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ORIGINAL ARTICLE

The Manchester-Fothergill procedure versus vaginal hysterectomy with uterosacral ligament suspension: a matched historical cohort study

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Abstract

Introduction and hypothesis This study compares vaginal hysterectomy with uterosacral ligament suspension (VH) with the Manchester-Fothergill procedure (MP) for treating pelvic organ prolapse (POP) in the apical compartment.

Methods Our matched historical cohort study is based on data from four Danish databases and the corresponding electronic medical records. Patients with POP surgically treated with VH ($n = 295$) or the MP ($n = 295$) in between 2010 and 2014 were matched for age and preoperative POP stage in the apical compartment. The main outcome was recurrent or de novo POP in any compartment. Secondary outcomes were recurrent or de novo POP in each compartment and complications.

Results The risk of recurrent or de novo POP in any compartment was higher after VH (18.3%) compared with the MP (7.8%) (Hazard ratio, HR = 2.5, 95% confidence interval (CI): 1.3–4.8). Recurrence in the apical compartment occurred in 5.1% after VH vs. 0.3% after the MP (hazard ratio (HR) = 10.0, 95% confidence interval (CI) 1.3–78.1). In the anterior compartment, rates of recurrent or de novo POP were 11.2% after VH vs. 4.1% after the MP (HR = 3.5, 95% CI 1.4–8.7) and in the posterior compartment 12.9% vs. 4.7% (HR = 2.6, 95% CI 1.3–5.4), respectively. There were more perioperative complications (2.7 vs. 0%, $p = 0.007$) and postoperative intra-abdominal bleeding (2 vs. 0%, $p = 0.03$) after VH.

Conclusions This study shows that the MP is superior to VH; if there is no other indication for hysterectomy, the MP should be preferred to VH for surgical treatment of POP in the apical compartment.

Keywords Manchester-Fothergill procedure · Pelvic organ prolapse · Recurrence · Vaginal hysterectomy

Introduction

Uterine prolapse is a common condition for which no current standard for surgical repair exists. Anatomical uterine prolapse affects 14.2% of postmenopausal women [1], and ~175,000 apical-compartment prolapse surgeries are performed annually in the USA [2]. The aging population in many developed countries has caused an increase in this rate [3], which may increase further. Due to an absence of evidence, the surgical strategy for uterine prolapse repair varies greatly. Vaginal hysterectomy (VH) has been the most common surgical method for years and remains the preferred procedure worldwide [4–6]. New surgical procedures for treating prolapse in the apical compartment have been developed in recent years, and in some countries, mesh-based procedures and robotic surgery have gained popularity. Currently, many patients demand uterus-preserving procedures [7, 8], and recent studies have shown less morbidity and shorter hospitalization associated to uterus-preserving procedures compared with VH [9, 10]. The Manchester-Fothergill procedure (MP)—a uterus-preserving technique performed for more than a century—has proven safe and durable [11]. Even so, studies comparing other surgical procedures to the MP are scarce, and only one small, randomized controlled trial (RCT) comparing VH to the MP exists [12]. In general, the existing literature is in favor of the MP [10].

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Materials and methods

Data sources

In Denmark, reporting to all databases is mandatory, which ensures data completeness of >90% [14, 15], except for DAD, for which data completeness is >70% [16]. Data was collected from four national databases and corresponding medical records. The Danish personal identification number was used to link data from four national databases and corresponding medical records:

The Danish Urogynecological Database (DugaBase) comprises data on pelvic organ prolapse (POP) surgery performed in all public or private hospitals in Denmark. From it, we obtained body mass index (BMI), age at surgery, smoking status, weekly alcohol consumption, American Society of Anesthesiologists(ASA) score, preoperative Pelvic Organ Prolapse Quantification (POP-Q) staging for all compartments (estimated by the simplified technique from Swift et al. [13]), surgeon experience level with each procedure, hospital referral, and preoperative short-form questionnaire on objective examination and patient characteristics completed by the gynecologist. In Denmark, no formal recommendation for a routine preoperative screening of prolapse patients exists, and the preoperative examination varies between hospitals. However, all patients undergo a gynecological examination preoperatively, but ultrasound scans, endometrial biopsies, etc., are done at the individual doctor's discretion.

The Danish Hysterectomy and Hysteroscopy Database (DHHD) contains data on all hysterectomies performed in public or private hospitals in Denmark. This enabled us to exclude patients hysterectomized due to indications other than POP in the apical compartment.

The Danish Anesthesia Database (DAD) holds data on all surgeries in Denmark requiring anesthesia. Data on BMI and ASA score was primarily obtained from the DugaBase, but for patients with missing data or unlikely values (BMI <15 or >50 and ASA > 4), data was replaced with that from DAD.

The Danish National Pathology Registry (DNPR) and the Danish National Data Bank (DNDB) comprise information on all pathological evaluations in Denmark covering all public and private hospitals and clinics. From there, information on pathological evaluation of tissue removed by VH or the MP was obtained. For the MP group, data on any tissue excised from the uterus/cervix during follow-up was collected. From the corresponding electronic medical records, data regarding patient characteristics, the surgical procedure, concomitant surgery, perioperative complications, and postoperative complications were extracted. Minor complications were defined as requiring either no treatment, pharmacological treatment (e.g., over-the-counter analgesics), or other kinds of treatment not requiring anesthesia (cutting of vaginal sutures in the outpatient clinic, etc.).Data from follow-up was compiled for any compartment regarding recurrence, surgical, or pessary treatment due to recurrent/de novo POP, and regarding pelvic floor muscle training. Patients had either an outpatient workup or a phone interview 3 months postoperatively. In case of symptom relapse, new symptoms, or any problem related to surgery, the patient was invited for an examination. Review of the medical records was done by two of the authors (CKT and KRH).

This study contains information on public hospital contacts, admissions, and outpatient visits in the Capital region only, because different electronic health information systems exist nationwide and between public hospitals, private clinics, and general practitioners.

Study population

We included women with prolapse in the apical compartment who had either VH or the MP done at one of four public university hospitals in the Capital region of Denmark. All operations were performed from 2010 to 2014, and all hospitals had a specialized urogynecological unit. Distribution of operations between hospitals is shown in Table 1. Surgeries performed after 2010 only were included, as data completeness in DugaBase was <90% before 2010 [14]. Patients were followed from the date of VH/MP until recurrence/de novo POP, hysterectomy (for the MP group only), or until 31 August 2016, whichever came first. All patients were followed until 31 August 2016 for postoperative complications.

Exclusion criteria were previous POP surgery in the apical compartment, connective tissue disease, concurrent indication for VH, the MP plus hysteropexy, and concomitant surgical procedures at the time of the VH/MP (e.g., transvaginal tape).

Matching was according to age and preoperative POP-Q stage. An age difference up to 5 years between patients was accepted, whereas the preoperative POP-Q stage in the apical compartment was equal for all pairs. Matching was done by an independent statistician, and the process is displayed in Fig. 1. Due to exclusions after the first matching, a second matching was necessary to include as many patients as possible. The nonexcluded partner in an excluded pair re-entered the pool of patients available for matching.

Table 1 Distribution of surgeries

Hospital	Surgeries, *n* (%)	MP, *n* (%)	VHs, *n* (%)
1	17 (2.9)	17 (5.8)	0 (0)
2	244 (41.3)	182 (61.7)	62 (21)
3	190 (32.2)	49 (16.6)	141 (47.8)
4	139 (23.6)	47 (15.9)	92 (31.2)
Total	590 (100)	295 (100)	295 (100)

MPs Manchester-Fothergill procedures, *VHs* vaginal hysterectomies

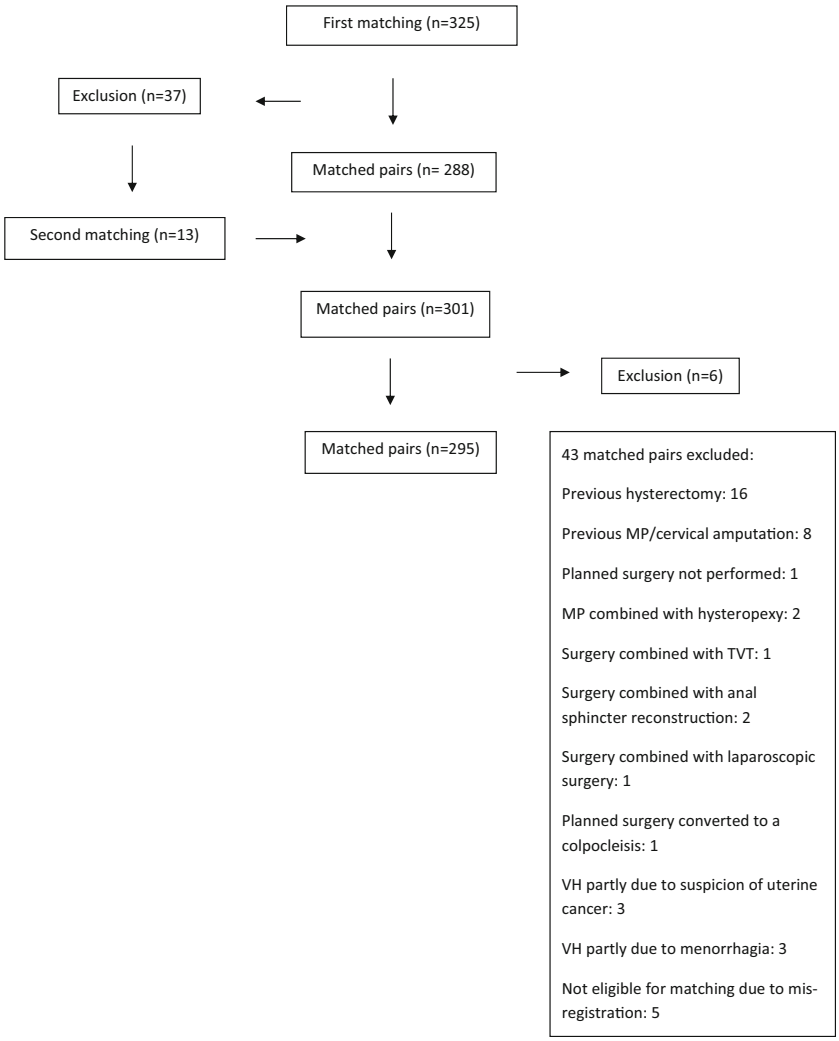

Fig. 1 Participant matching process

Description of surgical procedures

For vaginal hysterectomy, the vaginal wall is circumcised around the cervix, the bladder is isolated, and the peritoneum is opened, making access to the pouch of Douglas. The uterosacral and cardinal ligaments are cut and the uterus removed. The vaginal vault is suspended by high or low uterosacral ligament (USL) suspension. High suspension consists of attaching sutures to the USL bilaterally followed by a fixation of the anterior and posterior arm of each suture to the pubocervical and rectovaginal fascia [17]. In low suspension, sutures are attached to the left USL, followed by plication of the peritoneum of the cul-de-sac, succeeded by placement of sutures through the right USL. Before internal sutures are tied, additional sutures are potentially placed through the posterior vaginal wall, through the USLs, back through the vaginal wall, and tied in the vagina [18]. Finally, the mucosa is closed in both suspension procedures. High and low suspension was analyzed as a single group.The first step in the MP [19] is circumcision and isolation of the cervix. The cardinal ligaments are cut and the cervix amputated. The distal part of the cardinal ligaments is then sutured to the front side of the remaining cervical stump, and a new portio is created using Sturmdorff sutures. VH and the MP can be accompanied by anterior and/or posterior colporrhaphy and/or perineorrhaphy.

Outcome measures

Primary outcome was recurrent or de novo POP in any compartment. Recurrence was defined as POP in a previously operated compartment, and de novo POP as new occurrence in a previously unoperated compartment. Both where defined as one or more of the following:

- POP treated with pessary or surgery
- POP-Q stage II with POP symptoms
- POP-Q stage ≥ III independent of POP symptoms

Secondary outcomes were recurrence and de novo POP in each compartment, perioperative and postoperative

complications, pathological evaluation of the surgically removed uterus/cervix, and—for the MP group—uterine/cervical samples taken during follow-up.

Statistical analysis

The sample size for this study is based on a calculation using McNemar's *Z*-test with two-sided equality, where a difference was considered clinically important if 15% of patients had recurrence/de novo POP in any compartment after one procedure while 25% had recurrence or de novo POP after the other. Power (1-p) was set to 0.8 and α to 5%. This equals a total sample size of 253 pairs.

A Cox proportional hazard model was used to examine the association between surgical procedure and recurrence/de novo POP. Because of competing risk (i.e., hysterectomy for the MP group), the hazard ratio (HR) is interpreted as cause specific. Due to the matched design, baseline intensity is estimated for every combination of matched variables. The time axis shows time from date of operation until censoring. Two-sided 95% confidence intervals (CI) and *p* values for the HR were calculated on the basis of Wald's test of the Cox regression parameter. The risk of having an event at any given time was illustrated in cumulative hazard plots. Logistic regression was used to analyze the association between postoperative complications and surgical procedure. Age and POP-Q stage were incorporated in the model due to the matched design. A *p* value <0.05 was considered significant for all tests. Statistical analyses were conducted using SAS Enterprise Guide 7.11 (SAS, NC, USA).

Approval

The Danish Health and Medicines Authority has approved acquisition of data from patient records for the study (3–3013-1397/1 and 3–3013-1397/2), and the data collection was also approved by the Danish Data Protection Agency (2012–58-0004).

Results

Study population

We matched 338 pairs. Initially, 325 pairs were matched, and due to exclusion of 37 pairs, a second matching was done yielding another 13 pairs. After the second matching, six patients were excluded, resulting in 295 matched pairs. Reasons for exclusion of the 43 matched pairs are listed in Fig. 1, and baseline characteristics are shown in Table 2.

No significant differences in baseline characteristics were found, except for use of local estrogen treatment, which was more frequent in the VH group, as hospital four—which mainly performed VH—was the only hospital routinely prescribing local estrogen treatment preoperatively. The two procedures were also unevenly distributed among hospitals, with hospital three and four mainly doing VH while hospitals one and two preferred the MP.

All patients in the VH group had an apical support procedure: 246 (83.34%) were low suspensions and 49 (16.6%) high. Follow-up ranged from 20 to 80 (mean 51) months for the VH group and 48 months for the MP group ($p = 0.02$).

Outcome measures

Recurrence or de novo POP

Recurrence or de novo POP in any compartment and in each compartment individually was significantly more frequent after VH. Table 3 summarizes recurrences and de novo POP, while Fig. 2 shows cumulative hazard plots for compartments combined and each compartment specifically. Within 20 months of the primary POP surgery, 83.3% of all recurrences in any compartment occurred after VH and 78.2% after the MP, indicating a sufficient follow-up period to disclose a meaningful recurrence rate.

Complications

Table 4 shows perioperative and postoperative complications.

Perioperative complications more often occurred in the VH group. Only 36 patients ($n = 237$) in the VH group and 23 ($n = 257$) in the MP group had blood loss >100 ml ($p = 0.03$). Postoperative complications were also more frequent after VH, though the difference was not significant. Altogether, 80 postoperative complications were seen after VH and 68 after the MP ($p = 0.3$). The subgroup of minor complications accounted for most postoperative complications. Frequent minor complications were hematomas (12 patients after VH vs. four after the MP) and pain (13 patients after VH vs eight after the MP). Remarkably, dyspareunia was only recorded in six patients after VH and none after the MP; however, patients were not routinely asked about dyspareunia pre- and postoperatively. Intraabdominal bleeding occurred only after VH: six patients experienced blood loss ≥1000 ml. Median blood loss was 1700 ml (range 1000–3700 ml). All patients underwent surgical treatment within 24 h, and in three patients, open surgery was necessary. Blood transfusion was administered in all cases (median 3.5 U, range 2–6 U), whereas fresh–frozen plasma was administered in two patients. Superficial vaginal bleeding requiring surgical treatment was found in two patients in each group. Antibiotic treatment in hospital was equally frequent in both groups. Only infections diagnosed <30 days postoperatively were included. Urinary tract infections were excluded, as we had no access to data from general

Table 2 Baseline characteristics

Characteristic	MP	VH	*P* value
Age at surgery (years), mean ± SD [total patients]	59.6 ± 13.0 [295]	61.1 ± 11.4 [295]	0.2*
Body Mass Index (kg/cm^2), mean ± SD [total patients]	25.7 ± 4.0 [287]	25.4 ± 3.8 [295]	0.4*
Current smoker, n (%) [total patients]	40 (13.6) [277]	33 (11.2) [271]	0.5**
Weekly alcohol consumption, median units (range) [total patients]	[194]	[221]	
	3.0 (0–21)	3.0 (0–16)	0.2***
ASA classification,[total patients]	[294]	[295]	0.6**
I n (%)	151 (51.3)	142 (48.2)	
II n (%)	124 (42.2)	137 (46.4)	
III n (%)	19 (6.5)	16 (5.4)	
IV n (%)	0 (0)	0 (0)	
Local estrogen treatment, n (%) total patients]	121 (41.01) [285]	157 (53.22) [291]	0.006**
Cesarean sections, median (range) [total patients]	0 (0–4) [269]	0 (0–2) [284]	0.4**
Vaginal deliveries, median (range) [total patients]	2 (0–5) [269]	2 (0–9) [284]	0.1**
Mean (±SD)	2.0 ± 0.9	2.2 ± 1.1	
Preoperative POP-Q stage apical compartment [total patients]	[295]	[295]	1.0**
I n (%)	4 (1.3)	4 (1.3)	
II n (%)	208 (70.5)	208 (70.5)	
III n (%)	76 (25.8)	76 (25.8)	
IV n (%)	7 (2.4)	7 (2.4)	
Preoperative POP-Q stage anterior compartment [total patients]	[293]	[294]	0.3**
0 n (%)	35 (11.9)	23 (7.8)	
I n (%)	35 (11.9)	37 (12.6)	
II n (%)	89 (30.1)	78 (26.5)	
III n (%)	125 (42.4)	145 (49.3)	
IV n (%)	9 (3.0)	11 (3.8)	
Preoperative POP-Q stage posterior compartment[total patients]	*[288]*	*[293]*	*0.1***
0 n (%)	*97 (33.7)*	*107 (36.5)*	
I n (%)	*124 (43.0)*	*97 (33.1)*	
II n (%)	*50 (17.4)*	*70 (23.9)*	
III *n* (%)	*16 (5.6)*	*17 (5.8)*	
IV n (%)	*1 (0.3)*	*2 (0.7)*	
Previous colporrhaphy [total patients]	[295]	[295]	
No n (%)	261 (90.3)	268 (90.8)	0.4**
Anterior colporrhaphy n (%)	21 (7.3)	22 (7.5)	1.0**
Posterior colporrhaphy n (%)	13 (4.5)	10 (3.4)	0.7**
Previous surgery in the genital pelvis, n (%) [total patients]	46 (15.6) [295]	38 (12.9) [295]	0.4**
Antithrombotic treatment [total patients]	[271]	[271]	0.2**
No n (%)	23 (85.2)	242 (89.3)	
Yes n (%)	40 (14.8)	29 (10.7)	
Surgeon experience level with each procedure [total patients]	[289]	[294]	0.6**
≤ 25 surgeries n (%)	47 (16.2)	54 (18.3)	
26–100 surgeries n (%)	32 (11.0)	38 (12.8)	
>100 surgeries n (%)	210 (72.6)	202 (68.6)	
Concomitant surgery [total patients]	[295]	[295]	
Anterior colporrhaphy n (%)	245 (83.1)	242 (82.0)	0.8**
Posterior colporrhaphy/enterocele n (%)	60 (20.3)	96 (32.5)	0.001**
Perineorrhaphy n (%)	27 (9.2)	43 (14.6)	0.06**

MP Manchester-Fothergill procedure, *VH* vaginal hysterectomy, *SD* standard deviation

**T*-test. **Fisher's exact test. ***Wilcoxon rank-sum test

Table 3 Recurrence or de novo pelvic organ prolapse (POP)

	MP	VH	*P* value*
Any compartment, n (%) [total patients]	*23 (7.8) [295]*	*54 (18.3) [295]*	*0.0002*
Risk of recurrence/de novo POP, HR (95% CI)	1.0 (ref.)	2.5 (1.3–4.8)	
Apical compartment, n (%) [total patients]	*1* (0.3) *[295]*	*15* (5.1) *[295]*	*0.0004*
Risk of recurrence, HR (95% CI)	1.0 (ref.)	10.0 (1.3–78.1)	
Surgical treatment, n (%) [total patients]	0 (0) [295]	8 (2.7) [295]	0.007
Pessary treatment, n (%) [total patients]	1 (0.3) [295]	9 (3.1) [295]	0.02
PMFT, n (%) [total patients]	0 (0) [295]	2 (0.7) [295]	0.5
No treatment, n (%) [total patients]	0 (0) [295]	2 (0.7) [295]	1.0
Anterior compartment, n (%) [total patients]	*12 (4.1) [295]*	*33 (11.2) [295]*	*0.002*
Risk of recurrence/de novo POP, HR (95% CI)	1.0 (ref.)	3.5 (1.4–8.7)	
Recurrence (previously operated), n (%) [total patients]	11 (4.1) [266]	22 (8.3) [264]	0.05
De novo POP, n (%)	1 (3.4) [29]	11 (35.5) [31]	0.002
Surgical treatment, n (%) [total patients]	6 (2.0) [295]	19 (6.4) [295]	0.01
Pessary treatment, n (%)	5 (1.7) [295]	13 (4.4) [295]	0.09
PMFT**, n (%) [total patients]	7 (2.4) [295]	10 (3.4) [295]	0.6
No treatment, n (%) [total patients]	2 (0.7) [295]	3 (1.0) [295]	0.7
Posterior compartment, n (%) [total patients]	*14 (4.7) [295]*	*38 (12.9) [295]*	*0.0007*
Risk of recurrence/de novo POP, HR (95% CI)	1.0 (ref.)	2.6 (1.3–5.4)	
Recurrence (previously operated), n (%) [total patients]	1 (1.4) [73]	9 (8.5) [106]	0.05
De novo POP, n (%) [total patients]	13 (5.9) [222]	29 (15.3) [189]	0.02
Surgical treatment, n (%) [total patients]	6 (2.0) [295]	25 (8.5) [295]	0.0006
Pessary treatment, n (%) [total patients]	1 (0.3) [295]	10 (3.4) [295]	0.01
PMFT**, n (%) [total patients]	9 (3.1) [295]	11 (3.7) [295]	0.8
No treatment, n (%) [total patients]	5 (1.7) [295]	2 (0.7) [295]	0.5

MP Manchester-Fothergill procedure, *VH* vaginal hysterectomy, *PFMT* pelvic floor muscle training, *HR* hazard ratio, *CI* confidence interval

* Fisher's exact test

practitioners or private clinics. In the VH group, one patient acquired pneumonia, another was treated for a vaginal infection, and in a third, it was not possible to determine the cause of infection. Three patients in the MP group were treated for vaginal or cervical infection: one patient had an infected vaginal mucosal defect and another an infection of unknown origin.

No difference in urinary retention was found, and the median duration for both groups was 14 days. An unacknowledged obstruction of the left ureter at bladder level was discovered 33 days postoperatively in a patient from the MP group. At diagnosis, the patient had developed urosepsis and hydronephrosis requiring an acute nephrostomy. Two-and-a half months postoperatively, the patient suffered from pyelonephritis, which recurred 1 month later. Later again, the ureter ostium was resected, and a JJ-catheter was incorporated. This was removed 6 months postoperatively, and the patient regained normal renal function. Three other complications requiring surgery occurred in the VH group; one was a suture removal using local anesthesia 73 days postoperatively, another suture loosening under general anesthesia after 14 days, and a third underwent gastroscopy 2 days postoperatively because of hematemesis.

Pathological evaluation

For the MPs ($n = 270$), mean length of the amputated cervix was 24.9 mm (range 4–60 mm) compared with a mean length of 34.3 mm (range 15–80 mm) for the cervix attached to the removed uterus in the VH group ($n = 136$). A small lymfocytic lymphoma was found in the uterus removed from one patient who had previously been examined because of an increased M-component. A concurrent lymphoma was found in bone marrow samples. The uterine lymphoma did not lead to any further treatment. In one patient from the MP group, a mild cervical dysplasia was revealed. No treatment was given, and dysplasia was not seen in later cervical smears.

One case of asymptomatic hematometra was seen 1 year postoperatively in a patient suspicious of having a uterine polyp on ultrasound scan. No polyp was found, but a hematometra was removed hysteroscopically. Endometrial biopsies revealed no malignancy. The same patient subsequently had a

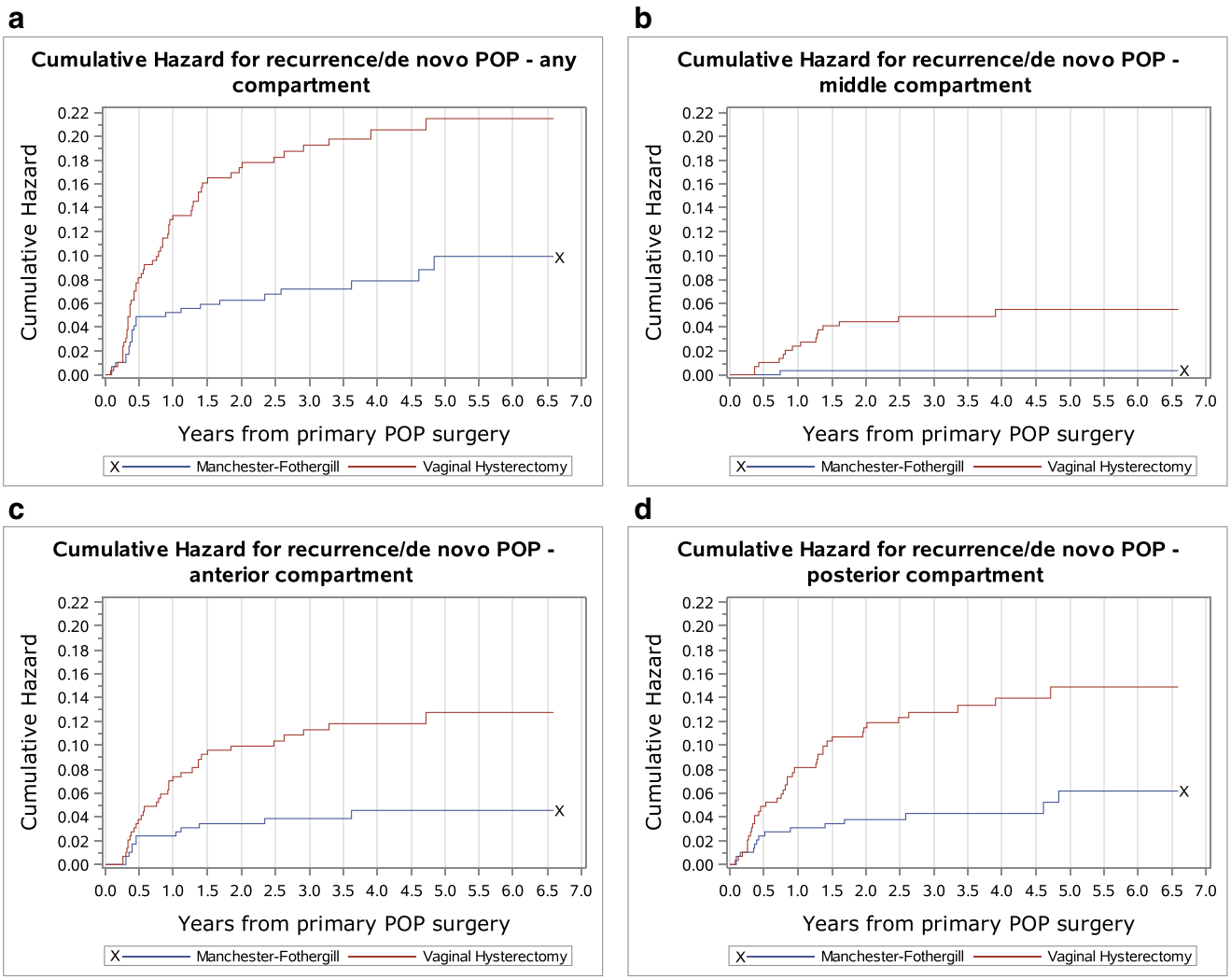

Fig. 2 Cumulative hazard plots showing cumulative hazard of recurrence/de novo pelvic organ prolapse (POP) as a function of time from surgery in any compartment (**a**), the apical (**b**), the anterior (**c**), and the posterior (**d**) compartment

nonmalignant pyometra. Another patient had a pyometra evacuated 82 days postoperatively, as an ultrasound scan had revealed a broadened endometrium; no malignancy was found.

During follow-up, one case of stadium IA endometrial adenocarcinoma was identified 15 months postoperatively. Endometrial samples were taken because of prolonged menstrual bleeding in a premenopausal patient. A laparoscopic total hysterectomy with concomitant bilateral salpingo-oophorectomy was done, and no further treatment was needed. Another patient had a complex endometrial hyperplasia with atypia. At the end of follow-up, the patient had undergone no treatment. Three more patients underwent hysterectomy: one at 36 months for suspicion of endometrial carcinoma and another 31 months postoperatively due to symptomatic fibromas. The third patient had a prophylactic hysterectomy concurrently with bilateral salpingo-oophorectomy for suspicion of ovarian cancer 60 months postoperatively. No uterine malignancy was detected in any of the cases.

Discussion

We found that the MP is more durable than VH for all compartments. The relative risk of recurrence in the apical compartment was 10 after VH (1.3–78.1) and recurrence rate was in agreement with the literature (4–7%) [17, 20, 21]. Conversely, low recurrence rates after MP the MP were demonstrated in previous studies [10, 21]. Frequent recurrences in the anterior compartment is an important issue in POP surgery [21, 22]. It is therefore encouraging that only 4.1% had recurrence in this compartment after the MP vs a recurrence rate twice as high after VH (8.3%). Recurrence in the posterior compartment was infrequent after the MP and 8.5% in the posterior compartment after VH. VH patients without anterior colporrhaphy at the index procedure were at high risk of de novo POP in the anterior compartment (35.5%); the same was not true for the MP patients (3.4%). However, the risk was higher in the posterior compartment after VH. The increased

Table 4 Complications

Complication	MP n = 295	VH n = 295	*P* value*
Perioperative complications, n (%)	*0 (0)*	*8 (2.7)*	*0.007*
Obstruction of ureter detected perioperatively and suture cut/loosened	0 (0)	4 (1.4)	
Organ lesion**	0 (0)	1 (0.3)	
Other***	0 (0)	1 (0.3)	
Bleeding > 500 ml	0 (0)	2 (0.7)	
Postoperative complications, n (%)	*50 (16.9)*	*63 (21.4)*	*0.2*
Risk of postoperative complication, OR (95% CI)	1.0 (ref.)	1.3 (0.9–1.9)	
Unaknowledged obstruction of ureter requiring surgery n (%)	1 (0.3)	0 (0)	
Urinary retention n (%) §	7 (2.4)	9 (3.0)	0.8
Hematometra/pyometra n (%)	3 (1.0)	0 (0)	
Antibiotic treatment in hospital n (%)	5 (1.7)	3 (1.0)	0.7
Bleeding n (%)	2 (0.7)	8 (2.7)	0.1
Superficial n (%)	2 (0.7)	2 (0.7)	
Intra-abdominal n (%)	0 (0)	6 (2.0)	0.03
Other complication requiring surgery n (%)	0 (0)	3 (1.0)	
Minor complications n (%)	50 (16.9)	57 (19.3)	0.5

MP Manchester-Fothergill procedure. *VH* vaginal hysterectomy, *OR* odds ratio, *CI* confidence interval

* Fisher's exact test. ** Bladder lesion. *** Missed surgical napkin removed laparoscopically during ongoing anesthesia. *CI* Confidence interval. § Urinary retention: Retention requiring treatment with intermittent catheterization/indwelling catheter

recurrence and de novo POP indicate that removing the uterus causes deterioration of vaginal suspension, including vaginal support level I [23]. Only one small RCT [12] comparing the two procedures exists, and it reported no difference between groups regarding quality of life scores. Vaginal length was longer after the MP, while there was no significant difference in POP-Q C-point. A matched cohort study showed significant shorter time to reoperation due to recurrence for the VH group [24]. Matching criteria were similar to the study reported here; however, although the sample size was smaller, follow-up was longer.

More perioperative complications and intra-abdominal bleeding were related to VH. This corroborates results from a recent study that showed a higher rate of severe complications after VH (1.9% vs. 0.2%) [25]. More complications after VH were also confirmed in another review [10], and a register study found an increased risk of further surgery due to complications [26].

In contrast to uterus-preserving procedures, VH eliminates the risk of future uterine pathology. The risk of endometrial cancer is known to be 0.24–0.35% [27–29], and a decision analysis [29] showed no benefits from concomitant hysterectomy in case of colpocleisis. In our study, one case (0.3%) of endometrial cancer was seen.

Our study reflects the variety in surgical strategy for repairing uterine prolapse, as a large difference in choice of surgical procedure was seen between hospitals. There was no difference in surgeon experience level, indicating that none of the procedures were primarily performed by less experienced surgeons. The study is also the largest to date comparing VH to the MP for treating prolapse in the apical compartment. Strengths include patient matching according to age and preoperative prolapse stage in the apical compartment. Since reporting to the databases is mandatory, data completeness is high for all included databases, and data validity is high for the DugaBase [14], the main database used in this study. Reporting data to The Danish National Pathology Registry and Data Bank is automatic by all hospitals and clinics in Denmark. In this study, we had no information regarding all POP-Q points—only POP-Q stage, which can hide a potential difference in cervical length between groups. However, pathological evaluation showed that amputated cervices from the MP group were 24.9 mm and cervices attached to the removed uteri were 34.3 mm. Hence, a potential difference in cervical elongation degree is expected to be negligible. A weakness of this study is the lack of access to data from private practitioners and clinics, as the recurrence rate might be higher than shown in this study. We do not know whether the reporting of complications is comparable between departments, and information bias cannot be ruled out, though it seems reasonable to assume that reporting of major complications is equal between departments. Except for participant matching on a few selected criteria, no other attempts were made to adjust for further confounding, making residual confounding a potential issue. Low and high USL suspension was analyzed as a single group, which might be a limitation; however, a large study

from 2017 showed equal outcomes for these two suspension types [30]. The the MP is a less invasive procedure with shorter operating time and hospitalization [10]. Considered this, as well as the higher rate of recurrence, de novo POP, and complications, VH appears less attractive in from an economic aspect also. The project group is currently conducting an economic analysis comparing the two procedures.

Based on our results and the existing literature, the MP should be preferred to VH with USL suspension for surgical treatment of POP in the apical compartment when no specific indication for hysterectomy is present. In the future, uterine-preserving procedures should be compared with the MP rather than with VH.

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Compliance with ethical standards

Conflicts of interest C.K. Tolstrup has, in relation to the study, received a research grant from the Nordic Urogynaecological Association (NUGA) and a travel grant from the Oticon Foundation, and has, outside the study, a conference fee and travel expenses paid by Astellas Pharma.

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