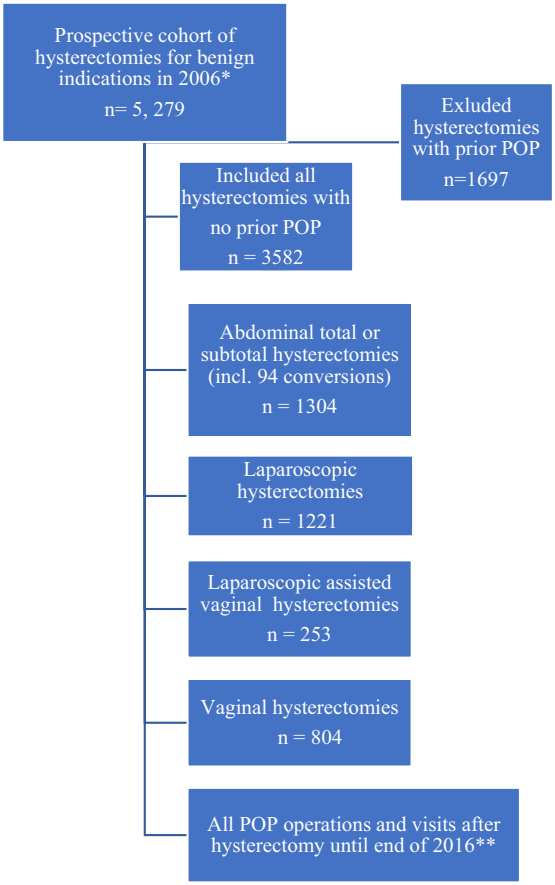

FIGURE 1 Flow of the sample collection. POP, pelvic organ prolapse. *By data collected in the prospective cohort. **By Data from the Care Register for Health Care.

diagnoses (ICD-10 N81*) and/or POP operations (NSCP codes LEF*) from 1996 up to end of 2016. From the Care Register we could identify a prolapse compartment but not prolapse stage.

The primary outcome was the rate of post-hysterectomy POP surgery and/or POP diagnosed at an outpatient clinical visit 60 days or more after the index hysterectomy. Follow-up ended at the first operation or visit for POP. We also evaluated if the presence of POP was associated with the specific surgical procedures and patient related factors, such as the hysterectomy approach, preceding and concomitant operations, age, BMI, parity, vaginal deliveries, indication, uterus size, some autoimmune disease, chronic obstructive pulmonary disease/asthma, difficulty of the hysterectomy, intra- and perioperative complications, experience of the surgeon and hospital type. The frequency of pre- and post-hysterectomy UI (urinary incontinence) diagnoses were also assessed.

The risk factor analysis was conducted for all of the above-mentioned variables by univariate and multivariate analysis. The variables were found to be significant in a univariate model (hysterectomy approach, vaginal deliveries and concomitant SUI operation) were tested in a multivariate Cox regression analysis and adjusted with each other, age, BMI, previous cesarean section and uterus size. For visualization, we created Kaplan–Meier curves for cumulative survival without a POP operation according to the hysterectomy approach.

For continuous variables, results were expressed as mean and standard deviation or as median and interquartile range, and significance calculated using the independent *t* test. In the case of ordinal variable, proportions were calculated by the Chi-squared or Fisher's exact test as appropriate. When comparing more than two groups, the one-way ANOVA was used. A significance level of $p < 0.05$ was used. Data analysis was performed using IBM SPSS Statistics 26.0.

2.1 | Ethics statement

The study protocol was approved by the Ethical Committee of the Helsinki and Uusimaa Hospital District (Dnro 457/E8/04 on December 16, 2004 and 343/13/03/03/2015 on March 3, 2015) and was registered in the Clinical Trials (NCT00744172). The Finnish Institute for Health and Welfare of Finland authorized the use of the data from the Care Register (THL/986/5.05.00/2018). The research was conducted in accordance with the principles embodied in the Declaration of Helsinki and in accordance with local statutory requirements and all participants gave written informed consent to participate in the study.

3 | RESULTS

Abdominal hysterectomy was the most common approach ($n = 1304$), followed by laparoscopic ($n = 1221$), vaginal ($n = 804$) and laparoscopic-assisted vaginal hysterectomy ($n = 253$). Indications varied between the operation approaches; fibroids were the most common in women with AH, LH and LAVH and dysfunctional bleeding in VH, as prolapse indication was excluded in this study. The women with VH were the youngest, more often multiparous and had the least cesarean sections as compared to the women with other approaches. A BMI of over 30 (25.4%), uterus >500 g (37.6%) and minor complications (16.3%) were over-represented in the women with AH. Concomitant SUI operations were performed more often in women with VH (1.6%) as compared to the women with any other approach (all <0.8%, $p < 0.01$ VH vs LH and AH). The number of post-hysterectomy UI diagnoses ($n = 143$, 4.0%), exceeded that of pre-hysterectomy ($n = 93$, 2.6%) in all women. This increase was greatest (3.9%) among those with a history of LAVH ($p = 0.03$ LAVH vs AH). Baseline characteristics are presented in Table 1.

The women were followed for a median of 10.6 years. Outpatient visits for any POP symptom occurred in 92 (2.6%) of women and most of the diagnoses were posterior wall prolapses (58, 1.6%). Women with LAVH had more visits for any prolapse ($n = 12$, 4.7%) and for vaginal vault prolapse ($n = 4$, 1.6%) than those women with AH ($n = 21$, 1.6%, $p = 0.01$) ($n = 2$, 0.2%, $p = 0.02$, respectively). Time from hysterectomy to any POP visit was shorter in women with AH (4.0 years) as compared to those women with LH (6.8 years) and VH (7.1 years) ($p < 0.01$ for both, Table 2).

During the follow-up time, 58 women (1.6%) underwent some kind of POP operation, of which rectocele was the most common

TABLE 1 Sample demographics.

	All hyst.[a]	AH[b]	LH	LAVH	VH
n (%)	3582 (100)	1304 (36,4)	1221 (34,1)	253 (7,1)	804 (22,4)
Age, mean (SD)	48.8 (8.1)	49.8 (8.5)	48.6 (8.0)	49.3	46.7 (6.6)
Age, *n* (%)					
Under 45	1045 (29.1)	311 (23.8)	357 (29.2)	72 (28.5)	305 (37.9)
45–54	1897 (53.0)	712 (54.6)	643 (52.7)	120 (47.4)	422 (52.5)
55 and over	640 (17.9)	281 (21.5)	221 (18.1)	61 (24.1)	77 (9.6)
BMI, mean (SD)	26.5 (5.9)	27.2 (5.3)	25.9 (4.6)	26.2 (4.6)	26.2 (5.0)
BMI > 30	736 (20.5)	331 (25.4)	213 (17.4)	47 (18.6)	145 (18.0)
Deliveries					
Cesarean sections one or more	579 (16.2)	1076 (17.5)	1025 (16.1)	50 (19.8)	105 (13.1)
Vaginal deliveries	2488 (69.5)	525 (59.7)	405 (66.8)	55 (78.3)	695 (86.4)
Nulliparous or status unknown	785 (21.9)	378 (29.0)	303 (24.8)	37 (14.6)	67 (8.3)
1–2 vaginal deliveries	1701 (47.5)	552 (42.3)	578 (47.3)	130 (51.4)	441 (54.9)
3 or more vaginal deliveries	787 (22.0)	227 (17.4)	238 (19.5)	68 (26.9)	254 (31.6)
Preceding operations					
Any preceding operation*	1859 (51.9)	659 (50.5)	652 (53.4)	145 (57.3)	403 (50.1)
Preceding laparotomy	866 (24.2)	375 (28.8)	283 (23.2)	70 (27.7)	138 (17.2)
Preceding laparoscopy	944 (26.4)	234 (17.9)	370 (30.3)	83 (32.8)	257 (32.0)
Main indication					
Fibroids	1662 (46.4)	768 (58.9)	489 (40.0)	92 (36.4)	313 (38.9)
Dysfunctional uterine bleeding	1032 (28.8)	192 (14.7)	386 (31.6)	81 (32.0)	373 (46.4)
Dysmenorrea	131 (3.7)	27 (2.1)	51 (4.2)	14 (5.5)	39 (4.9)
Endometriosis	125 (3.5)	82 (6.3)	37 (3.0)	5 (2.0)	1 (0.1)
Adnexal mass or other	632 (17.6)	235 (18.0)	258 (21.1)	61 (24.1)	78 (9.7)
Uterus size, mean (g) (SD)	286 (295)	427 (419)	209 (143)	215 (138)	200 (131)
Uterus >500 g	679 (19.0)	490 (37.6)	110 (9.0)	20 (7.9)	59 (7.3)
Operations					
Any concomitant operation	1510 (42.2)	731 (56.1)	553 (45.3)	134 (53.0)	92 (11.4)
Bilateral salpingectomy	944 (26.4)	464 (35.6)	359 (29.4)	92 (36.4)	29 (3.6)
SUI operation (TOT, TVT, Burch)	22 (0.6)	1 (0.1)	6 (0.5)	2 (0.8)	13 (1.6)
Operator experience					
<30 hysterectomies	762 (21.3)	286 (21.9)	275 (22.5)	57 (22.5)	144 (17.9)
>30 hysterectomies	2695 (75.2)	974 (74.7)	905 (74.1)	180 (71.1)	636 (79.1)
Operator status					
Specialist	2686 (75.0)	954 (73.2)	945 (77.4)	191 (75.5)	596 (74.1)
Resident	695 (19.4)	281 (21.5)	207 (17.0)	43 (17.0)	164 (20.4)
Complications					
Any	420 (11.7)	230 (17.6)	87 (7.1)	28 (11.1)	75 (9.3)
Minor	455 (12.7)	213 (16.3)	130 (10.6)	29 (11.5)	83 (10.3)
Major	147 (4.1)	66 (5.1)	45 (3.7)	7 (2.8)	29 (3.6)
Operating hospital					
University	1409 (39.3)	388 (29.8)	667 (54.6)	94 (37.2)	260 (32.3)
Central	1318 (36.8)	618 (47.4)	327 (26.8)	98 (38.7)	275 (34.2)
Local	814 (22.7)	292 (22.4)	203 (16.6)	59 (23.3)	260 (32.3)
Private	41 (1.1)	6 (0.5)	24 (2.0)	2 (0.8)	9 (1.1)

(Continues)

TABLE 1 (Continued)

	All hyst.[a]	AH[b]	LH	LAVH	VH
UI diagnosis or operation *n* (%)					
Concomitant SUI operation	22 (0.6)	1 (0.1)	6 (0.5)	2 (0.8)	13 (1.6)
UI diagnosis pre-hysterectomy	93 (2.6)	29 (2.2)	25 (2.0)	8 (3.2)	31 (3.9)
UI diagnosis post-hysterectomy	143 (4.0)	43 (3.3)	45 (3.7)	18 (7.1)	37 (4.6)

Abbreviations: AH, abdominal hysterectomy; BMI, body mass index; LAVH, laparoscopic-assisted vaginal hysterectomy; LH, laparoscopic hysterectomy; SAH, subtotal abdominal hysterectomy; SD, standard deviation; SUI, stress urinary incontinence; TOT, transobturator tape; TVT, tension-free vaginal tape; VH, vaginal hysterectomy.

*Including cesarean sections, laparoscopies, laparotomies.

[a]All hysterctomies.

[b]including SAH and conversions.

TABLE 2 Incidence of prolapse repair and visits after different hysterectomy approaches by type.

	All hyst. *n* = 3582	AH *n* = 1304	LH *n* = 1221	LAVH *n* = 253	VH *n* = 804	*p*-value
POP operation *n* (%)						
Any prolapse repair						
Yes	58 (1.6)	12 (0.9)	19 (1.6)	9 (3.6)*	18 (2.2)	0.01
No	3524 (98.4)	1292 (99.1)	1202 (98.4)	244 (96.4)	786 (97.8)	
Type of repair						
Colporrhaphy anterior						
Yes	24 (0.7)	6 (0.5)	9 (0.7)	2 (0.8)	7 (0.9)	0.69
No	3558 (99.3)	1298 (99.5)	1212 (99.3)	251 (99.2)	797 (99.1)	
Colporrhaphy posterior						
Yes	39 (1.1)	7 (0.5)	14 (1.1)	5 (2.0)*	13 (1.6)	0.05
No	3543 (98.9)	1297 (99.5)	1207 (98.9)	248 (98.0)	791 (98.4)	
Vaginal vault repair						
Yes	11 (0.3)	1 (0.1)	1 (0.1)	5 (2.0)*	4 (0.5)	<0.01
No	3571 (99.7)	1303 (99.9)	1220 (99.9)	248 (98.0)	800 (99.5)	
Time, years, median (IQR)	6.4 (4.1–9.4)	5.1 (2.5–8.2)	6.0 (3.6–9.5)	6.4 (3.5–9.2)	7.9 (5.9–9.8)	0.29
POP visits *n* (%)						
Prolapse visit						
Yes	92 (2.6)	21 (1.6)	34 (2.8)	12 (4.7)*	25 (3.1)	0.01
No	3490 (97.4)	1283 (98.4)	1187 (97.2)	241 (95.3)	779 (96.9)	
Type of prolapse						
Cystocele						
Yes	35 (1.0)	9 (0.7)	12 (1.0)	6 (2.4)	8 (1.0)	0.10
No	3547 (99.0)	1295 (99.3)	1209 (99.0)	247 (97.6)	796 (99.0)	
Rectocele						
Yes	58 (1.6)	13 (1.0)	21 (1.7)	6 (2.4)	18 (2.2)	0.11
No	3524 (98.4)	1291 (99.0)	1200 (98.3)	247 (97.6)	786 (97.8)	
Vaginal vault prolapse						
Yes	20 (0.6)	2 (0.2)	7 (0.6)	4 (1.6)*	7 (0.9)	0.02
No	3562 (99.4)	1302 (99.8)	1214 (99.4)	249 (98.4)	797 (99.1)	
Time, years, median (IQR)	6.1 (2.8–9.0)	4.0 (1.9–7.3)*	6.8 (5.2–9.4)	4.6 (1.0–8.7)	7.1 (4.8–9.3)	<0.01

Abbreviations: AH, abdominal hysterectomy; All hyst, all hysterectomies; IQR, interquartile range; LAVH, laparoscopic-assisted vaginal hysterectomy; LH, laparoscopic hysterectomy; POP, pelvic organ prolapse; VH, vaginal hysterectomy.

*Significant.

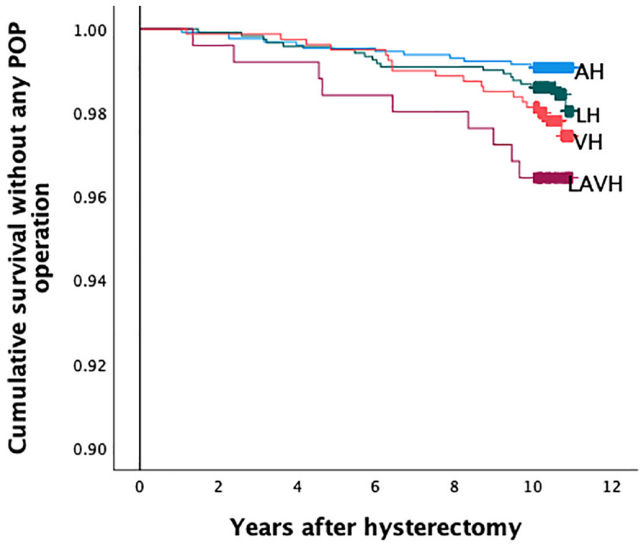

FIGURE 2 Kaplan–Meier cumulative survival without any pelvic organ prolapse (POP) operation after hysterectomy during more than 10 years of follow-up time. AH, abdominal hysterectomy; LAVH, laparoscopic-assisted vaginal hysterectomy, LH, laparoscopic hysterectomy; VH, vaginal hysterectomy.

($n = 39$, 1.1%). Twenty of 58 (34.4%) women had more than one POP operation. The women with LAVH underwent post-hysterectomy POP operation ($n = 9$, 3.6%), more often than those with AH ($n = 12$, 0.9%) ($p < 0.01$) (Table 2, Figure 2) The women with LAVH experienced post-hysterectomy vaginal vault prolapse (2.0%) more often than those undergoing any other hysterectomy approach ($p < 0.01$) (Table 2).

In adjusted survival analysis the women with a history of LAVH had a three times higher risk for any POP operation (hazard ratio [HR] 3.0, confidence interval [CI]: 1.2–7.7) and 4.3 times higher risk for vaginal vault prolapse as compared to those women with AH (HR 4.3, CI: 1.4–13.9). For POP visits those with a history of LAVH had a 2.2 times higher risk for any POP visit than those with AH (HR 2.2, CI: 1.0–4.9) (Table 3).

In the univariate analysis only LAVH and VH approaches were associated with risk for POP operations (HR 3.9, CI: 1.2–11.6, and HR 2.4, CI: 1.2–5.1) and visits (HR 3.0, CI: 1.5–6.1, and HR 1.9, CI: 1.0–3.4) when AH was used as a reference, whereas no associations were found in the subanalysis with other patient and operation related risk factors, no associations were found (data not shown).

In the multivariate analyses LAVH, vaginal deliveries and concomitant SUI operations associated with risk for a POP operation whereas only LAVH associated with a twofold higher risk for POP visits (Table 4). We also conducted two-category risk factor analysis in which LAVH associated with a 2.2 times higher risk for any POP operation (CI: 1.1–4.6) and a 1.8 times higher risk for any POP visit (CI: 1.0–3.4). Vaginal deliveries and the combination of hysterectomy with SUI operation were associated with risk for any POP operations (HR 4.4, CI 1.7–11.0, and HR 11.9, CI: 4.3–32.7, respectively) and POP visits (HR 3.9, CI: 2.0–7.8, and HR 7.2, CI: 2.7–20.0, respectively), (Table 5). When we excluded all the women with a concomitant SUI operation ($n = 22$) from our analysis, the women with LAVH still had higher risk for any post-hysterectomy prolapse repair and visit (data not shown).

4 | DISCUSSION

We assessed rates and risk factors for POP operations and visits in a cohort of 3582 women with a history of hysterectomy for any other benign indication than POP. During more than 10 years of follow-up time, only 1.6% of the women underwent a POP operation, mainly in women with a history of LAVH. The rate of POP operations was approximately two-thirds of the rate of POP visits (2.6%), which indicates that some women were treated conservatively. A Danish national registry study with a 20-year follow-up observed that approximately one third of all POP operations after hysterectomy were performed within 5 years after hysterectomy, and the risk for POP operations decreased after 7 years.[8] Also in our study, 58% of POP operations and 62% of POP visits occurred during the first 7 years of follow-up.

The number of POP operations and visits that were observed during follow-up was lower than in previous studies showing clearly higher post-hysterectomy POP operation rates (5%–13%).[7,8,10] It is possible that our 10-year follow-up time, which was shorter than in previous studies,[11,12] was not long enough to catch all post-hysterectomy POPs, since the mean age of the women in our cohort was only 58 years at the end of the follow-up. In the previous Finnish and U.S. studies the highest incidence peaks of POP surgeries are among women over 70 years.[13,14] Thus, it is possible that some of the women in our cohort will still ensue a POP operation in the future. However, in contrast to previous studies, we excluded women with a prior POP operation or POP diagnosis, which could at least partly explain our low rate, since existing POP is a the significant risk factor for further pelvic floor problems.[10,11,15,16] This explanation is supported by the Swedish study that reported low numbers of post-hysterectomy POP operations in women with a history of VH and AH for non-POP indication.[12] Furthermore, a smaller study population, larger number of excluded patients and participation partly based on only telephone interviews in the previous studies may also explain the difference.[12]

We were able to analyze four different hysterectomy approaches and found that women with LAVH had the highest risk for post-hysterectomy POP, even after adjusting for confounders like BMI, age, vaginal deliveries, uterus size, previous abdominal operations, and concomitant SUI operations. These findings contradicted those of Gabriel et al.[16] where most of the POPs (17%) occurred in the women with a history of VH (including the women with a history of LAVH). We separated these surgical methods, since it is likely that some women with VH may have had occult POP. The risk associated with LAVH is likely true, since also outpatient visits for POP were highest among women with LAVH. Explanation for this LAVH-associated risk is unclear, since in LAVH, VH and AH, the

TABLE 3 Multivariate risk analysis for POP operations and visits after hysterectomy. All adjusted with each other.

Multivariate analysis for POP operations	Vaginal vault/anterior repair		Posterior repair		Any POP repair	
	Hazard ratio	95% CI	Hazard ratio	95% CI	Hazard ratio	95% CI
Tested factors						
Age (continuous)	1.0	1.0–1.1	1.0	1.0–1.1	1.0	1.0–1.1
BMI (continuous)	1.0	1.0–1.1	1.0	1.0–1.1	0.9	0.9–1.1
Uterus size						
<300 g	ref		ref		ref	
300–500 g	1.2	0.4–3.2	1.3	0.5–3.1	1.2	0.6–2.6
>500 g	1.5	0.5–4.8	1.4	0.4–4.3	1.3	0.5–3.2
Previous cesarean section	0.2	0.1–1.7	0.7	0.2–2.4	0.4	0.1–1.4
Vaginal deliveries						
No vaginal deliveries	ref		ref		ref	
1–2 vaginal deliveries	4.7	1.1–20.5*	2.9	0.8–10.0	3.6	1.2–10.4*
3 or more vaginal deliveries	3.8	0.8–18.7	6.2	1.8–22.1*	5.1	1.7–15.3*
Hysterectomy approach						
Abdominal	ref		ref		ref	
Laparoscopic	1.2	0.4–3.8	2.0	0.7–5.3	1.4	0.6–3.1
Laparoscopic-assisted vaginal	4.3	1.4–13.9*	2.5	0.7–9.0	3.0	1.2–7.7*
Vaginal	1.6	0.5–4.9	2.5	0.9–6.8	1.8	0.8–4.2
Concomitant SUI operation	1.0	<0.1–<0.1	7.9	1.8–34.2*	5.5	1.3–23.6*
Multivariate analysis for POP visits						
Age (continuous)	1.0	1.0–1.1	1.0	1.0–1.1	1.0	1.0–1.1
BMI (continuous)	1.0	1.0–1.1	1.0	1.0–1.1	1.0	1.0–1.1
Uterus size						
<300 g	ref		ref		ref	
300–500 g	1.2	0.5–3.0	1.1	0.5–2.3	1.1	0.6–2.0
>500 g	1.2	0.4–3.6	0.9	0.3–2.5	0.9	0.4–2.0
Previous cesarean section	0.2	0.03–1.5	0.5	0.2–1.5	0.5	0.2–1.2
Vaginal deliveries						
No vaginal deliveries	ref		ref		ref	
1–2 vaginal deliveries	5.2	1.6–17.5*	4.7	1.6–12.8*	4.0	1.8–9.0*
Three or more vaginal deliveries	4.4	1.2–15.8*	4.9	1.6–14.8*	3.9	1.6–9.1*
Hysterectomy approach						
Abdominal	ref		ref		ref	
Laparoscopic	1.1	0.4–2.9	1.7	0.8–3.6	1.5	0.8–2.8
Laparoscopic-assisted vaginal	3.1	1.1–9.2*	1.8	0.6–5.2	2.2	1.0–4.9*
Vaginal	1.1	0.4–3.1	1.8	0.8–4.0	1.5	0.8–2.9
Concomitant SUI operation	1.0	<0.1–<0.1	5.4	1.3–22.7	3.7	0.9–15.3

Abbreviations: BMI, body mass index; CI, confidence interval; HR, hazard ratio; POP, pelvic organ prolapse; ref, reference; SUI, stress urinary incontinence.

*Significant.

uterosacral ligament suspension, which is crucial for re-establishing apical support, is likely done in contrast to the technique of LH in 2006, when most vaginal cuff sutures were performed without cuff suspensions. In a recent study, however, the cuff suspension was found to be indifferent for subsequent prolapse.[16] It is also possible that the women selected for LAVH already had a more descending uterus preoperatively, and/or more vaginal laxity, since 27% of these women were multiparous, and we found that vaginal deliveries were also associated with a risk for POP. In contrast, women who underwent LH were more likely selected to this hysterectomy approach

TABLE 4 Survival analysis for POP operations and visits across four hysterectomy approaches.

	Any POP repair					Vaginal vault/anterior repair					Posterior repair				
	n	Crude HR (95%CI)	*p*-value	Adjusted HR (95%CI)	*p*-value	*n*	Crude HR (95%CI)	*p*-value	Adjusted HR (95%CI)	*p*-value	*n*	Crude HR (95%CI)	*p*-value	Adjusted HR (95%CI)	*p*-value
Hysterectomy approach															
Abdominal *n* = 1304	12	1 ref		ref		7	1 ref		ref		7	1 ref		ref	
Laparoscopic *n* = 1221	19	1.7 (0.8–3.5)	0.15	1.4 (0.6–3.1)	0.42	10	1.5 (0.6–4.0)	0.03	1.2 (0.4–3.8)	0.67	14	2.2 (0.9–5.3)	0.10	2.0 (0.7–5.3)	0.17
LAVH *n* = 253	9	3.9 (1.6–9.2)[a]	<0.01	3.0 (1.2–7.7)[a]	0.02	7	5.2 (1.8–14.9)[a]	<0.01	4.3 (1.4–13.9)[a]	0.01	5	3.7 (1.2–11.6)[a]	0.03	2.5 (0.7–9.0)	0.16
Vaginal *n* = 804	18	2.4 (1.2–5.1)[a]	0.02	1.8 (0.8–4.2)	0.13	11	2.0 (0.8–5.6)	0.14	1.6 (0.5–4.9)	0.42	13	3.0 (1.2–7.6)	0.02	2.5 (0.9–6.8)	0.08
	Any POP visit					**Vaginal vault/cystocele visit**					**Rectocele visit**				
Hysterectomy approach															
Abdominal *n* = 1304	21	1 ref		ref		11	1 ref		ref		13	1 ref		ref	
Laparoscopic *n* = 1221	34	1.7(1.0–3.0)[a]	0.05	1.5 (0.8–2.8)	0.17	19	1.5 (0.7–3.6)	0.15	1.4 (0.6–3.2)	0.42	21	1.7 (0.9–3.5)	0.12	1.7 (0.8–3.6)	0.17
LAVH *n* = 253	12	3.0(1.5–6.1)[a]	<0.01	2.2 (1.0–4.9)[a]	0.04	10	4.0 (1.5–11.0)[a]	<0.01	2.6 (0.9–7.3)	0.07	6	2.4 (0.9–6.3)	0.08	1.8 (0.6–5.2)	0.29
Vaginal *n* = 804	25	1.9(1.0–3.4)[a]	0.03	1.5 (0.8–2.9)	0.21	15	1.6 (0.6–4.1)	0.11	1.4 (0.6–3.4)	0.46	18	2.2 (1.1–4.6)[a]	0.03	1.8 (0.8–4.0)	0.14

Abbreviations: CI, confidence interval; HR, hazard ratio; LAVH, laparoscopic-assisted vaginal hysterectomy; POP, pelvic organ prolapse; ref, reference.

[a]Adjusted for BMI (continuous), age (continuous), previous cesarean section, indication, bilateral adnexal removal, uterus size, vaginal deliveries, surgeon experience, complications and concomitant stress urinary incontinence (SUI) operation.

TABLE 5 Risk factor analysis for POP operations and POP visits after hysterectomy for two-category variables.

	No POP oper	Any POP oper	Crude OR (95% CI)	Adjusted HR (95% CI)	*p*-value
n (%)	*n* = 3524 (98.4)	*n* = 58 (1.6)			
LAVH					
No	3280 (91.5)	49 (1.4)	Reference	Reference	
Yes	244 (6.8)	9 (0.3)	2.4 (1.2–4.9)*	2.2 (1.1–4.6)*	0.03
Vaginal deliveries					
No	1089 (30.4)	5 (0.1)	Reference	Reference	
Yes	2435 (68.0)	53 (1.5)	4.7 (1.9–11.7)*	4.4 (1.7–11.0)*	<0.01
SUI operation[a]					
No	3506 (97.9)	51 (1.4)	Reference	Reference	
Yes	18 (0.5)	7 (0.2)	22.3 (10.1–49.2)*	11.9 (4.3–32.7)*	<0.01
	No POP visit	Any POP visit	Crude OR (95% CI)	Adjusted HR[a] (95% CI)	*p*-value
n (%)	3490 (97.4)	92 (2.6)			
LAVH					
No	3249 (90.7)	80 (2.2)	Reference	Reference	
Yes	241 (6.7)	12 (0.3)	2.0 (1.1–3.7)*	1.8 (1.0–3.4)*	0.05
Vaginal deliveries					
No	1089 (30.4)	5 (0.1)	Reference	Reference	
Yes	2435 (68.0)	53 (1.5)	4.1 (2.1–8.2)*	3.9 (2.0–7.8)*	<0.01
SUI operation[a]					
No	3472 (96.9)	88 (2.5)	Reference	Reference	
Yes	18 (0.5)	4 (0.1)	13.4 (6.2–29.0)*	7.2 (2.7–20.0)*	<0.01

Note: Adjusted with each other, body mass index (continuous) and age (continuous).

Abbreviations: CI, confidence interval; HR, hazard ratio; LAVH, laparoscopic-assisted vaginal hysterectomy; OR, odds ratio; POP, pelvic organ prolapse; SUI, stress urinary incontinence.

[a]Concomitant SUI operation.

*Significant.

due to a narrower upper vaginal segment and not having any occult prolapse. Further, pulling and stretching of the supportive tissues in LAVH may add to the surgical trauma and the optional cuff suspension may be compromised.

Posterior vaginal wall prolapse was the most common post-hysterectomy POP operation and reason for visit after the hysterectomy approaches. This finding is in line with the Danish study.[11] Our data showed that women with LAVH also had a risk for vaginal vault repair, whereas anterior wall repair was the most common POP operation after all hysterectomy approaches in the Swedish nationwide cohort.[12] The differences between these studies are unknown, even if retrospective study design may be one explanation. Further, in the Swedish study[12] there were only two hysterectomy approaches and overall lower POP procedures. It is unclear why POP develops faster after AH than after other approaches, but there are possible explanations.[17] The women with AH were older, had higher BMI and weight of the uterus, and had more complications. Moreover, time to prolapse was shortest after vaginal hysterectomy in the previous study,[16] which contrasts our finding. The reason for this discrepancy might be that in their study, prolapse was the main indication for over 60% of vaginal hysterectomies and cancer for abdominal ones (30%).

The strengths of our study were the relatively large size of the prospective cohort, capability to analyze hysterectomy approaches with the exclusion of women with previous POP and clear end-point data from the reliable national care register. Moreover, our cohort included 79% of all women hysterectomized for benign indication in Finland in 2006. In most previous studies, POP has been an indication for almost all vaginal hysterectomies owing to a low number of no prior POP vaginal hysterectomies.[16] Lykke et al.[11] determined the risk of subsequent prolapse across four approaches of hysterectomies (abdominal, subtotal abdominal, laparoscopic which included vaginal-assisted and vaginal hysterectomy) which differed from our study, and potential confounding factors such as BMI, parity and weight of uterus were not analyzed. This could potentially change the outcome. Further, the Swedish study had five approaches of hysterectomy but the valid risk analysis could not be performed for laparoscopic approaches could not be done due to insufficient numbers of subsequent prolapse surgeries.[7]

Our study had limitations. We were unable to identify POP in women who were not referred to specialized health care or were not seeking treatment. However, we believe that the operations

and visits represent well symptomatic POP well due to good access to healthcare in Finland. In the study of Lukanovic et al.[18] post-hysterectomy prolapse was corrected in a median of 16 years with premenopausal women and in a median of 7 years with postmenopausal women, thus considering that half of the women in our cohort were pre-menopausal, it is likely that more POP operations will be performed in the future. Moreover, we lacked data on the stage of prolapses, but we postulate that operated patients represent well symptomatic, more advanced prolapses (stage 2, 3 and 4), since up to 73% of advanced prolapses are concomitant vaginal vault and anterior wall prolapses.[19] In the recent review by Constantini et al.[20] concomitant vaginal repair when performing sacrocolpopexy is recommend in case of advanced apical prolapse, since most reoperations are isolated cystoceles. Further, it is demonstrated that advanced anterior prolapse is highly correlated with apical prolapses.[21] To overcome this bias, we combined vaginal vault and anterior wall prolapses in the risk analysis. We found that LAVH was associated with risk for concomitant vaginal vault and anterior wall prolapses (HR 4.3, CI: 1.4–13.9) which covered 78% of the prolapses among the women with LAVH. Operation techniques have evolved since 2006 as LAVH is rarely used nowadays (approximately 20% of all benign hysterectomies in Finland 2020[22]), and laparoscopic suturing has increased the enablement of re-establishing apical support. Thus, these data of LAVH cannot be directly utilized in patient counseling.

5 | CONCLUSION

Clinical implication of our study for women considering benign hysterectomy is that without preceding POP, the risk for post-hysterectomy prolapse is small, only 1.6%. Risk factors associate with LAVH, vaginal deliveries and concomitant SUI operations. Good preoperative patient information is important for benign indications because of availability of conservative treatment options and considering functional changes in pelvic floor after hysterectomy and aging. Future research should focus on the role and type of cuff suspension in different hysterectomy approaches and enlighten its possible effect on POP stages.

AUTHOR CONTRIBUTIONS

TK: Protocol and project development, data collection and management, data analysis, manuscript writing and editing. PH, MM, PR-S and JS: Protocol and project development, manuscript writing and editing. ST, TB, JJ, JM and ET: Data collection and management, manuscript writing and editing.

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CONFLICT OF INTEREST STATEMENT

All the authors declare that they have no conflict of interest.

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