Assessment of Pelvic Floor Function and Quality of Life in Patients Treated for Cervical Cancer: A Multicenter Retrospective Study

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Keywords

Cervical cancer · Radical hysterectomy · Radiotherapy · Pelvic floor function · Lower urinary tract symptoms · Defecation symptoms · Quality of life

Abstract

Objectives: Our study aimed to evaluate the quality of life (QoL) and pelvic floor function of cervical cancer (CC) patients after treatment. **Design:** This was a cross-sectional observational cohort study. **Participants:** The participants included in this study were CC patients who underwent radical hysterectomy (RH) from 2012 to 2018 at 18 medical centers across China. **Methods:** The validated versions of the Pelvic floor Distress Inventory-Short Form 20, Overactive Bladder Symptom Score, and Euro QoL Five-Dimension questionnaires were used to evaluate postoperative pelvic floor dysfunction (PFD) and QoL. **Results:** A total of 689 CC patients were enrolled. The incidence of stress urinary incontinence (SUI), incomplete urinary emptying, and constipation were 32.7, 27.7, and 28.6%, respectively. Multivariate analysis confirmed that laparoscopic RH (LRH) and vaginal wall resection greater than 3 cm were risk factors for lower urinary tract

symptoms (LUTS). LRH and chemotherapy were risk factors for SUI. Chemoradiotherapy and LRH were risk factors for overactive bladder (OAB). A high body mass index and LRH were risk factors for more severe defecation symptoms. ARH and large amount of operative blood loss were risk factors for poor QoL. **Conclusion:** PFD is common in CC patients after treatment. LRH seems to increase the postoperative distress, including LUTS and defecation symptoms. Postoperative urinary incontinence and OAB are more bothersome for patients undergoing chemotherapy and radiotherapy. We recommend evaluating pelvic floor function as a standard assessment during follow-up.

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Introduction

Cervical cancer (CC) is the fourth most common cancer in women worldwide. In developing countries, this disease is the leading cause of cancer-related death in women and also represents a major public health problem [1]. Women with CC presenting with International Federation of Gynecology and Obstetrics (FIGO) stage

IA, IB, and small IIA tumors are preferably treated with radical hysterectomy (RH) and pelvic lymphadenectomy, with or without adjuvant chemoradiotherapy, depending on the pathology results [2]. However, the complications of treatment have persistent negative effects on the physical and psychosocial function of patients. RH involves more extensive removal of the vagina, uterosacral ligaments, and parametrial tissue. Damage to the autonomic nerve tissue is likely to occur during RH and cause pelvic floor disorders [3]. Pelvic floor dysfunction (PFD) is widely recognized as a public health issue with significant impact on quality of life (QoL) for millions of women globally [4]. Radical surgical treatment is especially known to affect bladder function, resulting in lower urinary tract symptoms (LUTS), with an incidence varying from 12 to 85% due to the use of different definitions and diagnostic tools [5]. Radiotherapy of the pelvis is also known to cause adverse effects on bladder and bowel function, such as overactive bladder (OAB) symptoms and anal incontinence [6]. Unfortunately, few studies have examined postoperative pelvic floor function and QoL in CC patients. This study aimed to evaluate QoL and pelvic organ function for CC patients after treatment and identify the risk factors of distress.

Materials and Methods

This is a multicenter cross-sectional observational cohort study. The study protocol was approved by the Institutional Review Boards of Peking University People's Hospital, and the study is registered at www.clinicaltrials.gov (NCT02492542). We recruited CC patients who underwent RH from June 2012 to June 2018 at 18 medical centers across China. The inclusion criteria were as follows: (1) patients aged over 18 years; (2) patients with a diagnosis of CC who underwent RH; (3) patients with a follow-up duration of 3–24 months after surgery; and (4) patients who agreed to participate in the study and signed the informed consent form. The exclusion criteria were as follows: previous urinary and bowel symptoms, anti-incontinence procedure, or pelvic surgery. Selected patients were invited to the hospitals to sign the informed consent form and were asked to answer specific questionnaires. The validated versions of the Pelvic Floor Distress Inventory-Short Form 20 (PFDI-20), Overactive Bladder Symptom Score (OABss), and Euro Qol Five-Dimension (EQ-5D) questionnaires were used in a detailed evaluation of postoperative PFD and QoL. The PFDI-20 was divided into the Urogenital Distress Inventory (UDI-6) and the Colorectal Anal Distress Inventory (CRADI-8). The official Chinese versions of the questionnaires were used. LUTS, OAB, and defecation were evaluated by the validated versions of the UDI-6, OABss, and CRADI-8. Higher scores on these questionnaires indicated worsening of symptoms. The UDI-6 can be divided into several subscales, and stress urinary incontinence (SUI) was evaluated by questions 3 and 4. The EQ-5D questionnaire is designed to be self-administered by patients. The questionnaire

includes 5 functional domains (mobility, self-care, usual activities, pain/discomfort, and anxiety/depression) and the EQ visual analog scale (EQ VAS). The EQ VAS records the patient's self-rated health using a vertical VAS, where the end points are labeled "The best health you can imagine" and "The worst health you can imagine." It is used to measure the health outcome that reflects the patient's own judgment. Based on the questionnaire scores, we investigated the postoperative pelvic floor function and health status of patients and analyzed the related factors.

All patients underwent type III RH, with or without nerve-sparing techniques. The operations were performed by skilled surgeons with extensive training and experience in gynecologic oncology, using standardized surgical approaches. In addition, some patients received adjuvant therapy according to the clinical stage and pathology results. Specimens of the length of resected tissues were measured after surgery by the surgeon.

All demographic, surgical, and oncological data were calculated and reported. Demographic variables included age (<45 or ≥45 years), body mass index (BMI; kg/m²), parity (<2 or ≥2), and medical history of increased abdominal pressure (yes or no). Disease-related variables included the FIGO stage of disease (categorized as [1] IA; [2] IB1+IIA1; [3] IB2+IIA2; or [4] IIB), adjuvant chemoradiotherapy (yes vs. no), pathological type, and time interval between date of treatment and date of completion of the questionnaire. Surgical variables included the operation time (hours), operative blood loss, operation approach (laparoscopic vs. abdominal), nerve-sparing procedure (yes vs. no), and the length of resected vaginal wall and ligament.

SPSS program version 24.0 was used for statistical analyses. The statistical methods employed included Pearson's χ^2 test and a generalized estimating equation. The generalized estimating equation was performed to identify variables that were significantly associated with postoperative pelvic floor function and QoL. $p = 0.05$ was accepted as the degree of significance. Data are given as the mean $\pm$ standard deviation or percentage.

Results

A total of 718 women met the criteria and were originally recruited in this study. However, 29 patients were excluded because of loss of data. Therefore, 689 patients were considered for the final analysis. The demographic and disease-related characteristics of the patients are shown in Table 1. Patient ages ranged from 23 to 78 years, and 66.5% of the patients were older than 45 years. The average BMI was 23.91 kg/m², and approximately 11.0% of the patients were obese. According to the FIGO stage, 5.1, 73.3, 16.7, and 4.9% of the patients were classified as IA, IB1+IIA1, IB2+IIA2, and IIB, with most presenting in the early stage. Based on the preference and experience of surgeons, 60.4% of the patients underwent laparoscopic RH (LRH), and 39.6% underwent abdominal RH (ARH). The follow-up time ranged from 3 to 24 months, and the median time was 12 months.

Table 1. Demographic characteristics and disease-related data of patients

Characteristics	N (%)
Age	
<45 years	231 (33.5)
≥45 years	458 (66.5)
BMI	23.91±3.16
<18.5	15 (2.2)
18.5–23.9	355 (51.5)
24.0–27.9	243 (35.3)
≥28.0	76 (11.0)
Parity	
<2	382 (55.4)
≥2	307 (44.6)
FIGO stage	
IA	35 (5.1)
IB1+IIA1	505 (73.3)
IB2+IIA2	115 (16.7)
IIB	34 (4.9)
Pathological type	
Squamous cell carcinoma	557 (80.8)
Adenocarcinoma	96 (14.0)
Adenosquamous carcinoma	12 (1.7)
Others	24 (3.5)
Operation approach	
Laparoscopic	416 (60.4)
Abdominal	273 (39.6)
Treatment modalities	
Surgery only	220 (31.9)
Surgery + chemotherapy	176 (25.5)
Surgery + chemoradiotherapy	293 (42.5)
Follow-up time	
3–6 months	158 (22.9)
6–12 months	203 (29.5)
12–24 months	328 (47.6)

FIGO, International Federation of Gynecology and Obstetrics; BMI, body mass index.

Table 2 displays the self-reported prevalence of pelvic floor symptoms after treatment. CC patients had a significantly increased risk of urinary dysfunction. The results showed that 32.7% of patients complained about SUI, which was the most common symptom among patients in this study, based on the responses to the specific question of the UDI-6. In addition, 27.7% of patients reported incomplete emptying of urine, 28.6% reported constipation, and 24.4% reported incomplete emptying of stool.

Table 3 shows the results of the univariate and multivariate logistic regression analysis for the factors related to postoperative pelvic floor function and QoL, re-

Table 2. The incidence of postoperative urinary and defecation symptoms

Symptoms	Incidence (%)
Urinary function	
Urge UI	121 (17.6)
SUI	225 (32.7)
Incomplete emptying of urine	191 (27.7)
Frequent urination	96 (13.9)
Defecation function	
Constipation	197 (28.6)
Incomplete emptying of stool	168 (24.4)
Fecal incontinence	41 (6.0)
Painful defecation	60 (8.7)

SUI, stress urinary incontinence; UI, urinary incontinence.

spectively. The univariate analysis indicated that a low BMI, surgical LRH, length of the resected uterosacral ligament ≤3 cm, and low operative blood loss were significantly protective factors for QoL according to the EQ-5D score. Age over 45 years old, LRH, length of the resected cardinal ligament, uterosacral ligament or vaginal wall greater than 3 cm, and operation time longer than 4 hours were significant risk factors for LUTS based on the UDI-6 score. Chemotherapy and LRH were significant risk factors for SUI. Parity ≥2, chemoradiotherapy, LRH, length of the resected cardinal ligament, uterosacral ligament or vaginal wall greater than 3 cm, and follow-up time were significantly related to the OABss. Increased BMI, parity ≥2, LRH, and length of the resected cardinal ligament greater than 3 cm were significantly related to severe defecation distress according to the CRADI-8 score.

The multivariate analysis results are shown in Table 4. In the multivariate analysis, a high BMI and large amount of operative blood loss were independent risk factors for poor QoL (odds ratio [OR] = 1.330, 95% confidence interval [CI]: 1.007–1.758, OR = 1.376, 95% CI: 1.170–1.830, respectively), and LRH was an independent protective factor (OR = 0.099, 95% CI: 0.013–0.723). LRH was an independent risk factor for LUTS (OR = 1.167, 95% CI: 1.068–1.276), and a vaginal wall resection length ≤3 cm was an independent protective factor based on the UDI-6 score (OR = 0.867, 95% CI: –0.740–0.982). LRH and chemotherapy were independent risk factors for SUI (OR = 1.495, 95% CI: 1.064–2.099, OR = 2.357, 95% CI: 1.111–4.998, respectively). Parity ≤2 was a protective factor for OAB (OR = 0.565, 95% CI: 0.390–0.819), while chemo-

Table 3. Univariate analysis of the related factor to pelvic floor function and QoL

Variables	SUI OR (95% CI)	UDI-6 OR (95% CI)	CRADI-8 OR (95% CI)	OABss OR (95% CI)	EQ-5D OR (95% CI)
Age					
<45 years	0.745 (0.528–1.051)	0.922 (0.841–1.911)*	1.061 (0.9830–1.145)	0.900 (0.534–1.516)	0.504 (0.065–3.903)
≥45 years	1	1	1	1	1
BMI, kg/m ²	1.034 (0.984–1.087)	1.008 (0.993–1.022)	1.011 (1.002–1.021)*	1.032 (0.970–1.099)	1.298 (0.977–1.723)*
Parity					
<2	0.911 (0.661–1.256)	0.942 (0.858–1.035)	0.906 (0.846–0.969)*	0.561 (0.344–0.917)*	0.495 (0.075–3.259)
≥2	1	1	1	1	1
Medical history of increased abdominal pressure (yes or no)	1.164 (0.835–1.622)	1.041 (0.944–1.148)	0.981 (0.918–1.049)	1.389 (0.850–2.273)	0.317 (0.045–2.243)
FIGO stage					
IA	0.806 (0.353–1.842)	0.858 (0.682–1.105)	0.968 (0.799–1.189)	0.441 (0.075–2.574)	11.487 (0.035–37.837)
IB1+IIA1	1.071 (0.510–2.248)	1.029 (0.820–1.290)	0.983 (0.843–1.148)	0.865 (0.293–2.549)	0.617 (0.007–52.430)
IB2+IIA2	1.236 (0.458–3.336)	0.967 (0.758–1.233)	0.985 (0.835–1.164)	0.954 (0.290–3.143)	0.224 (0.002–26.852)
IIB	1	1	1	1	1
Treatment modalities					
Surgery	1	1	1	1	1
Surgery + chemotherapy	2.524 (1.195–5.329)*	0.988 (0.875–1.115)	0.959 (0.875–1.050)	1.093 (0.694–1.72)	0.313 (0.026–3.806)
Surgery + chemoradiotherapy	2.033 (0.948–4.360)	1.007 (0.902–1.124)	0.981 (0.903–1.065)	1.569 (1.021–0.412)*	0.228 (0.022–2.325)
Surgery + radiotherapy	1.460 (0.689–3.093)	0.899 (0.749–1.079)	0.994 (0.865–1.142)	2.188 (0.897–0.340)	4.063 (0.124–13.325)
Surgical approach					
LRH	1.598 (1.144–2.232)*	1.189 (1.087–1.301)*	1.102 (1.035–1.174)*	1.650 (0.968–2.812)*	0.158 (0.024–1.060)*
ARH	1	1	1	1	1
Nerve sparing (yes or no)	0.664 (0.394–1.118)	1.046 (0.886–1.235)	0.983 (0.892–1.084)	0.698 (0.271–1.799)	1.263 (0.037–42.923)
Length of resected cardinal ligament					
≤3 cm	0.655 (0.392–1.095)	0.853 (0.737–0.988)*	0.916 (0.827–1.915)*	0.491 (0.250–0.964)*	17.418 (0.846–358.480)*
>3 cm	1	1	1	1	1
Length of resected uterosacral ligament					
≤3 cm	0.946 (0.497–1.803)	0.819 (0.656–1.021)*	0.914 (0.785–1.064)	0.496 (0.222–1.111)*	0.537 (0.015–19.202)
>3 cm	1	1	1	1	1
Length of resected vaginal wall					
≤3 cm	0.890 (0.581–1.364)	0.822 (0.712–0.950)*	0.970 (0.883–1.065)	0.445 (0.248–0.797)*	5.042 (0.384–66.181)
>3 cm	1	1	1	1	1
Operation blood loss (mL)	1 (0.999–1)	1	1	1 (1–1.001)	0.504 (0.239–1.063)*
Operation time					
<4 h	0.734 (0.533–1.011)	0.915 (0.836–1.002)*	1.040 (0.973–1.111)	1.001 (0.615–1.630)	4.307 (0.660–28.108)
≥4 h	1	1	1	1	1
Follow-up time					
3–6 months	0.825 (0.569–1.198)	0.952 (0.847–1.069)	1.067 (0.973–1.170)	0.733 (0.393–1.367)	0.042 (0.004–0.455)
6–12 months	0.699 (0.462–1.059)	0.928 (0.838–1.028)	0.955 (0.890–1.026)	0.579 (0.317–1.058)*	0.645 (0.072–5.770)
12–24 months	1	1	1	1	1

BMI, body mass index (kg/m²); FIGO, International Federation of Gynecology and Obstetrics; LRH, laparoscopic radical hysterectomy; ARH, abdominal radical hysterectomy; OABss, Overactive Bladder Symptom Score; SUI, stress urinary incontinence; UDI-6, Urogenital Distress Inventory; CRADI-8, Colorectal Anal Distress Inventory; EQ-5D, Euro Qol Five-Dimension; QoL, quality of life; OR, odds ratio; CI, confidence interval. Data presented as OR (95% CI) unless otherwise specified. * $p < 0.05$ indicates statistical significance.

radiotherapy, and LRH were risk factors for OAB (OR = 1.549, 95% CI: 1.002–2.396, OR = 1.592, 95% CI: 1.112–2.280, respectively). A high BMI and LRH were independent risk factors for worse defecation symptoms (OR = 1.011, 95% CI: 1.002–1.021, OR = 1.100, 95% CI: 1.032–1.171, respectively), and parity ≤2 was a protective factor (OR = 0.906, 95% CI: 0.847–0.969).

Table 5 shows the results of the operation-related variables of patients in the LRH and ARH groups. Statistically significant differences were observed in terms of length of the resected cardinal ligament and vaginal wall ($p = 0.002$, $p < 0.001$, respectively), which indicated that LRH results in a larger range of parametrial tissue resection.

Table 4. Multivariate analysis of the related factor to pelvic floor function and QoL

Variables	SUI OR (95% CI)	UDI-6 OR (95% CI)	CRADI-8 OR (95% CI)	OABss OR (95% CI)	EQ-5D OR (95% CI)
Age					
<45 years		0.924 (0.844–1.011)	1.068 (0.990–1.1151)		
≥45 years		1	1		
BMI, kg/m ²			1.011 (1.002–1.021)*		1.330 (1.007–1.758)*
Parity					
<2			0.906 (0.847–0.969)*	0.565 (0.390–0.819)*	
≥2			1	1	
Treatment modalities					
Surgery	1			1	
Surgery + chemotherapy	2.357 (1.111–4.998)*			1.110 (0.711–1.733)	
Surgery + chemoradiotherapy	1.990 (0.0925–4.279)			1.549 (1.002–2.396)*	
Surgery + radiotherapy	1.456 (0.686–3.092)			2.309 (0.946–5.637)	
Operation approach					
LRH	1.495 (1.064–2.099)*	1.167 (1.068–1.276)*	1.100 (1.032–1.171)*	1.592 (1.112–2.280)*	0.099 (0.013–0.723)*
ARH	1	1	1	1	1
Length of resected cardinal ligament					
≤3 cm		1.010 (0.815–1.252)	0.938 (0.844–1.041)	0.813 (0.323–2.042)	7.551 (0.348–163.631)
>3 cm		1	1	1	1
Length of resected uterosacral ligament					
≤3 cm		0.843 (0.616–1.153)		0.577 (0.173–1.927)	
>3 cm		1		1	
Length of resected vaginal wall					
≤3 cm		0.867 (0.740–0.982)*		0.668 (0.399–1.118)	
>3 cm		1		1	
Operation blood loss, mL					1.376 (1.170–1.830)*
Operation time					
<4 h		0.964 (0.874–1.062)			
≥4 h		1			
Follow-up time					
3–6 months			1.059 (0.969–1.158)	0.930 (0.589–1.469)	
6–12 months			0.951 (0.886–1.021)	0.586 (0.403–0.854)	
12–24 months			1	1	

BMI, body mass index (kg/m²); LRH, laparoscopic radical hysterectomy; ARH, abdominal radical hysterectomy; OABss, Overactive Bladder Symptom Score; SUI, stress urinary incontinence; UDI-6, Urogenital Distress Inventory; CRADI-8, Colorectal Anal Distress Inventory; EQ-5D, Euro Qol Five-Dimension; QoL, quality of life; OR, odds ratio; CI, confidence interval. Data presented as OR (95% CI) unless otherwise specified. * $p < 0.05$ indicates statistical significance.

Discussion

CC is one of the most widespread gynecological malignancies in women worldwide. In China, CC is associated with a high incidence and mortality rate, which severely damages the physical and mental health of patients [7]. Currently, RH with pelvic lymphadenectomy is the standard treatment for early stage CC patients. This treatment regimen has a 5-year overall rate of up to 80% [8]. However, RH is associated with long-term adverse effects on pelvic floor function. Many patients complain of pelvic floor symptoms such as UI, OAB, constipation, and sexual dysfunction after surgery [9]. Moreover, some studies have reported that surgery with adjuvant chemoradio-

therapy is associated with urological complications that are twice as severe and gastrointestinal adverse events that are 3 times more severe than those reported after surgery alone [10]. In recent years, oncologists have focused on the overall survival of CC patients. However, QoL and pelvic floor function are also important but often ignored factors.

The results of our study after a long-term follow-up demonstrate that CC patients have bothersome pelvic floor symptoms postoperatively. UI is the most pronounced symptom. The incidence of SUI is 32.7% and that of incomplete urinary emptying is 27.7%. Constipation is the most often reported colorectal symptom after RH, with a prevalence of 28.6%. Other studies have re-

Table 5. The operation-related variables of the patients between LRH and ARH group

	LRH (<i>n</i> = 416), <i>n</i> (%)	ARH (<i>n</i> = 273), <i>n</i> (%)	<i>p</i> value
Length of resected cardinal ligament >3 cm	53 (12.7)	15 (5.5)	0.002*
Length of resected uterosacral ligament >3 cm	30 (7.2)	14 (5.1)	0.274
Length of resected vaginal wall >3 cm	89 (21.4)	23 (8.4)	<0.001*

LRH, laparoscopic radical hysterectomy; ARH, abdominal radical hysterectomy. * *p* < 0.05 indicates statistical significance.

ported that the incidence of postoperative urinary dysfunction varies from 12 to 85% [5]. The prevalence of intestinal dysfunction can reach 75% [11]. In addition, the difference in incidence is likely due to the diagnostic method of urinary symptoms, variation in the follow-up period, and variation in surgical techniques.

The advantages of laparoscopy in oncological surgery, such as minimal intraoperative blood loss, reduced postoperative pain, shorter hospitalization times, and reduction of health-care costs, have been described [12]. However, the difference in postoperative pelvic floor function between the laparoscopic and abdominal approach is still controversial. In our study, we found that LRH was a risk factor for LUTS, especially for postoperative symptoms of SUI and OAB. Postoperative LUTS occur due to partial or complete disruption of the sympathetic and parasympathetic fibers that pass through the paracervix and innervate the urethrovesical complex during resection of the uterosacral and rectovaginal ligaments, the dorsal and lateral paracervix, the caudal part of the vesicouterine ligaments, or the vagina [13]. We then compared the resection range of parametrial tissue between the LRH and ARH groups and found that LRH involved a longer resection length of the ligament and vaginal wall. Since the scope of laparoscopy is clearer than that of abdominal surgery, surgeons tended to perform longer resections to achieve better oncological outcomes. Therefore, we speculate that the larger ligament resection could explain the increased possibility of nerve injury with the laparoscopic approach compared with ARH and could result in long-term complications.

Although LRH may increase the prevalence of LUTS and defecation distress, we found that laparoscopic surgery resulted in a better physical and mental condition. Compared to ARH, laparoscopic surgery provides a clearer surgical field, which can avoid damage to the abdominal tissue or vascular structures and decrease the

amount of blood loss during the operation. Moreover, the surgical procedure is mainly performed by electrocoagulation, which can also minimize the amount of blood loss. In addition, postoperative intestinal function recovers more quickly after laparoscopic than abdominal surgery, and the postoperative abdominal incision heals faster because of the minimal invasiveness. Obesity was a risk factor for poor QoL, and moderate exercise is helpful for obtaining a favorable physical condition as well as a pleasant mood. The results of previous studies showed that spiritual well-being and social support were predictive factors that significantly affected QoL among CC patients, and a better understanding of long-term QoL in CC survivors is crucial [14, 15].

Defecation symptoms are also bothersome for patients. Our results showed that a high BMI, parity >2, and laparoscopic surgery increased the severity of bowel symptoms. RH involves extensive dissection of the pelvic structures, which can cause increased damage to the nerves innervating of rectum. Hazewinkel et al. [10] reported that a great disturbance in body image was associated with severe defecation symptoms, which is similar to our results. Our findings are also consistent with those from Laterza et al. [16], who found that laparoscopic surgery increased the occurrence of obstructed defecation compared to abdominal surgery. Direct injury to the parasympathetic nerves lateral to the vaginal fornix and in the broad ligament of the uterus is responsible for post-hysterectomy constipation [17].

Chemoradiotherapy is associated with greater distress caused by pelvic floor symptoms than in patients treated with RH. The incidence of UI was 36% in patients who underwent RH with chemotherapy or radiotherapy [18]. In our study, the ORs of SUI and OAB were 2.4 and 1.549, respectively, for patients who received chemotherapy and chemoradiotherapy compared to those with RH alone. Other studies showed similar results. Noronha et al. [19]

reported that radiotherapy and chemoradiotherapy treatments for CC are more frequently associated with urinary and intestinal dysfunctions, with a higher incidence of urinary frequency and diarrhea, than surgery alone. Chemotherapy and radiotherapy increased the likelihood of some types of serious acute toxicity, particularly hematologic and gastrointestinal toxicity. However, acute toxicity and diarrhea during radiation therapy for CC significantly increase the risk of severe late toxicity and affect the patient's QoL. Radiotherapy is known to cause fibrosis in bladder walls, which results in a low compliance of the bladder and explains the elevated risk of urinary urgency and frequency in patients who undergo primary radiotherapy [20, 21]. Therefore, oncologists should consider a treatment strategy to minimize the development of PFD following adjuvant therapy.

Currently, nerve-sparing RH has been introduced with the aim of reducing pelvic dysfunction related to conventional RH. Because of the close proximity of the paracervix and supporting tissues around the uterus with the pelvic nerves, the integrity of pelvic innervation may be compromised during RH [22]. Although no significant differences between patients who underwent nerve-sparing procedures and those who underwent non-nerve-sparing procedures were observed in our study, some studies have demonstrated that nerve-sparing techniques appear to improve bladder function without compromising overall survival [23]. Ditto et al. [24] reported a significant difference between patients undergoing nerve-sparing RH and patients undergoing non-nerve-sparing RH. The nerve-sparing group had better bladder function and a lower postoperative complication rate than the nerve-resection group. Another study found that RH with a non-nerve-sparing procedure, adjuvant radiotherapy, and voiding with abdominal pressure at 3 months after surgery were risk factors for persistent low bladder compliance [25]. The nerve-sparing approach during RH has become popular in recent years and can better identify visceral nerve fibers and surgical landmarks, thereby improving dissection of the vascular structures from the nerve tissue of the parametrium [26].

The following limitations of our study merit attention. First, the study was retrospective nature, and although the patients with previous urinary and bowel symptoms were excluded, we lacked information about preoperative pelvic floor function for comparison purposes. The second limitation is that we evaluated postoperative urinary and bowel function based on answers to questionnaires, which are subjective and can be influ-

enced by the status or mood of patients. Therefore, the results might not accurately represent pelvic floor function. Objective evaluation and diagnostic methods should be used to detect pelvic nerve and muscle dysfunction. Additionally, the surgeries were completed by different oncological surgeons, and some subjective bias was present regarding the operation, which might be difficult to control.

A strength of our study was that we used validated self-report questionnaires to assess a wide spectrum of pelvic floor symptoms. Additionally, we achieved a questionnaire response rate of 96%. Our results showed that CC survivors have a high prevalence of urinary and bowel symptoms after treatment, and compared with abdominal surgery, laparoscopic surgery caused more distress. Furthermore, our results suggest that adjuvant therapy increased the adverse effects on pelvic floor function compared to RH alone. However, additional randomized controlled trials are needed to confirm these results.

Conclusion

PFD is common in CC patients who undergo RH with or without adjuvant therapy. Many patients complain about bothersome urinary and defecation dysfunction symptoms, especially patients who are obese, have high parity, and undergo laparoscopic surgery. The distress and symptoms considerably influence the patients' daily lives. These results emphasize the necessity to evaluate CC patients after treatment. Furthermore, evaluation of pelvic floor function, using methods such as a validated questionnaire, and objective examinations should be completed during the follow-up period. Performance of these assessments during follow-up visits could assist surgeons in considering treatments for bothersome symptoms, which will likely relieve distress and enhance the patient's QoL.

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Statement of Ethics

This study was approved by the Ethics Committee of Peking University People's Hospital, and the study is registered at www.clinicaltrials.gov (NCT02492542).

Conflict of Interest Statement

None of the authors of this article have any conflict of interest, financial, or otherwise.

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Author Contributions

Sha Wang contributed to manuscript writing, data collection, and data analysis; Hongwu Wen, Yunong Gao, and Qiubo Lv contributed to design of the study and data collection; Tingting Cao and Shiyang Wang contributed to data collection; Jing Wang, Yi Li, and Haibo Wang contributed to data analysis and interpretation of data; Zhiqi Wang contributed to design of the study; Xiuli Sun and Jianliu Wang contributed to design of the study and manuscript revision. All the authors approved the final version of the manuscript.

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