

Effects of genital prolapse surgery and hysterectomy on pelvic floor function

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Abstract

This study was aimed to evaluate the effects of hysterectomy on pelvic floor function.

We conducted a prospective observational multicenter study with three-year follow-up in thirteen teaching and non-teaching hospitals in the Netherlands. Four-hundred-thirty females who underwent hysterectomy for benign disease other than symptomatic uterine prolapse were included. Validated disease-specific quality-of-life questionnaire were completed before surgery and at 6 months, 12 months and three years after surgery to assess the presence of micturition symptoms, defecation symptoms and sexual problems.

Micturition symptoms at three year after surgery were more common following vaginal hysterectomy than following abdominal hysterectomy (OR 2.2, 95% CI 1.3-4.0). Micturition symptoms that more often disappeared following abdominal hysterectomy included urgency (OR 2.4, 95% CI 1.0-5.5) and obstructive micturition (OR 2.9, 95% CI 1.0-8.2).

Constipation had developed in 2% of the patients without constipation before surgery and persisted in 46% of the patients with constipation before surgery.

Sexual pleasure statistically significantly improved in all patients, independently of the performed technique of hysterectomy. At six months after vaginal, subtotal abdominal hysterectomy and total abdominal hysterectomy, the prevalence of one or more bothersome sexual problems was 43%, 41% and 39% respectively (Chi-square test: $p = 0.88$). From our prospective study it can be concluded that removal of the cervix during hysterectomy does not worsen pelvic floor function. Abdominal hysterectomy might have benefits over vaginal hysterectomy with respect to micturition. Hysterectomy does not cause constipation. Sexual function following hysterectomy does not depend on the performed technique and is on average better than before surgery.

Key words: Constipation, hysterectomy, pelvic floor function, prospective study, quality of life.

This PhD thesis comprises 2 subjects:

1. A multi-centre prospective study to evaluate the effects of vaginal and abdominal hysterectomy for benign disease (different from pelvic organ prolapse (POP) on micturition, defecation and sexual functioning, and its related quality of life ("HysVA study").
2. A multicentre randomised controlled trial was performed to compare functional and anatomical effects of abdominal and vaginal surgical correction of uterine prolapse ("ProVA trial"). Abdominal surgery involved laparotomic

sacrocolpopexy and vaginal surgery involved vaginal hysterectomy with or without anterior colporrhaphy and with or without posterior colporrhaphy.

Part 1: HysVA study

Background

Hysterectomy is one of the most commonly performed gynaecological operations. It is often performed for benign conditions such as menorrhagia, metrorrhagia, abdominal pain and dysmenorrhoea.

The main goal of hysterectomy is to resolve these symptoms in order to improve quality of life. In some patients this goal is not realized due to unwanted side effects related to the procedure itself.

The prevalence of micturition symptoms, defecation symptoms and sexual dysfunction is increased in patients who have undergone a hysterectomy. The nature of this association is not clear. The increased prevalence of micturition symptoms, defecation symptoms and sexual dysfunction may have been present before hysterectomy (Helstrom *et al.*, 1993; Roovers *et al.*, 2000).

The changes in pelvic floor function that are caused by hysterectomy have been suggested to result from damage to pelvic floor innervation and pelvic fibromuscular structures during surgery (Prior *et al.*, 1992; Smith and Ballantyne, 1968; Taylor *et al.*, 1990; Parys *et al.*, 1989). The pelvic plexus is at risk in four areas during hysterectomy. Firstly, the main branches of the plexus passing beneath the uterine arteries may be damaged during the division of the cardinal ligaments (Smith and Ballantyne, 1968). Secondly, the major part of the vesical innervation, which enters the bladder base before spreading throughout the detrusor muscle, may be damaged during blunt dissection of the bladder from the uterus and cervix (Smith and Ballantyne, 1968). Thirdly, the extensive dissection of the para-vaginal tissue may disrupt the pelvic neurons passing from the lateral aspect of the vagina (Parys *et al.*, 1989). Finally, the removal of the cervix will result in loss of a large segment of the plexus which is intimately related to it (Paris *et al.*, 1989).

Aside from damage to pelvic floor innervation and fibromuscular structures, hysterectomy may also result in impaired pelvic floor function because of altered anatomic position of the pelvic organs. The susceptibility to develop an enterocele and/or a vault prolapse is increased due to this altered anatomy (Wiersma *et al.*, 1997; Symmonds *et al.*, 1981).

A prospective multi-centre study was conducted to compare the effects of vaginal and abdominal hysterectomy for benign conditions on pelvic floor function.

Aims of the study

The aim of this study were to provide an evidence based answer to the following questions:

1. Are the effects of vaginal and abdominal hysterectomy on micturition similar?
2. Does hysterectomy cause constipation?
3. Does mode of hysterectomy influence sexual function following hysterectomy?

Design “HysVA study”

An observational study was performed between January 1999 and July 2000 in 13 teaching hospitals in the Netherlands. Women who had been offered a hysterectomy for benign conditions were included. Exclusion criteria were endometriosis and symptomatic prolapse of the uterus as indication for hysterectomy. Written informed consent was obtained from all participating women. The medical ethic committee in all participating hospitals approved this study.

Gynaecologists were free to choose a surgical route. Perioperative treatment was similar in all participating hospitals. All women received perioperative prophylaxis for deep vein thrombosis and a single dose of intravenous prophylactic antibiotic during surgery. A 14 french gauge Foley indwelling catheter with a 5 ml balloon was used to catheterise the bladder after surgery. This was removed after 24 hours. In case of bladder retention (twice a residual volume after voiding of more than 100ml), the patient started clean intermitted self catheterisation. Post-operative pain medication was similar in all participating hospitals.

Measurements

Disease specific quality of life questionnaires

All patients were asked to complete questionnaires before surgery, and at 6 weeks, 6 months, 12 months and 3 year after surgery. The following 3 questionnaires were sent to participating patients:

- A. The Dutch validated version of the Urogenital Distress Inventory (UDI) (Shumaker *et al.*, 1994, van der Vaart *et al.*, 2000).

The UDI consists of 19 items and each item measures if a micturition symptom is present and to what extent the patient is bothered by this symptom. The latter is measured on a four point scale ranging from not at all to severely bothered. In this study we dichotomized the reported bother to “bothersome” (in case the patient reported about a symptom: “I am little bothered”, “I am much bothered” or “I am severely bothered”) or to “not bothersome” (in case the patient reported about a symptom “I am not bothered at all” or in case the symptom was not present).

- B. The Dutch validated version of the Defecation Distress Inventory (DDI) (van Brummen *et al.*, 2006, Roovers *et al.*, 2008).

The DDI is questionnaire that was developed identical to the Urogenital Distress Inventory (Shumaker *et al.*, 1994; van der Vaart *et al.*, 2000) by our

research group and is used to assess the presence and experienced discomfort of defecation symptoms. The 15 questions were developed after studying the literature and international definitions, interviewing patients who presented with constipation or fecal incontinence, and by interviewing three experts in the field from the Department of Surgery and Department of Obstetrics and Gynecology from the University Medical Centre Utrecht, The Netherlands. Eventually, a structured interview of the 15 selected items was held with 20 female patients. For this study we used the response to two questions of the DDI: "Do you have less than 3 bowel movements a week?" and the question: "Do you have to strain > 25 percent of the time to have a bowel movement?" According to the definition of Drossman *et al.*, constipation was considered to be present if the patient responded positive to both of these questions (Drossman *et al.*, 1982).

C. The Questionnaire for screening Sexual Dysfunctions (QSD) (Roovers *et al.*, 2004)

The QSD is a validated questionnaire to assess the presence, frequency and experienced discomfort of sexual dysfunctions and consists of 36 questions. The first part of the question asks whether a dysfunction is present or not, the second part asks about the frequency of occurrence of this symptom (measured with a five-point Likert scale ranging from hardly ever to always) and the third part asks about the experienced amount of discomfort of the dysfunction (measured with a five-point Likert scale ranging from not at all to severely). The first 16 questions concern the general perception of the own sexuality and the frequency of sexual activity. The next 18 questions concern different types of problems during sexual activity. From this part of the QSD, questions were selected to identify patients with bothersome problems with lubrication, orgasm, pain of genitals, sensation of genitals and arousal. In the Appendix the questions that were selected from the QSD are presented. We regarded a symptom to be bothersome, in case the experienced bother of that symptom was scored as "I am bothered" or "I am much bothered" or "I am severely bothered". We regarded a symptom not to be bothersome in case the experienced bother of that symptom was scored as "slightly bothered" or in case the symptom was not present.

Clinical data

The following clinical data were prospectively collected: age, body mass index, parity, surgical history, maximal diameter of the uterus as assessed by ultrasonography, presence of comorbidity (requiring

drugs for diabetes, hypertension, hyperthyroidism, hypercholesterolemia, chronic obstructive pulmonary disease, or rheumatoid arthritis), duration of the operation, estimated blood loss, size of prolapse of the uterus in centimetres above or below the hymen (expressed as a negative respectively positive number) as measured when pulling down the uterus under anaesthesia, simultaneously performed surgical procedures, complications due to surgery and duration of hospital stay.

Hysterectomy and micturition

Background

One of the most common reported adverse effects of hysterectomy are lower urinary tract symptoms (LUTS), particularly urinary incontinence (Parys *et al.*, 1989; Brown *et al.*, 2000). Development of LUTS could be explained by damage occurring during surgery to the innervation and supportive tissues of the pelvis (Prior *et al.*, 1992; Delancey, 1997). Theoretically this damage differs between vaginal and abdominal hysterectomy and therefore it is relevant to evaluate whether surgical approach has effect on the prevalence of LUTS following hysterectomy.

If technically feasible, the vaginal approach is preferred based on the reported benefits of shorter hospitalisation, less complications and lower costs (Van Den Eeden *et al.*, 1998). A difference between vaginal and abdominal hysterectomy in the persistence or development of LUTS could alter or enforce this preference as LUTS are known to have a negative effect on patient's quality of life (Hunskar *et al.*, 1991; van der Vaart *et al.*, 2002).

Analysis

We compared the prevalence of bothersome LUTS after surgery between patients undergoing vaginal hysterectomy and patients undergoing abdominal hysterectomy. Statistical significance was determined by the χ^2 test. Findings were also stratified according to the presence or absence of symptoms before hysterectomy. Odds ratios and 95% confidence intervals were calculated when the difference in prevalence of persistent or newly developed LUTS between both surgical approaches was statistical significant. The odds ratios were adjusted in multivariable logistic regression analysis for those other variables that were statistically different at a p-value level of < 0.15 between both operative groups. The reason to include all variables with a p-value < 0.15 was that we did not want to miss any potential clinical important information.

Table 1. — Group comparison of patient characteristics.

	Vaginal hysterectomy N = 112		Abdominal hysterectomy N = 318		P*
BMI (kg/m ²)	25.1	(18; 38)	24.6	(17; 39)	0.43
Age (years) (mean, SD)	43.5	(6.5)	44.7	(6.8)	0.10
Parity n	2	(0-6)	2	(0-7)	< 0.01
Diameter of uterus (mean, SD)	8.1	(1.4)	10.7	(3.6)	< 0.01
Descensus uterus (cm)	-2.0	(-7; -2)	-6.0	(-10; 0)	< 0.01
History of caesarean section	10	(8.8)	40	(12.6)	0.29
Previous abdominal surgery	44	(38.6)	135	(42.2)	0.50
Comorbidity	42	(38.2)	93	(31.0)	0.18
Indication for hysterectomy					
Menorrhagia	84	(73.7)	208	(64.6)	0.08
Metrorrhagia	50	(43.9)	85	(26.4)	< 0.01
Abdominal pain	25	(21.9)	162	(50.3)	< 0.01
Dysmenorroe	30	(26.3)	76	(22.7)	0.43
Other	15	(13.2)	28	(8.7)	0.17
Bothersome LUTS preoperative					
Frequency	37	(33.0)	103	(32.8)	0.97
Urgency	42	(38.2)	119	(38.4)	0.97
Urge incontinence	22	(19.8)	70	(22.0)	0.63
Stress incontinence	51	(45.9)	143	(45.1)	0.88
Dysuria	15	(13.4)	40	(12.7)	0.84
Obstructive micturition	28	(25.7)	98	(31.1)	0.24
Any micturition symptoms	77	(71.3)	218	(72.7)	0.79

Values are numbers (percentages) or median (range) unless stated otherwise

* Based on unpaired *t* tests or non parametric test or χ^2 tests for heterogeneity with appropriate degrees of freedom.

Results

During the study period 430 women were included. The response rate was 92% at six months after surgery and 77% at three year after surgery. No statistical significant differences were observed in patient characteristics between responders and non-responders. Vaginal hysterectomy was performed in 112 (26%) women and abdominal hysterectomy in 318 (74%) women.

Table 1 shows the characteristics of patients operated by vaginal and abdominal approach. Patients who underwent vaginal hysterectomy had on average higher parity, smaller uterine size and more descent of the uterus. In addition, differences were observed in the indication for hysterectomy between vaginally and abdominally operated patients. The prevalence of bothersome LUTS before surgery was similar for both groups. No differences in the use of hormone replacement therapy before and after surgery were observed between both surgical techniques.

The performed surgical procedures and complications are shown in Table 2.

Figure 1 shows the prevalence of patients with one or more LUTS in both groups over the follow-up

period. At three year after surgery, LUTS were more common in the vaginal group as compared to the abdominal group (OR 2.2, 95%CI 1.3-4.0). After adjustment for differences between both groups in patient characteristics, this difference was still statistically significant (adjusted OR 3.0, 95%CI 1.4-6.2). It appeared that the difference between both approaches in the prevalence of LUTS increased over time.

Figure 2 and 3 show how often LUTS persisted respectively developed following vaginal and abdominal hysterectomy. At three year after surgery LUTS had persisted significantly more often following vaginal hysterectomy (OR 3.3, 95% CI 1.3-8.2, adjusted OR 3.0, 95% CI 1.0-9.1) LUTS also developed more often following vaginal hysterectomy (OR 2.1, 95% CI 0.7-6.2, adjusted OR 11.6, 95% CI 2.0-68.4).

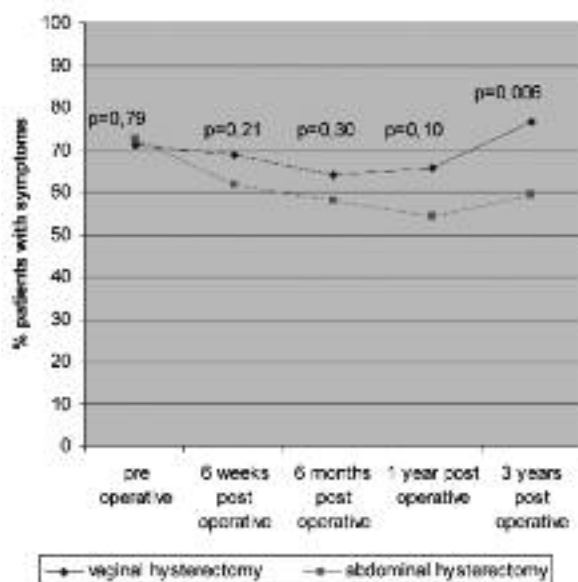
In Table 3 the prevalence of persisting and de novo LUTS six months and three years after surgery are shown for both groups. In univariate analysis, at six months after hysterectomy obstructive micturition had persisted statistically significantly more often in the vaginal group as compared to the abdominal group (OR 3.5, 95% CI 1.3-9.8). In the multivariate analysis this difference did not reach statistical

Table 2. — Surgical procedures and complications.

Number	430
Surgical Procedures	
Total abdominal hysterectomy	223 (51)
Subtotal abdominal hysterectomy	95 (22)
Vaginal hysterectomy	112 (26)
Surgery Time (minutes)	
	62 (20)
Blood loss (cc)	
	282 (218)
Complications during surgery	
Bleeding requiring transfusion	14 (3)
Bleeding requiring re-operation	2 (0)
Bladder lesion	2 (0)
Complications during hospital admission	
Vault abscess	4 (1)
Vault hematoma	2 (0)
Cystitis	6 (1)
Bladder retention	4 (1)
Fever of unknown origin	3 (1)
Pulmonary embolism	2 (0)

Values are means (standard deviation) or numbers (percentage).

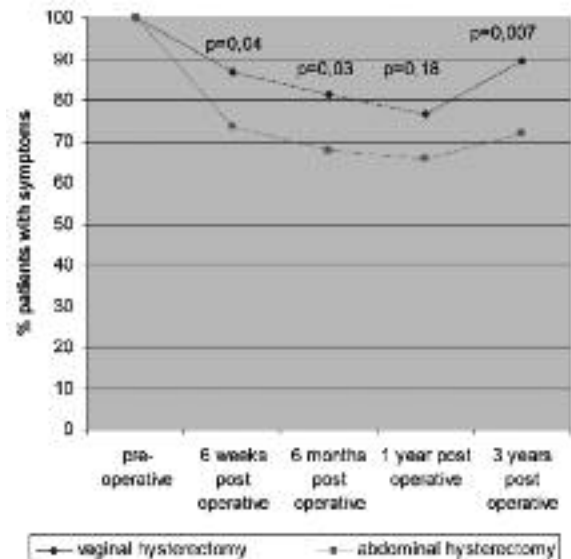
* Some patients had more than one complication.



* P values are based on χ^2 tests for heterogeneity with appropriate degrees of freedom.

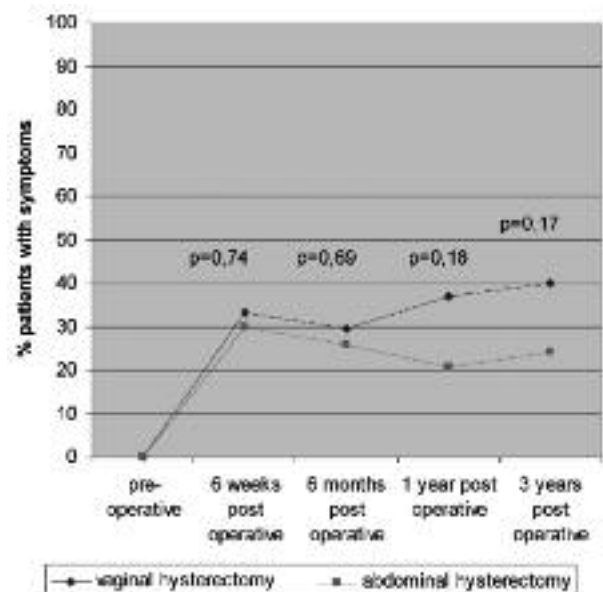
Fig. 1. — Proportion of patients with bothersome LUTS before surgery and at six weeks, six months, one year and three years after surgery.

significance (adjusted OR 1.7, 95% CI 0.5-6.0). The same phenomenon was observed when analyzing the three year data (univariate analysis : OR 2.9, 95% CI 1.0-8.2, adjusted OR 2.1, 95% CI 0.6-7.8). Urgency had also persisted statistically significant more often in the vaginal group at three year after surgery (OR 2.4, 95% CI 1.0-5.5, adjusted OR. 2.7 95% CI 0.8-8.4). At 6 months after surgery, stress incontinence had developed more often following vaginal hys-



* P values are based on χ^2 tests for heterogeneity with appropriate degrees of freedom.

Fig. 2. — Proportion of patients with persisting bothersome LUTS at six weeks, six months, one year and three years after surgery.



* P values are based on χ^2 tests for heterogeneity with appropriate degrees of freedom.

Fig. 3. — Proportion of patients with de novo bothersome LUTS at six weeks, six months, one year and three years after surgery.

terectomy as compared to following abdominal hysterectomy (OR 2.8, 95% CI 1.2-7.0, adjusted OR 3.6, 95%CI 1.0-12.9). ANOVA analysis to study showed that the differences between the groups did not dependent upon the centre.

Table 3. — Comparison of persisting and de novo bothersome LUTS at 6 months and 3 years after hysterectomy.

	Persisting symptoms			De novo symptoms		
	Vaginal hysterectomy	Abdominal hysterectomy	P*	Vaginal hysterectomy	Abdominal hysterectomy	P*
Frequency						
6 months	18 (53)	35 (39)	0.15	12 (18)	23 (12)	0.22
3 years	17 (55)	34 (43)	0.26	11 (20)	22 (14)	0.23
Urgency						
6 months	21 (54)	54 (56)	0.68	10 (17)	27 (15)	0.82
3 years	21 (66)	42 (45)	0.04	11 (22)	26 (18)	0.51
Urge incontinence						
6 months	9 (45)	30 (49)	0.75	6 (7)	14 (6)	0.68
3 years	10 (59)	31 (60)	0.95	12 (18)	26 (13)	0.35
Stress incontinence						
6 months	33 (75)	78 (61)	0.10	10 (19)	12 (7)	0.02
3 years	36 (84)	75 (71)	0.12	13 (31)	27 (19)	0.10
Dysuria						
6 months	3 (27)	10 (29)	0.93	3 (3)	17 (7)	0.22
3 years	1 (11)	7 (23)	0.45	2 (3)	10 (5)	0.46
Obstructive micturition						
6 months	18 (75)	39 (46)	0.01	5 (7)	31 (16)	0.05
3 years	15 (71)	35 (47)	0.05	9 (14)	26 (16)	0.81
Any micturition symptoms						
6 months	53 (82)	130 (68)	0.03	8 (30)	19 (26)	0.69
3 year	51 (90)	118 (72)	0.01	8 (40)	14 (24)	0.17

Values are numbers (percentage)

* Based on χ^2 tests for heterogeneity with appropriate degrees of freedom.

Hysterectomy does not cause constipation (Roovers *et al.*, 2008)

Background

Several authors have addressed the effect of hysterectomy on the occurrence of constipation (van Dam *et al.*, 1997; Taylor *et al.*, 1989; Heaton *et al.*, 1993). However, the theory of damage to the pelvic plexus that innervates the left colon and the rectum was refuted by Prior and co-authors who found after hysterectomy evidence of increased rectal sensitivity, which, by definition, is the reverse of autonomic denervation (Prior *et al.*, 1992). As most of the studies relating constipation to hysterectomy have a retrospective design, it is not clear whether hysterectomy truly induces constipation or whether constipation was already present before the hysterectomy. Furthermore, little is known about potential risk factors for the development of constipation following hysterectomy. The lack of data on this subject bothers the gynecologist with the difficult task to inform the patient about her individ-

ual risk to develop constipation following hysterectomy.

Analysis

The aim of the statistical analysis was to calculate the risk on constipation after hysterectomy and to identify which patient characteristics are prognostic factors for the development or persistence of constipation. The prevalence of constipation that persisted or had developed after hysterectomy was compared for the presence or absence of different patient characteristics and tested for statistical significance using Fisher's exact test. The risk on constipation after hysterectomy was expressed by the Relative Risk (RR) and 95 percent confidence interval (CI). The RR expresses the risk of a patient in whom a condition is present as compared to a patient in whom this condition is not present. Variables that were tested for their statistical significance were age, body mass index, parity, history of abdominal surgery, presence of co-morbidity, indication for hysterectomy, presence of fibroma, maximal diameter of the uterus,

vaginal or abdominal approach, and removal of the cervix.

Results

Of the 413 included patients, 344 (83 percent) responded to the DDI at 3-year follow-up. Characteristics of responders and non-responders were similar.

De novo constipation after hysterectomy

At 3 years after surgery, constipation had developed in 7 (2%) of the 309 patients without constipation before surgery. Table 4 shows the risk on development of constipation according to the different patient characteristics and surgical parameters. It appeared that preservation of the cervix was associated with a higher risk to develop constipation after hysterectomy. We reviewed the medical files of the 7 patients who developed constipation and found out that in 3 of these patients total hysterectomy was planned but during surgery, because of difficult surgical conditions like adhesions and/or fibroma extending into the cervix, it was decided to preserve the cervix. All patients developing constipation had undergone abdominal hysterectomy, had fibroma on ultrasound, had not undergone previous abdominal surgery and did not have metrorrhagia as indication for hysterectomy.

Persistence of constipation

Constipation persisted in 16 (46%) of the 35 patients with constipation before surgery. Table 4 shows the risk on persistence of constipation according to the different patient characteristics and surgical parameters. Persistence of constipation appeared not to be related to any of these variables.

Does mode of hysterectomy influence sexual function following hysterectomy? (Roovers *et al.*, 2004)

Background

Historically, the uterus has been regarded as the regulator and controller of important physiological functions, a sexual organ, a source of energy and vitality, and a maintainer of youth and attractiveness (Sloan, 1978). Women therefore rightly enquire whether hysterectomy may affect their sexual well-being. Some fear that hysterectomy will bring the end of sexual attractiveness. Adverse, but also beneficial effects of hysterectomy on sexual well-being have been reported (Helstrom *et al.*, 1993; Rhodes *et al.*, 1999; Helstrom *et al.*, 1995; Kilcku *et al.*, 1983; Virtanen *et al.*, 1993; Polivy, 1974).

Of all potential anatomical sides where damage to the pelvic plexus may occur, only damage to the cervix has been evaluated. Many believe in a beneficial effect of preservation of the cervix with respect to sexual well-being after hysterectomy. This was supported by quantitative evidence in one study (Kilcku *et al.*, 1983). In contrast, one other study reported a beneficial effect of removal of the cervix (Virtanen *et al.*, 1993).

Recently, a randomized controlled trial showed similar effects of total and subtotal hysterectomy on sexual well-being (Thakar *et al.*, 2002). However, merely reporting the incidence of sexual problems is insufficient. Symptoms may not affect sexual pleasure if they do not interfere with normal sexual well-being. In other words, only symptoms that are regarded as bothersome by the patient herself, are likely to adversely affect sexual pleasure. To what extent these bothersome symptoms differ between total and subtotal hysterectomy had not been investigated.

Analysis

The number of patients sexually active, the reported frequency of intercourse and the general satisfaction about sexuality before surgery and six months after surgery, were compared. The main analysis only concerned patients who were sexually active both before and after hysterectomy.

The prevalence of bothersome sexual problems that persisted or had developed after surgery were compared between techniques of hysterectomy and tested for statistical significance, using chi-square test. Findings were also stratified according to presence or absence of the symptoms before hysterectomy. For symptoms of which the prevalence of persistent or newly developed symptoms between techniques of hysterectomy differed more than 10% between two groups, odds ratios (OR) and 95% confidence intervals (CI) were calculated using logistic regression analysis. The OR expresses the odds that a symptom persists or develops in a patient who underwent a technique of hysterectomy as compared to the odds of a patient who underwent an other technique of hysterectomy. The ORs were adjusted for differences in other determinants of sexual well-being in multivariable logistic regression analysis. These included age, parity, body mass index, uteral seize, descensus of the uterus, indication for hysterectomy, use of anti-depressive drugs, co-morbidity and duration of relation with partner.

Results

Of 477 patients who underwent a hysterectomy in one of the participating hospitals during the study

Table 4. — The risk on development or persistence of constipation 3 year after hysterectomy for different patient characteristics and surgical parameters.

Patient characteristic / surgical parameter		Risk on development of constipation					Risk on persistence of constipation				
		n	(%)	RR	95% CI	P-value ^o	n	(percent)	RR	95 percent CI [¶]	P-value ^o
Age (years)	< 40	3/70	(4)	2.3	(0.2–21.2)	0.63	5/10	(50)	*	*	1.00
	40–50	3/179	(2)	0.9	(0.1–8.4)	1.00	9/21	(43)	*	*	0.45
	> 50	1/53	(2)	1.0			1/1	(100)	1.0		
Body Mass Index (kg/m²)	< 22	0/51	(0)	*	*	0.33	5/10	(50)	0.9	(0.4–2.0)	0.87
	22–25	2/99	(2)	0.6	(0.1–3.0)	0.70	1/5	(20)	0.4	(0.1–2.3)	0.32
	> 25	5/145	(3)	1.0			8/15	(53)	1.0		
Parous	Yes	4/252	(2)	1.0			14/29	(48)	1.0		
	No	3/50	(6)	3.8	(0.9–16.4)	0.09	1/3	(33)	0.7	(0.1–3.6)	1.00
History of abdominal surgery	Yes	0/116	(0)	1.0			4/10	(40)	1.0		
	No	7/186	(4)	*	*	0.06	11/22	(50)	1.3	(0.5–3.0)	0.71
Co-morbidity	Yes	3/85	(4)	1.0			4/11	(36)	1.0		
	No	4/208	(2)	0.5	(0.1–2.4)	0.42	10/20	(50)	1.4	(0.6–3.4)	0.71
Indication for hysterectomy											
Menorrhagia	Yes	5/206	(2)	1.0			10/25	(40)	1.0		
	No	2/96	(2)	0.9	(0.2–4.3)	1.00	5/7	(71)	1.8	(0.9–3.5)	0.21
Metrorrhagia	Yes	0/95	(0)	1.0			5/9	(56)	1.0		
	No	7/207	(3)	*	*	0.10	10/23	(44)	0.8	(0.4–1.7)	0.70
Abdominal pain	Yes	4/133	(3)	1.0			6/11	(55)	1.0		
	No	3/169	(2)	0.6	(0.1–2.6)	0.70	9/21	(43)	0.8	(0.4–1.6)	0.71
Dysmenorrhoe	Yes	1/67	(1)	1.0			5/9	(56)	1.0		
	No	6/235	(2)	1.7	(0.2–14.0)	1.00	10/23	(44)	0.8	(0.4–1.7)	0.70
Fibroma present on ultrasound	Yes	7/206	(3)	1.0			7/19	(37)	1.0		
	No	0/92	(0)	*	*	0.10	8/13	(62)	1.7	(0.8–3.5)	0.28
Maximal diameter of uterus (cm)	< 8	0/52	(0)	*	*	0.18	3/6	(50)	1.0	(0.3–2.8)	1.00
	8–10	2/142	(1)	0.3	(0.1–1.5)	0.24	7/16	(44)	0.9	(0.4–2.0)	1.00
	> 10	5/108	(5)	1.0			5/10	(50)	1.0		
Surgical approach	Vaginal	0/74	(0)	1.0			6/11	(55)	1.0		
	Abdominal	7/228	(3)	*	*	0.20	9/21	(43)	0.8	(0.4–1.6)	0.71
Removal of the cervix	Total	2/219	(1)	1.0			11/23	(48)	1.0		
	Subtotal	5/83	(6)	6.6	(1.3–33.3)	0.02	4/9	(44)	0.9	(0.4–2.2)	1.00

RR = relative risk; CI = confidence interval; ^o calculated by Fisher's exact test; * can not be calculated.

period, 413 patients decided to also respond to the QSD. Of the 379 participating patients who had a male partner, 352 (93%) responded at six months after surgery.

Sexual activity before and after surgery did not seem to differ between patients undergoing different techniques of hysterectomy. In addition, of the patients who were sexually active, frequency of intercourse was similar before and after hysterectomy, for all three techniques (data not shown). The general satisfaction about sexuality improved after all techniques of hysterectomy with 0.5 points on a 0 – 10 scale. Differences in improvement following different techniques of hysterectomy were not observed.

Of the 352 patients who responded six months after hysterectomy, 310 patients reported to be

sexually active both before and after surgery. These 310 patients, consisting of 89 (28.7%) patients who underwent vaginal hysterectomy, 76 (24.5%) patients who underwent subtotal abdominal hysterectomy and 145 (46.8%) patients who underwent abdominal hysterectomy, were included in the further analysis. Of the 32 patients who were not sexually active before hysterectomy, 17 (53%) patients became sexually active after surgery. No statistically significant differences among surgical techniques were observed in remaining or becoming sexually active. Patient characteristics and distribution of types of hysterectomy were similar in the different hospitals. Statistically significant differences among groups were observed in maximal diameter of the uterus, descensus of the uterus, indication for hysterectomy and co-morbidity. The frequency of

bothersome sexual problems before hysterectomy was similar among the groups.

Table 5 shows the prevalence of bothersome problems during sexual activity that persisted or developed, at six months after surgery, according to technique of hysterectomy. As before and after operation data are paired, it can be exactly read how often sexual problems reported after hysterectomy persisted or developed. Overall a reduction of all sexual problems reported before hysterectomy was observed after surgery. Statistically significant differences between techniques of hysterectomy were not observed.

Patients who had undergone total or subtotal abdominal hysterectomy, had an increased, but not statistically significant, prevalence of persisting problems with lubrication (adjusted OR 1.6 (95% CI 0.7-3.6), adjusted OR 2.3 (95% CI 0.4-11.9) respectively) and persisting problems with arousal (adjusted OR 1.2 (95% CI 0.6-2.5), adjusted OR 2.1

(95% CI 0.5-8.6) respectively) as compared to patients who had undergone vaginal hysterectomy. Problems with sensation of genitals more often persisted following total or subtotal abdominal hysterectomy as compared to vaginal hysterectomy. The number of patients that reported bothersome problems with sensation of the genitals before hysterectomy was too low to allow multivariate analysis.

Of the patients who reported one or more of the measured bothersome sexual problems before hysterectomy, 59%, 54% and 56% reported to still have sexual problems following vaginal hysterectomy, subtotal abdominal hysterectomy and total abdominal hysterectomy respectively. New sexual problems developed in 23%, 24% and 19% of the patients who underwent respectively vaginal hysterectomy, subtotal abdominal hysterectomy and total abdominal hysterectomy.

Table 5. — Reported bothersome problems during sexual activity that persist or develop after surgery, according to surgical technique.

	Vaginal hysterectomy (n = 89)		Subtotal abdominal hysterectomy (n = 76)			Total abdominal hysterectomy (n = 145)			p-value ¹
	Before surgery	Problem present after surgery	Before surgery	Problem present after surgery	Before surgery	Problems present after surgery			
Reported bothersome sexual problem before hysterectomy	n	n (%)	n	n (%)	n	n (%)			
Problems with lubrication	89	14 (16)	76	18 (24)	145	36 (25)		0.24	
Present	25	9 (36)	22	12 (54)	39	22 (56)		0.25	
Not present	64	5 (8)	54	6 (11)	106	14 (13)		0.56	
Problems with orgasm	89	19 (21)	76	16 (21)	145	32 (22)		0.98	
Present	27	13 (48)	23	11 (48)	35	18 (51)		0.95	
Not present	62	6 (10)	53	5 (9)	110	14 (13)		0.75	
Problems with pain of genitals	89	15 (17)	76	10 (13)	145	25 (17)		0.72	
Present	26	8 (31)	16	5 (31)	45	18 (40)		0.68	
Not present	63	7 (11)	60	5 (8)	100	7 (7)		0.66	
Problems with sensation of genitals	89	5 (6)	76	7 (9)	145	12 (8)		0.65	
Present	6	1 (17)	9	3 (33)	13	5 (38)		0.64	
Not present	83	4 (5)	67	4 (6)	132	7 (5)		0.94	
Problems with arousal	89	16 (18)	76	16 (21)	145	33 (23)		0.68	
Present	30	12 (40)	26	14 (54)	44	23 (52)		0.50	
Not present	59	4 (7)	50	2 (4)	101	10 (10)		0.42	
Any sexual problem	89	38 (43)	76	31 (41)	145	57 (39)		0.88	
Present	49	29 (59)	43	23 (54)	81	45 (56)		0.85	
Not present	40	9 (23)	33	8 (24)	64	12 (19)		0.80	

¹ calculated with Chi-square Test.

Discussion

As far as known this is the only prospective cohort study that evaluates the effects of hysterectomy on micturition, defecation and sexual functioning. The main findings were that patients develop more often micturition symptoms following vaginal hysterectomy than following abdominal hysterectomy. Hysterectomy does not cause constipation. Sexual functioning improves after hysterectomy for benign disease and this improvement does not depend on the surgical technique that is performed.

Are the effects of vaginal and abdominal hysterectomy on micturition similar?

We performed a prospective observational study to compare the long term effect of surgical approach of hysterectomy on LUTS. It was observed that LUTS were more common following vaginal hysterectomy than following abdominal hysterectomy and that this difference increases over time. This difference can be explained both by a difference in the development and in the persistence of LUTS following both approaches. Symptoms that more often persisted following vaginal hysterectomy were urgency and obstructive micturition. After adjustment for the differences in parity, uterine size, descent of the uterus and indication for hysterectomy, the difference was no longer significant. Stress incontinence developed more often following vaginal hysterectomy than following abdominal surgery. After adjustment for differences in prognostic factors the odds ratio was still statistical significant.

Before interpreting the data some issues need to be addressed. First, the non-randomized design of this study may have resulted in prognostic incomparability. To deal with this problem we made two adjustments. Only patients in whom both operation techniques would have been technically feasible were included. Furthermore, the prospective design of our study allowed detailed documentation of all known possible confounders. We used logistic regression analysis to correct all significant odds ratios for differences in prognostic factors with a p-value < 0.15. Of course unknown confounders were not assessed and these may still bias our results. Ideally we would have performed a randomised controlled trial, but too few gynaecologists were willing to participate.

Second, this study was conducted in 13 different hospitals, technical differences in performing vaginal or abdominal hysterectomy could easily affect the results of this study. As reported, statistically significant differences in incidence of bothersome LUTS

between the different study centres were not observed.

Third, in this study we performed a subjective measurement of LUTS rather than an objective outcome measurement like urodynamic investigation. This decision was based on the assumption that self-reported symptoms affect quality of life more than urodynamic findings. Furthermore, it has been shown that the association between LUTS and urodynamic findings are poor questioning whether the latter is a clinically valuable outcome measurement (Abrams, 1983).

The study is strengthened by the use of the same validated questionnaires pre- and post-operatively. The high response rate shows that the questions could be consistently answered but also represents the effort of the research team to keep all patients motivated to continue their participation in this study.

One previous prospective study comparing long term effects of vaginal and abdominal hysterectomy on micturition. This study performed by Gustafsson showed that nor vaginal or abdominal hysterectomy negatively affected micturition three years after surgery (Gustafsson *et al.*, 2006). However they did not compare symptoms between vaginal and abdominal hysterectomy, they only compared the incidence of LUTS after operation to the incidence before operation. Other studies even found an overall improvement in micturition symptoms after hysterectomy (El-Toukhy *et al.*, 2004; Roovers *et al.*, 2001). In our study we also found an overall decrease in LUTS following abdominal hysterectomy whereas the prevalence of LUTS in the vaginal group was slightly higher at three year after surgery as compared to before surgery.

One explanation for the difference in micturition symptoms between both approaches is that the average uterine size in the abdominal group is larger. It has been stated that initial improvement of LUTS following the removal of an enlarged uterus can be explained by reduction of external pressure on the bladder with improved bladder function as result (Langer *et al.*, 1988). However, after adjustment for differences in uterine size between both groups, LUTS are still more common following vaginal hysterectomy.

Another explanation is that there exists a difference in damage of the pelvic innervation between both approaches. As mentioned in the introduction this damage may occur at four different locations. During vaginal hysterectomy there may be more nerve damage to the innervation of the bladder base as the dissection of the bladder is performed bluntly and possible less gently. Furthermore, during vaginal hysterectomy there is continued traction on the

uterus that especially in difficult cases may be very strong and could contribute to irreversible damage of the pelvic innervation.

The blunt and possibly less gentle dissection of the bladder during vaginal hysterectomy may be responsible for the higher risk to develop urgency symptoms (Smith and Ballantyne, 1968). During vaginal dissection partial denervation of the detrusor muscle may occur resulting in post-junctional hypersensitivity of the detrusor muscle (Harrison *et al.*, 1989; Sibley, 1997). We are not the first to report that vaginal hysterectomy may induce more overactive bladder symptoms as compared to abdominal hysterectomy. Two small retrospective studies concluded that vaginal hysterectomy appears to have a higher risk on urge incontinence as compared to abdominal hysterectomy (Roovers *et al.*, 2001; Vervest *et al.*, 1989). This was not confirmed by a prospective study performed by Altman and colleagues, maybe because their follow-up was too short (Altman *et al.*, 2003).

Several studies reported no differences in post-operative stress incontinence between vaginal and abdominal hysterectomy (Gustafsson *et al.*, 2006; Langer *et al.*, 1988). However, the only study that report a difference also observed that the vaginal approach was associated with a higher risk (Altman *et al.*, 2003). In our study the difference is explained both by persisting and de novo symptoms. A possible explanation is that during vaginal hysterectomy a larger amount of downwards traction is applied to the tissue which can cause more supportive tissue damage and more hypermobility of the urethra. The same effect has been described after vaginal delivery compared to caesarean section (Dietz *et al.*, 2002; Toozs-Hobson *et al.*, 2008). Due to stretching or compression and overstretching of the pelvic floor the pudendal nerve can be damaged (Thom *et al.*, 1997). In a similar way the continuous downwards traction during vaginal hysterectomy may contribute to irreversible damage of the pelvic innervation.

The observed difference in obstructive symptoms has not previously been described. We hypothesize that both partial denervation of the detrusor muscle and impaired urethral sphincter function can be hold responsible for difficulties in emptying the bladder. Due to these physiological changes the synergistic combination of relaxation of the external sphincter and contraction of the detrusor muscle mandatory to empty the bladder may be disabled (Dorflinger and Monga, 2001).

An interesting observation of our study is that the difference in prevalence of LUTS between both surgical approaches increases over time. It is known that it may take years to develop urinary incontinence

after a trauma to the pelvic innervation, like vaginal birth or pelvic surgery (DeLancey, 1993; Snooks *et al.*, 1990). Obviously, such trauma can be considered as a "hit" that makes the patient more susceptible for the effect that ageing has on LUTS, particularly on urinary incontinence. Based on our findings we state that vaginal hysterectomy should be regarded as a "hit" whereas abdominal hysterectomy should not.

In conclusion the risk of bothersome LUTS three years after vaginal hysterectomy is twice as high as after abdominal hysterectomy. This difference can be explained by both persisting and development of LUTS and persists after correction for all differences in parity, descent of the uterus, uterine size and indication for hysterectomy. In the separate symptoms a clinical relevant higher prevalence of most symptoms was found in the vaginal group as compared to the abdominal group. Significant differences were found in the persistence of urgency and obstructive miction complaints and the development of stress incontinence. After adjustment for differences in patient characteristics only the difference in stress incontinence remains significant. Since the presence of LUTS negatively affects quality of life, the increased risk on post-operative LUTS should be balanced against the lower morbidity of the vaginal approach (van der Vaart *et al.*, 2000) The results of our study will help to further optimize counselling of patients undergoing hysterectomy for benign conditions.

Does hysterectomy cause constipation?

The aim of our study was to investigate whether hysterectomy causes constipation and to identify prognostic factors for the development or persistence of constipation. Two percent of the patients developed constipation. Preservation of the cervix appeared to be associated with an increased occurrence of constipation but the small numbers make the relevance of this finding questionable. In nearly half of the patients reporting constipation before hysterectomy, this symptom had disappeared at three year after surgery.

The present study was based on a multicenter cohort study of 413 females undergoing vaginal, subtotal abdominal, or total abdominal hysterectomy. Data were prospectively collected, potential confounders were accurately documented, and a validated questionnaire was used to assess the occurrence of constipation. Some limitations need to be discussed. First, the number of patients in the stratum with constipation present before surgery was relatively small. Therefore, it was difficult to study predictors of persistence of constipation. Second, the number of patients that developed constipation

was so low that it is questionable whether one should attempt to identify risk factors for this occurrence. One of the strengths of our study is that we managed to assess complete follow-up of more than 80 percent of our cohort at three years after surgery.

There is a widespread but poorly quantified belief that hysterectomy is associated with bowel problems, especially constipation. This belief has been based on retrospective studies relating bowel dysfunction to hysterectomy. Taylor and co-authors compared females with bowel symptoms after hysterectomy with age-matched control subjects. Posthysterectomy females reported more commonly infrequent bowel movement, use of laxatives and consulted more often a doctor because of constipation (Taylor *et al.*, 1993). Van Dam *et al.* compared bowel function in 593 females who had undergone hysterectomy to a control group consisting of 100 women who had undergone laparoscopic cholecystectomy (van Dam, 1997). Bowel dysfunction was significantly more common following hysterectomy. Heaton and co-authors also observed that constipation was more common following hysterectomy than following laparoscopic cholecystectomy (Heaton *et al.*, 1993). Because of the retrospective design of these studies it seems reasonable to assume that the operation precedes the onset of bowel dysfunction. Furthermore, retrospective studies may be biased by recall bias, in specific, patients may have forgotten the exact timing of the onset of constipation.

Similar to our findings, one other study prospectively evaluating the effects of hysterectomy on constipation did not observe an increased incidence of constipation postoperatively (Goffen *et al.*, 1997). In a randomized trial comparing the effects of total and subtotal abdominal hysterectomy on pelvic floor function, the prevalence of constipation after surgery was lower than before surgery. The authors did not present the data stratified for presence or absence of constipation before hysterectomy.

The reported prevalence of constipation in the community ranges from 2-28 percent and depends on the used definition (Talley, 2004). The definition for constipation we use has been described by Drossman *et al* and includes both frequency of defecation and “the necessity to strain” (Drossman *et al.*, 1982). In most studies constipation is defined as a bowel frequency of less than three times a week (Talley, 2004). The use of our stricter definition may explain the low prevalence of constipation both before and after hysterectomy. However, it has been shown that adding “the necessity to strain” to the definition significantly increases the sensitivity of the symptoms to identify individuals with constipation (Koch *et al.*, 1997).

Studies initiated to identify prognostic factors for the development or persistence of constipation have, as far as known, not been published. In this study, the small number of patients that developed constipation (7/309) and the small number with constipation before surgery (35/344) limited the identification of prognostic variables for the development and persistence of constipation. However, it was an interesting observation that preservation of the cervix appeared to be associated with an increased incidence of constipation after hysterectomy. In a randomized trial comparing the effects of total and subtotal abdominal hysterectomy on pelvic floor function, preservation of the cervix and prevalence of constipation after surgery were not related to each other (Thakar *et al.*, 2002). As mentioned in the results section, review of the medical files of the 7 patients who developed constipation showed that in 3 of these patients during surgery the cervix could not be removed because of difficult surgical conditions like adhesions and/or fibroma extending into the cervix. As a consequence the prognostic value of the variable “preservation of the cervix” seems to be confounded by the technical difficulty of the procedure. Even while preserving the cervix, it is likely that these surgical procedures have caused more autonomic nerve damage with development of constipation as result.

In our study only 2 percent of the patients developed constipation. As the prevalence of constipation increases with age, the observed development in our study might well reflect the natural course of this symptom (Potter and Wagg, 2005). Therefore we tend to conclude that hysterectomy does not affect the occurrence of constipation. Preservation of the cervix was associated with an increased risk on the development of constipation after hysterectomy but this was largely explained by more difficult and extensive surgery. If present before hysterectomy, constipation had disappeared at 3 year after surgery in almost half of the patients.

Does mode of hysterectomy influence sexual function following hysterectomy?

In this prospective multi-center study sexual well-being improved after vaginal hysterectomy, subtotal abdominal hysterectomy and total abdominal hysterectomy. Technique of hysterectomy did not appear to be a determinant for the persistence or development of bothersome problems during sexual activity.

Some limitations need to be discussed. First, the size of our study population may be too small to detect small differences. However, aside from the fact that the required number of patients according

to the power calculation was included in the study, we question whether differences that are not observed in a sample size of 413 patients do have any clinical relevance. Second, patients were not randomized for the technique of hysterectomy. Therefore, baseline differences in factors that influence sexual well-being may have confounded our results. To deal with this, we prospectively documented potential confounders and our findings were adjusted for these using logistic regression analysis. Ideally, we would have performed a randomized controlled trial, but too few gynaecologists were willing to participate in such trial. The gynaecologist's decision to perform either surgical technique depends on personal preference and individual technical skills. Additionally the indication for hysterectomy plays a role. Patients with unexplained abdominal pain are more likely to be operated abdominally. However, there is considerable overlap between indications and operation techniques. It is therefore possible to adjust for prognostic differences between the groups.

Studies evaluating the effects of surgical technique of hysterectomy on sexual well-being have mainly focused on the effect of removal of the cervix (Kilkkku *et al.*, 1983, Virtanen *et al.*, 1993, Thakar *et al.*, 2002). One study suggested that removal of the cervix adversely affects sexuality. In this study the first author interviewed patients who had been operated by himself. Recently, a randomized controlled trial compared the effects of total and subtotal hysterectomy on sexuality (Thakar *et al.*, 2002). Patient characteristics of the patients participating in this trial were comparable to those participating in our study. Like in our study, an adverse effect on sexuality of removal of the cervix was not observed. Apparently, more extensive disruption of local innervation and anatomical relationships during total hysterectomy does not lead to more sexual dysfunction. It has been suggested that substantial pelvic organ dysfunction is uncommon both following total and subtotal hysterectomy, as the most significant autonomic-nerve content is located in the middle-to-lateral third of the sacral and cardinal ligaments. When performing simple hysterectomy, only the medial third of these ligaments is interrupted.

We are the first to focus on sexual problems that are experienced as bothersome. As a consequence, gynaecologists can now not only inform patients about the prevalence of sexual symptoms after hysterectomy but also about the impact of these symptoms.

With respect to surgical approach, as far as we know, no studies have been published comparing the effects of vaginal and abdominal hysterectomy on sexuality. Statistically significant differences in the persistence or development of bothersome sexual

problems were not observed. A trend was observed towards a higher prevalence of persisting problems with lubrication and arousal after (subtotal or total) abdominal hysterectomy as compared to vaginal hysterectomy. This needs to be confirmed in a larger study.

In conclusion, we observed improvement of sexual pleasure and a decrease in prevalence of sexual problems after all surgical techniques of hysterectomy. As the chosen surgical technique does not appear to affect sexual well-being, we do not recommend gynaecologists to enrol hypothetical effects on sexuality in the decision of choosing the technique of hysterectomy.

Clinical implications and future perspective

From our prospective study it can be concluded that removal of the cervix during hysterectomy does not affect pelvic floor function. This finding is confirmed by a randomized controlled trial that followed-up less patients than we did (Thakar *et al.*, 2002). As 1 out of 10 patients experiences vaginal bleeding following subtotal hysterectomy we advise to remove the cervix during hysterectomy, except for cases in whom this is technically difficult. In this subcategory of patients preservation of the uterus may decrease the morbidity associated with hysterectomy.

Our study suggests that abdominal hysterectomy may have benefits over vaginal hysterectomy with respect to micturition. We aimed to conduct a randomized controlled trial before the start of the described study, but there were not enough centres willing to participate in such trial. Based on the results of this study, that could be different and we plan to re-explore the feasibility of a RCT comparing the effects of vaginal and abdominal hysterectomy on pelvic floor function. Until such RCT has been performed, gynaecologists can counsel their patients about pelvic floor effects based on our study whereas the decision of which surgical technique is performed is likely to remain predominantly based on technical variables.

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