Urinary continence outcomes of four years of follow-up and predictors of early and late urinary continence in patients undergoing robot-assisted radical prostatectomy

Xing Li
Chinese PLA General Hospital
Huan Zhang
Chinese PLA General Hospital
Zhuo Jia
Chinese PLA General Hospital
Yunpeng Wang
Chinese PLA General Hospital
Yong Song
Chinese PLA General Hospital
Limin Liao
China Rehabilitation Research Center
Xu Zhang (xzhang@foxmail.com)
Department of urology, Chinese PLA General Hospital/Chinese PLA Medical Academy28, fuxing road,eijing

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Abstract

Background: Although the wide application of robot-assisted radical prostatectomy (RARP) in recent years, studies about long urinary continence were few. In this study, we aimed to examine the outcomes of continence rates (CRs) and determine the risk and protective factors of early and late urinary continence in patients with prostate cancer (PCa) undergoing RARP. Methods: This retrospective study included 650 patients treated with RARP who completed perioperative data and at least one year of follow-up from January 2009 to November 2017. We analyzed the preoperative, intraoperative, and postoperative parameters of the patients. Continence was defined as no pad use. CRs from one to 48 months postoperatively were examined. Logistic regression analysis was performed to evaluate the associations between the predictive factors and urinary continence in the early and late stages. Results: CRs of the patients at one, three, six, 12, 24, 36, and 48 months postoperatively were 40.62%, 60.92%, 71.38%, 78.77%, 79.96%, 79.51%, and 76.50%, respectively. There were no significant differences in CR from 12 to 48 months postoperatively (P=0.766). Logistic regression analysis proved that pelvic lymph node dissection (PLND) was a significant risk factor of urinary continence at one month. Nerve sparing (NS) was a significant protective factor of urinary continence at one, three and six months. Age was an independent risk factor of urinary continence at six, 12 and 24 months. Other variables were not statistically significant predictors. Conclusions: Our results demonstrated that CR gradually improved with time within one year and stabilized one year after the surgery. PLND, NS and age were significant determinants of continence in the early and late stages, respectively. These parameters could be used for preoperatively identifying patients at high risk for urinary incontinence and counselling about postoperative expectations for urinary continence.

Background

Despite advances in surgical technique and methodology, postprostatectomy urinary incontinence (UI) remains a significant adverse event that leads to decreased quality of life [1,2]. It has been suggested that a number of factors are involved in recovery of urinary continence after radical prostatectomy (RP) [3,4]. Many patients have learned about this disease from the media. Hence, it is necessary to predict recovery of urinary continence early to minimize patients' concerns and embarrassment [5].

Along with technical progress, robot-assisted radical prostatectomy (RARP) is increasingly used worldwide [6]. Because the procedure can induce different degrees of damage to the bladder and urethra, UI is still inevitable even with the assistance of robotic systems [7,8]. It places physical and psychosocial burdens on patients.

It has been reported that urinary continence improves little in the 12 months after surgery [9]. Hence, many previous reports mainly addressed continence rates (CRs) and potential predictors within one year post RARP. However, continence may continue to develop two years postsurgery [7,10,11]. Few data are available at longer follow-up with urinary continence after 24 to 48 months. In addition, although a series of studies reported outcomes one year after surgery, most of them included a relatively small number of patients (usually fewer than 200). Moreover, the follow-up period was discontinuous or incomplete. For example, Yanagiuchi and co-workers examined and identified outcomes one and three months post RARP, while Olgin and Haga analyzed and evaluated outcomes three and 12 months after surgery [12-14]. In addition, Honda and colleagues reported continuous outcomes from one to six months postoperatively [15].

To the best of our knowledge, continuous follow-up data from one to 48 months on CRs and predictive factors for urinary continence after RARP with a higher number of patients have not been collected. Therefore, in this

retrospective study, we examined the outcomes of CRs one, three, six, 12, 24, 36, and 48 months after surgery and determined the risk and protective factors of urinary continence in the early and late stages.

Methods

Patients diagnosed with clinically localized prostate cancer who received treatment from September 2009 to November 2017 at our institution were retrospectively studied. Only patients who completed the outpatient visits or telephone interviews for at least one year were enrolled. We excluded patients with incomplete data and those unavailable for follow-up of continence. Patients who received preoperative transurethral resection; enuclation of the prostate; radioactive seed implantation; orchidectomy; bladder neck, urethral, or pelvic surgery and who underwent retropubic radical prostatectomy (RRP) or laparoscopic radical prostatectomy (LRP) were also excluded. In total, 650 eligible patients were left for the analysis. The study flow diagram is illustrated in Fig.1.

We gathered data from cases performed by 3 surgeons. RARP was performed by transperitoneal approach. Nerve sparing (NS) procedures were attempted in all potent patients with a clinical stage of T1 or T2, PSA ≤10 ng/mL, and Gleason score ≤7. To preserve the urethral length, it was performed proximally close to the prostate when dissected the urethra. Pelvic lymph node dissection (PLND) was selectively performed for sampling purposes in intermediate- and high-risk patients [16]. Urethrovesical anastomosis was made using 2-zero monofilament sutures with 5/8 needle.

Clinical data on demographic characteristics and surgery-related variables were retrieved from the patient medical records. Together with follow-up records, they were retrospectively collected in a computerized database. The tested factors were age at operation, body mass index (BMI), comorbidities including hypertension (HP), diabetes mellitus (DM), coronary heart disease (CHD) and cerebrovascular diseases (CD), serum prostate-specific antigen (PSA) level, prostate volume (PV), biopsy-determined Gleason score, clinical stage, operation time (OT), NS and PLND during surgery, and duration of indwelling catheter (DIC) after surgery. UI was defined as any leakage of urine after the surgery.

Statistical analysis

SPSS version 19.0 (SPSS, Inc., Chicago, IL, USA) was used for statistical analysis. Results are reported as mean ±standard deviation or percentage. The chi-square test was used to compare CRs at 12, 24, 36, and 48 months. The independent sample t-test or chi-square test was used to compare the predictive factors for urinary continence after RARP. All the aboved factors that may affect urinary continence were included into the univariate and multivariate logistic regression analysis to identify risk and protective factors. $P<0.05$ was considered significant.

Results

CRs at one, three, six, 12, 24, 36, and 48 months postsurgery were 40.62%, 60.92%, 71.38%, 78.77%, 79.96%, 79.51%, and 76.50%, respectively (Table 1). They gradually improved with time within one year. By comparing CRs at 12 and 48 months, we found that no significant difference in continence outcomes were observed during the four-year follow-up ($P=0.766$). It showed that CR stabilized one year after operation.

We compared the demographic data and baseline clinical characteristics of the two groups (continence and incontinence group) at one and 48 months (Tables 2-4). The incontinence group had less NS and more PLND than the continence group during the surgery at one-month follow-up ($P<0.05$) (Table 2). Likewise, the continence group

had more intraoperative NS than the incontinence group at three-month follow-up (P<0.05) (Table 2). Data from the six- and 12-month follow-ups are presented in Table 3. NS procedures in the continence group were performed more than those in the incontinence group at six-month follow-up (P<0.05). Urinary continence at six and 12 months after RARP was associated with age at surgery (P<0.05). Data from the 24- and 48-month follow-ups are presented in Table 4. Patients in the incontinence group were older than those in the continence group at 24-month follow-up (P<0.05). No significant variables were observed at 48-month follow-up.

Univariate and multivariate associations between urinary continence and predictive factors are shown in Tables 5, 6, and 7. In univariate logistic analysis, PLND was associated with incontinence one month postsurgery (P=0.009). In multivariate logistic analysis, PLND was a significant independent risk factor of early urinary continence at one month (OR 1.535, 95% CI 1.079-2.184, P=0.017) (Table 5).

Univariate logistic analysis showed that NS was associated with urinary continence at one month (OR 0.372, 95% CI 0.248-0.557, P=0.000), three months (OR 0.549, 95% CI 0.356-0.846, P=0.007), and six months (OR 0.561, 95% CI 0.346-0.909, P=0.019) (Tables 5 and 6). In multivariate logistic analysis, NS was a significant independent protective factor of urinary continence at one month (OR 0.360, 95% CI 0.231-0.561, P=0.000), three months (OR 0.546, 95% CI 0.342-0.872, P=0.011), and six months (OR 0.545, 95% CI 0.324-0.915, P=0.022) (Tables 5 and 6).

Univariate logistic analysis showed that age was associated with urinary continence at six months (OR 1.028, 95% CI 1.005-1.052, P=0.019), 12 months (OR 1.034, 95% CI 1.007-1.061, P=0.012), and 24 months (OR 1.970, 95% CI 1.943-1.998, P=0.017) (Tables 6 and 7). In multivariate logistic analysis, age was a significant independent risk factor of urinary continence at six months (OR 1.026, 95% CI 1.001-1.051, P=0.038), 12 months (OR 1.030, 95% CI 1.002-1.058, P=0.035), and 24 months (OR 1.968, 95% CI 1.939-1.997, P=0.038) (Tables 6 and 7). Other variables were not statistically significant predictors. No significant predictors of late urinary continence were seen at 48 months (Table 7).

Discussion

RARP quickly became the most widespread surgical procedure for prostate cancer in recent years [6]. Despite technical and methodological improvements in RP, UI does occur and negatively affects quality of life [17]. Assessment of predictors associated with urinary continence has been tried in many studies [7,15,18,19]. This is important for patients and surgeons [18]. Early expectation of a good outcome would help reduce patient anxiety, while early estimation of postoperative outcomes could help surgeons identify patients who are at high risk of UI and counsel them on postoperative expectations for urinary continence.

It has been reported that urinary continence is stable 12 months postsurgery [2]. Hence, many previous reports mainly address CRs within one year post RARP. Few data are available at more than 24 months follow-up for urinary continence. In our study, CRs one, two, three, and four years after surgery were 78.77%, 79.96%, 79.51%, and 76.50%, respectively (Table 1). No significant differences in continence outcomes were observed during the four-year follow-up. Our results certified that one year after RARP was the stable continence period [20]. Few studies have evaluated CR rates after 12 months. Shao and assists reported that CR at 24 months after RARP were 89.4%, while Xylinas and co-workers reported a 24-month urinary continence rate of 88% using the no-pad definition [7,21]. Murphy and colleagues reported a 36-month urinary continence rate of 94.7% using the no-pad or safety pad definition [22]. Mandel and assistants reported that CRs at 24 and 36 months after surgery were 89.5% and 90.9%, respectively [23]. Our CR 48 months after RARP was 76.50%, which we believe is the longest follow-up on the topic to date.

While many studies have evaluated predictors of urinary continence within one year after surgery, these studies either included a relatively small number of patients or had discontinuous follow-up. To our knowledge, this is the first study to evaluate predictors of continence one to 48 months after RARP in a relatively large sample.

In our cohort, CRs one, three, six, and 12 months after RARP were 40.62%, 60.92%, 71.38%, and 78.77%, respectively (Table 1). CR gradually improves at these times. Our results are in agreement with the recent study by Honda and assists which found that CRs at one, three, and six months were 40.7%, 63.0%, and 73.1%, respectively [15]. The definition of postoperative urinary continence varied among several studies. There is no consensus on UI after RP so far [24]. We chose the definition of incontinence as any leakage of urine, which seems to be the strictest. It has been reported that continence rate one year after RARP is 69% to 97% [1,25]. Our overall continence rate at 12 months was 78.77%, based on defining continence as no pad use. Although it is not excellent, it is within the average range.

To identify predictive factors for urinary continence, it was divided into two categories: early continence (< 3 months) and late continence (> 12 months) [26].

In general, PLND was selectively performed for sampling purposes in intermediate- and high-risk patients [16]. One month after surgery, PLND in the continence group occurred in 121 patients (45.83%), while it occurred in 217 patients in the incontinence group (56.22%) (P<0.05). Three months after surgery, there were no significant differences in both groups. Logistic analysis showed that PLND was a significant independent risk factor of early urinary continence at one month. Men who had PLND during surgery had a higher risk of UI. Lymphadenectomy may give rise to more transient damage to nerve vessel bundles (NVBs), which affects the recovery of urinary continence. However, with the recovery of body function, this impact is gradually diminishing.

Our logistic analysis showed that NS was a significant independent protective factor of urinary continence at one month, three months, and six months (Tables 5 and 6). This is in line with Reeves's study which found that avoiding damage to the nerves around the prostate improves urinary continence in the first six months after surgery [27]. Michl and colleagues investigated long-term CRs (12 months) after RP and showed a significant difference between the NS and non-NS groups [28]. The studies by Kadono and Steineck also indicated that NS is associated with urinary continence in the long term [20,29]. Probably important bias in the studies used for the analysis may have influenced the results. However, all the studies showed that NS during the surgery produced better postoperative continence outcomes.

Multiple studies have demonstrated that age is an independent risk factor for return of continence one to 12 months after RARP. Lavigueur-Blouin and co-workers evaluated early continence after RARP [30]. It showed that advanced age was an independent predictor at one month. Kim and colleagues have demonstrated that younger men are most likely to have an earlier return of continence three months after RARP [31]. Greco and assists performed a study that compared continence outcomes in RARP in older men with those of younger men [32]. They showed that CRs at one, three, and 12 months were comparable in two groups, but the older group had significantly lower continence rate at six months. Their results partly agree with those of our study. Shikanov and co-workers demonstrated that age was one predictor of continence return 12 months after RARP, which is partially in accordance with our results [33]. Our results show that age is a significant risk factor of continence six, 12, and 24 months after surgery (Tables 6 and 7). Men of advanced age had a higher risk of UI. Older men have poor endothelial dysfunction, which affects the vascular supply of the NVBs. In addition, it is difficult to perform pelvic floor exercises (PLE) due to an age-related decrease in skeletal muscle and neuronal plasticity mass [19]. All of these may affect functional outcomes.

One thing to point out is that the optimal time to remove the indwelling catheter has not yet been determined. Traditionally, urinary catheter removal has been performed between 10 and 21 days postoperatively [34]. Generally, the catheter is removed three weeks after operation in our center. It is to ensure better healing of the anastomosis. But most patients returned home after operation and removed the indwelling catheter at the local clinic. This leads to the inconsistency of catheter removal and our duration of indwelling catheter seems longer.

Limitations

Our results must be considered in light of some limitations. First, this is a retrospective study from a single institution, and surgeries were not performed by a single surgeon. Second, we did not analyze all variables due to undocumented surgical steps of the procedure, variations in surgical experience, and differences in pathological reports. Third, although we used the strict definition of continence, the continence conditions were reported by the patients rather than by using a quality questionnaire. Fourth, potential selection bias operating in those selected for the procedure may influence the results. In addition, missing data were unavoidable because many patients were lost to follow-up. Although our study has the aforementioned limitations, it clearly had a large sample size, and the survey of postoperative UI was time-continuous.

Conclusions

Our study has shown that CR gradually improves with time within one year after surgery and stabilizes one year later. PLND, NS and age were significant determinants of continence in the early and late stages, respectively. These parameters could be used to preoperatively identify patients at high risk for UI and counsel them on postoperative expectations for urinary continence.

Abbreviations

Our study has shown that CR gradually improves with time within one year after surgery and stabilizes one year later. PLND, NS and age were significant determinants of continence in the early and late stages, respectively. These parameters could be used to preoperatively identify patients at high risk for UI and counsel them on postoperative expectations for urinary continence.

Declarations

Acknowledgements

Not applicable.

Authors' contributions

XL: Protocol/project development, Data Collection, Data management, Statistical analysis, Manuscript writing HZ: Data Collection, Data analysis ZJ: Data Collection, Data analysis YW: Data Collection, Data analysis YS: Data Collection, Data analysis LL: Critical revision of the manuscript, Manuscript editing XZ: Critical revision of the manuscript, Manuscript editing. All authors read and approved the final version of the manuscript.

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Availability of data and materials

All the data supporting our findings is contained in the manuscript. The datasets used and/or analysed in the current study is available from the corresponding author on reasonable request.

Ethics approval and consent to participate

All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. Informed consent was obtained from all individual participants included in the study. This study was approved by the Chinese PLA General Hospital Local Ethics Committee.

Consent for publication

Not applicable.

Competing interests

The authors declare that they have no competing interest.

Author details

[1]Department of Urology, Medical College of People's Liberation Army, Chinese People's Liberation Army General Hospital, Fuxing Road. No: 28 Fengtai District, Beijing, China. [2] Department of Urology, Rehabilitation School of Capital Medical University, China Rehabilitation Research Center, Jiaomen North Road. No: 10 Fengtai District, Beijing, China.

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Tables

Table 1 Continence and incontinence data from one month to 48 months after RARP

	Continence rate	Incontinence rate
One month (N = 650)	40.62% (264/650)	59.38% (386/650)
Three months (N = 650)	60.92% (396/650)	39.08% (254/650)
Six months (N = 650)	71.38% (464/650)	28.62% (186/650)
12 months (N = 650)	78.77% (512/650)	21.23% (138/650)
24 months (N = 469)	79.96% (375/469)	20.04% (94/469)
36 months (N = 327)	79.51% (260/327)	20.49% (67/327)
48 months (N = 217)	76.50% (166/217)	23.50% (51/217)

Abbreviation: RARP: Robot-assisted radical prostatectomy

Table 2 Comparison of parameters between continence and incontinence patients at one and three months after operation

Variable	One Month			Three Months		
	Continence	Incontinence	P value	Continence	Incontinence	P value
Age (years)	65.60 ± 7.04	65.63 ± 7.94	0.959	65.20 ± 7.32	66.27 ± 7.94	0.080
BMI (kg/m^2)	24.85 ± 2.75	25.14 ± 2.98	0.209	25.01 ± 2.82	25.02 ± 3.01	0.964
Comorbidities, no (%)						
HP	77 (29.17%)	141 (36.53%)	0.051	122 (30.81%)	96 (37.80%)	0.066
DM	38 (14.39%)	77 (16.06%)	0.563	64 (16.16%)	36 (14.17%)	0.493
CHD	20 (7.58%)	43 (11.14%)	0.131	38 (9.60%)	25 (9.84%)	0.917
CD	9 (3.41%)	11 (2.85%)	0.685	10 (2.53%)	10 (3.94%)	0.309
PSA (ng/mL)	27.65 ± 32.92	32.11 ± 36.08	0.109	28.65 ± 32.17	32.86 ± 38.64	0.133
PV (mL)	37.73 ± 20.20	35.80 ± 18.58	0.211	37.15 ± 19.34	35.70 ± 19.15	0.348
Gleason score, no (%)			0.475			0.654
≤6	79 (29.92%)	114 (29.53%)		117 (29.55%)	76 (29.92%)	
7	95 (35.98%)	160 (41.45%)		151 (38.13%)	104 (40.94%)	
≥8	78 (29.55%)	97 (25.13%)		113 (28.54%)	62 (24.41%)	
Unknown	12 (4.55%)	15 (3.89%)		15 (3.78%)	12 (4.73%)	
Clinical T stage, no (%)			0.962			0.550
T1a,b	1 (0.37%)	1 (0.26%)		1 (0.25%)	1 (0.39%)	
T1c	46 (17.42%)	68 (17.62%)		69 (17.42%)	45 (17.72%)	
T2a,b	102 (38.64%)	139 (36.01%)		157 (39.65%)	84 (33.07%)	
T2c	103 (39.02%)	155 (40.16%)		149 (37.63%)	109 (42.91%)	
T3a	1 (0.37%)	2 (0.51%)		1 (0.25%)	2 (0.79%)	
T3b	11 (4.17%)	21 (5.44%)		19 (4.80%)	13 (5.12%)	
OT (mins)	151.61 ± 42.16	153.81 ± 48.78	0.551	151.02 ± 41.76	155.86 ± 52.30	0.192
NS, no (%)	73 (27.65%)	48 (12.44%)	0.000	87 (21.97%)	34 (13.39%)	0.045
PLND, no (%)	121 (45.83%)	217 (56.22%)	0.009	204 (51.52%)	134 (52.76%)	0.757
DIC (days)	21.22 ± 10.83	21.02 ± 10.09	0.810	21.28 ± 11.46	20.84 ± 8.46	0.601

Abbreviations: BMI: Body mass index; CHD: Coronary heart disease; CD: Cerebrovascular diseases; DM: Diabetes mellitus; DIC: Duration of indwelling catheter; HP: Hypertension; NS: Nerve sparing; OT: Operation time; PSA: Prostate-specific antigen; PV: Prostate volume; PLND: Pelvic lymph node dissection

Table 3 Comparison of parameters between continence and incontinence patients at six and twelve months after operation

Variable	Six Months			Twelve Months		
	Continence	Incontinence	P value	Continence	Incontinence	P value
Age (years)	65.17 ± 7.33	66.73 ± 8.08	0.018	65.23 ± 7.36	67.06 ± 8.22	0.012
BMI (kg/m^2)	25.05 ± 2.78	24.93 ± 3.14	0.631	25.07 ± 2.84	24.82 ± 3.06	0.362
Comorbidities, no (%)						
HP	150 (32.33%)	68 (36.56%)	0.302	172 (33.59%)	46 (33.33%)	0.954
DM	73 (15.73%)	27 (14.52%)	0.698	80 (15.63%)	20 (14.49%)	0.744
CHD	41 (8.84%)	22 (11.83%)	0.244	46 (8.98%)	17 (12.32%)	0.240
CD	12 (2.59%)	8 (4.30%)	0.253	13 (2.54%)	7 (5.07%)	0.126
PSA (ng/mL)	29.15 ± 33.12	33.16 ± 38.85	0.185	29.43 ± 32.66	32.51 ± 42.07	0.223
PV (mL)	37.14 ± 19.11	35.20 ± 19.63	0.245	36.95 ± 18.75	35.24 ± 21.10	0.354
Gleason score, no (%)			0.251			0.257
≦6	137 (29.53%)	56 (30.11%)		153 (29.88%)	40 (28.99%)	
7	178 (38.36%)	77 (41.40%)		197 (38.48%)	58 (42.03%)	
≧8	133 (28.66%)	42 (22.58%)		144 (28.13%)	31 (22.46%)	
Unknown	16 (3.45%)	11 (5.91%)		18 (3.51%)	9 (6.52%)	
Clinical T stage, no (%)			0.659			0.918
T1a,b	2 (0.43%)	0		2 (0.38%)	0	
T1c	78 (16.81%)	36 (19.35%)		88 (17.19%)	26 (18.84%)	
T2a,b	178 (38.36%)	63 (33.87%)		193 (37.70%)	48 (34.78%)	
T2c	179 (38.58%)	79 (42.47%)		201 (39.26%)	57 (41.30%)	
T3a	2 (0.43%)	1 (0.55%)		2 (0.38%)	1 (0.73%)	
T3b	25 (5.39%)	7 (3.76%)		26 (5.08%)	6 (4.35%)	
OT (mins)	152.42 ± 44.08	154.15 ± 51.17	0.666	151.66 ± 43.98	157.57 ± 53.49	0.182
NS, no (%)	97 (20.91%)	24 (12.90%)	0.018	103 (20.12%)	18 (13.04%)	0.058
PLND, no (%)	241 (51.94%)	97 (52.15%)	0.961	267 (52.15%)	71 (51.45%)	0.884
DIC (days)	21.34 ± 11.20	20.51 ± 8.00	0.356	21.37 ± 10.96	20.13 ± 7.83	0.215

Abbreviations: BMI: Body mass index; CHD: Coronary heart disease; CD: Cerebrovascular diseases; DM: Diabetes mellitus; DIC: Duration of indwelling catheter; HP: Hypertension; NS: Nerve sparing; OT: Operation time; PSA: Prostate-specific antigen; PV: Prostate volume; PLND: Pelvic lymph node dissection

Table 4 Comparison of parameters between continence and incontinence patients at 24 and 48 months after operation

Variable	24 Months			48 Months		
	Continence	Incontinence	P value	Continence	Incontinence	P value
Age (years)	63.93 ± 8.48	65.82 ± 7.62	0.016	65.70 ± 7.78	66.16 ± 7.97	0.719
BMI (kg/m^2)	25.16 ± 2.91	24.71 ± 3.05	0.186	25.21 ± 2.89	25.30 ± 2.61	0.832
Comorbidities, no (%)						
HP	138 (36.80%)	27 (28.72%)	0.143	53 (31.93%)	20 (39.22%)	0.335
DM	60 (16.00%)	11 (11.70%)	0.299	25 (15.06%)	13 (25.49%)	0.087
CHD	40 (10.67%)	6 (6.38%)	0.212	21	6 (11.76%)	0.867
CD	11 (2.93%)	4 (4.26%)	0.515	(12.65%) 5 (3.01%)	2 (3.92%)	0.748
PSA (ng/mL)	30.00 ± 34.03	33.77 ± 35.59	0.343	30.57 ± 40.59	35.60 ± 38.12	0.433
PV (mL)	35.97 ± 19.66	34.72 ± 15.95	0.567	34.50 ± 18.85	40.11 ± 20.82	0.071
Gleason score, no (%)			0.336			0.501
≦6	109 (29.07%)	29 (30.85%)		49 (29.52%)	20 (39.22%)	
7	151 (40.27%)	42 (44.68%)		63 (37.95%)	19 (37.25%)	
≧8	103 (27.47%)	18 (19.15%)		47 (28.31%)	11 (21.57%)	
Unknown	12 (3.19%)	5 (5.32%)		7 (4.22%)	1 (1.96%)	
Clinical T stage, no (%)			0.806			0.356
T1a,b	1 (0.27%)	0		0	0	
T1c	68 (18.13%)	15 (15.96%)		32 (19.28%)	8 (15.69%)	
T2a,b	133 (35.47%)	39 (41.49%)		54 (32.53%)	11 (21.57%)	
T2c	152 (40.53%)	34 (36.17%)		70 (42.17%)	29 (56.86%)	
T3a	2 (0.53%)	0		2 (1.20%)	0	
T3b	19 (5.07%)	6 (6.38%)		8 (4.82%)	3 (5.88%)	
OT (mins)	155.19 ± 48.98	146.79 ± 42.32	0.128	154.39 ± 49.88	152.14 ± 53.29	0.782
NS, no (%)	65 (17.33%)	12 (12.77%)	0.285	20 (12.05%)	8 (15.69%)	0.498
PLND, no (%)	204 (54.40%)	52 (55.32%)	0.873	91 (54.82%)	33 (64.71%)	0.212
DIC (days)	21.27 ± 11.21	19.94 ± 5.08	0.260	21.14 ± 12.23	20.20 ± 7.93	0.603

Abbreviations: BMI: Body mass index; CHD: Coronary heart disease; CD: Cerebrovascular diseases; DM: Diabetes mellitus; DIC: Duration of indwelling catheter; HP: Hypertension; NS: Nerve sparing; OT: Operation time; PSA: Prostate-specific antigen; PV: Prostate volume; PLND: Pelvic lymph node dissection

Table 5 Univariable and multivariable regression analysis for predictors of continence one and three months

Predictors	One Month				Three Months			
	Univariable		Multivariable		Univariable		Multivariable	
	OR, 95% CI	P value	OR, 95% CI	P value	OR, 95% CI	P value	OR, 95% CI	P value
Age	1.001, 0.980-1.021	0.959	1.001, 0.979-1.023	0.940	1.019, 0.998-1.041	0.080	1.018, 0.996-1.041	0.113
BMI	1.036, 0.981-1.094	0.209	1.023, 0.963-1.086	0.460	1.001, 0.948-1.057	0.964	0.998, 0.941-1.059	0.947
HP	1.398, 0.998-1.957	0.051	1.376, 0.947-1.999	0.094	1.365, 0.980-1.901	0.066	1.404, 0.978-2.015	0.066
DM	1.138, 0.734-1.764	0.563	0.999, 0.626-1.595	0.998	0.857, 0.550-1.334	0.493	0.748, 0.470-1.190	0.220
CHD	1.529, 0.878-2.665	0.134	1.476, 0.817-2.688	0.197	1.028, 0.605-1.750	0.917	0.885, 0.508-1.542	0.665
CD	0.831, 0.340-2.034	0.685	0.739, 0.289-1.889	0.528	1.582, 0.649-3.856	0.313	1.456, 0.582-3.640	0.422
PSA	1.004, 0.999-1.009	0.114	1.000, 0.995-1.005	0.985	1.003, 0.999-1.008	0.138	1.002, 0.997-1.006	0.501
PV	0.995, 0.987-1.003	0.212	0.994, 0.986-1.002	0.159	0.996, 0.988-1.004	0.348	0.995, 0.987-1.004	0.262
Gleason score	0.929, 0.774-1.116	0.433	0.801, 0.654-0.981	0.332	0.965, 0.802-1.160	0.702	0.926, 0.758-1.131	0.449
Clinical stage	1.060, 0.899-1.250	0.487	1.013, 0.850-1.208	0.883	1.077, 0.913-1.270	0.379	1.071, 0.902-1.273	0.434
OT	1.001, 0.998-1.004	0.551	1.000, 0.996-1.003	0.931	1.002, 0.999-1.006	0.193	1.002, 0.998-1.005	0.281
NS	0.372, 0.248-0.557	0.000	0.360, 0.231-0.561	0.000	0.549, 0.356-0.846	0.007	0.546, 0.342-0.872	0.011
PLND	1.517, 1.018-2.079	0.009	1.535, 1.079-2.184	0.017	1.051, 0.767-1.441	0.757	0.978, 0.690-1.386	0.901
DIC	0.998, 0.983-1.013	0.809	0.999, 0.983-1.014	0.869	0.996, 0.980-1.012	0.602	0.997, 0.981-1.013	0.713

Abbreviations: BMI: Body mass index; CHD: Coronary heart disease; CD: Cerebrovascular diseases; DM: Diabetes mellitus; DIC: Duration of indwelling catheter; HP: Hypertension; NS: Nerve sparing; OT: Operation time; PSA: Prostate-specific antigen; PV: Prostate volume; PLND: Pelvic lymph node dissection

Table 6 Univariable and multivariable regression analysis for predictors of continence six and twelve months

Predictors	Six Months				Twelve Months			
	Univariable		Multivariable		Univariable		Multivariable	
	OR, 95% CI	P value	OR, 95% CI	P value	OR, 95% CI	P value	OR, 95% CI	P value
Age	1.028, 1.005-1.052	0.019	1.026, 1.001-1.051	0.038	1.034, 1.007-1.061	0.012	1.030, 1.002-1.058	0.035
BMI	0.986, 0.929-1.046	0.630	0.993, 0.932-1.058	0.827	0.970, 0.908-1.036	0.362	0.983, 0.916-1.054	0.626
HP	1.206, 0.845-1.723	0.302	1.179, 0.800-1.737	0.404	0.988, 0.663-1.472	0.954	0.937, 0.606-1.448	0.768
DM	0.910, 0.564-1.468	0.698	0.834, 0.506-1.375	0.477	0.915, 0.538-1.556	0.744	0.873, 0.501-1.521	0.632
CHD	1.384, 0.800-2.395	0.246	1.190, 0.672-2.109	0.551	1.423, 0.788-2.571	0.242	1.275, 0.686-2.371	0.443
CD	1.693, 0.681-4.211	0.258	1.583, 0.617-4.064	0.339	2.051, 0.802-5.244	0.134	2.144, 0.806-5.072	0.126
PSA	1.003, 0.998-1.008	0.190	1.001, 0.996-1.006	0.614	1.003, 0.998-1.008	0.227	1.002, 0.996-1.007	0.517
PV	0.995, 0.985-1.004	0.245	0.995, 0.985-1.004	0.288	0.995, 0.985-1.005	0.354	0.995, 0.985-1.006	0.393
Gleason score	0.976, 0.800-1.192	0.815	0.946, 0.764-1.173	0.614	1.017, 0.816-1.267	0.879	0.998, 0.788-1.264	0.989
Clinical stage	0.973, 0.814-1.164	0.767	0.972, 0.807-1.171	0.765	0.996, 0.818-1.214	0.970	0.991, 0.807-1.218	0.932
OT	1.001, 0.997-1.004	0.665	1.001, 0.997-1.005	0.720	1.003, 0.999-1.007	0.182	1.003, 0.999-1.007	0.177
NS	0.561, 0.346-0.909	0.019	0.545, 0.324-0.915	0.022	0.596, 0.347-1.023	0.060	0.609, 0.342-1.086	0.093
PLND	1.008, 0.717-1.418	0.961	0.993, 0.683-1.444	0.971	0.972, 0.668-1.416	0.884	0.914, 0.606-1.380	0.670
DIC	0.991, 0.973-1.010	0.359	0.993, 0.975-1.012	0.474	0.986, 0.964-1.008	0.215	0.988, 0.966-1.011	0.304

Abbreviations: BMI: Body mass index; CHD: Coronary heart disease; CD: Cerebrovascular diseases; DM: Diabetes mellitus; DIC: Duration of indwelling catheter; HP: Hypertension; NS: Nerve sparing; OT: Operation time; PSA: Prostate-specific antigen; PV: Prostate volume; PLND: Pelvic lymph node dissection

Table 7 Univariable and multivariable regression analysis for predictors of continence 24 and 48 months

Predictors	24 Months				48 Months			
	Univariable		Multivariable		Univariable		Multivariable	
	OR, 95% CI	P value	OR, 95% CI	P value	OR, 95% CI	P value	OR, 95% CI	P value
Age	1.970, 1.943-1.998	0.017	1.968, 1.939-1.997	0.038	1.008, 0.967-1.049	0.717	1.009, 0.964-1.057	0.691
BMI	0.949, 0.877-1.026	0.186	0.956, 0.877-1.042	0.310	1.012, 0.906-1.131	0.831	0.999, 0.880-1.136	0.992
HP	0.692, 0.422-1.134	0.144	0.810, 0.474-1.384	0.441	1.376, 0.718-2.635	0.336	1.484, 0.708-3.109	0.296
DM	0.696, 0.350-1.383	0.301	0.779, 0.382-1.589	0.492	1.929, 0.902-4.125	0.090	1.803, 0.803-4.051	0.153
CHD	0.571, 0.235-1.390	0.217	0.642, 0.255-1.617	0.347	0.921, 0.350-2.421	0.867	0.847, 0.293-2.448	0.759
CD	1.471, 0.458-4.726	0.517	1.816, 0.535-6.160	0.339	1.314, 0.247-6.987	0.749	1.003, 0.158-6.389	0.997
PSA	1.003, 0.997-1.009	0.346	1.003, 0.996-1.009	0.419	1.003, 0.996-1.010	0.437	1.002, 0.995-1.010	0.530
PV	0.996, 0.984-1.009	0.567	0.996, 0.983-1.009	0.580	1.014, 0.999-1.029	0.077	1.014, 0.998-1.031	0.093
Gleason score	0.919, 0.699-1.207	0.542	0.892, 0.659-1.208	0.461	0.744, 0.509-1.089	0.128	0.691, 0.452-1.058	0.089
Clinical stage	1.013, 0.802-1.280	0.912	1.054, 0.824-1.348	0.677	1.222, 0.886-1.684	0.221	1.189, 0.835-1.692	0.337
OT	0.996, 0.991-1.001	0.128	0.997, 0.991-1.002	0.210	0.999, 0.993-1.005	0.781	0.998, 0.991-1.005	0.492
NS	0.698, 0.360-1.353	0.287	0.719, 0.352-1.472	0.367	1.358, 0.559-3.299	0.499	1.163, 0.427-3.167	0.767
PLND	1.038, 0.659-1.635	0.873	1.145, 0.690-1.902	0.600	1.511, 0.788-2.896	0.214	1.720, 0.828-3.573	0.146
DIC	0.983, 0.955-1.012	0.257	0.980, 0.949-1.013	0.228	0.991, 0.958-1.026	0.605	0.989, 0.950-1.030	0.604

Abbreviations: BMI: Body mass index; CHD: Coronary heart disease; CD: Cerebrovascular diseases; DM: Diabetes mellitus; DIC: Duration of indwelling catheter; HP: Hypertension; NS: Nerve sparing; OT: Operation time; PSA: Prostate-specific antigen; PV: Prostate volume; PLND: Pelvic lymph node dissection

Figures

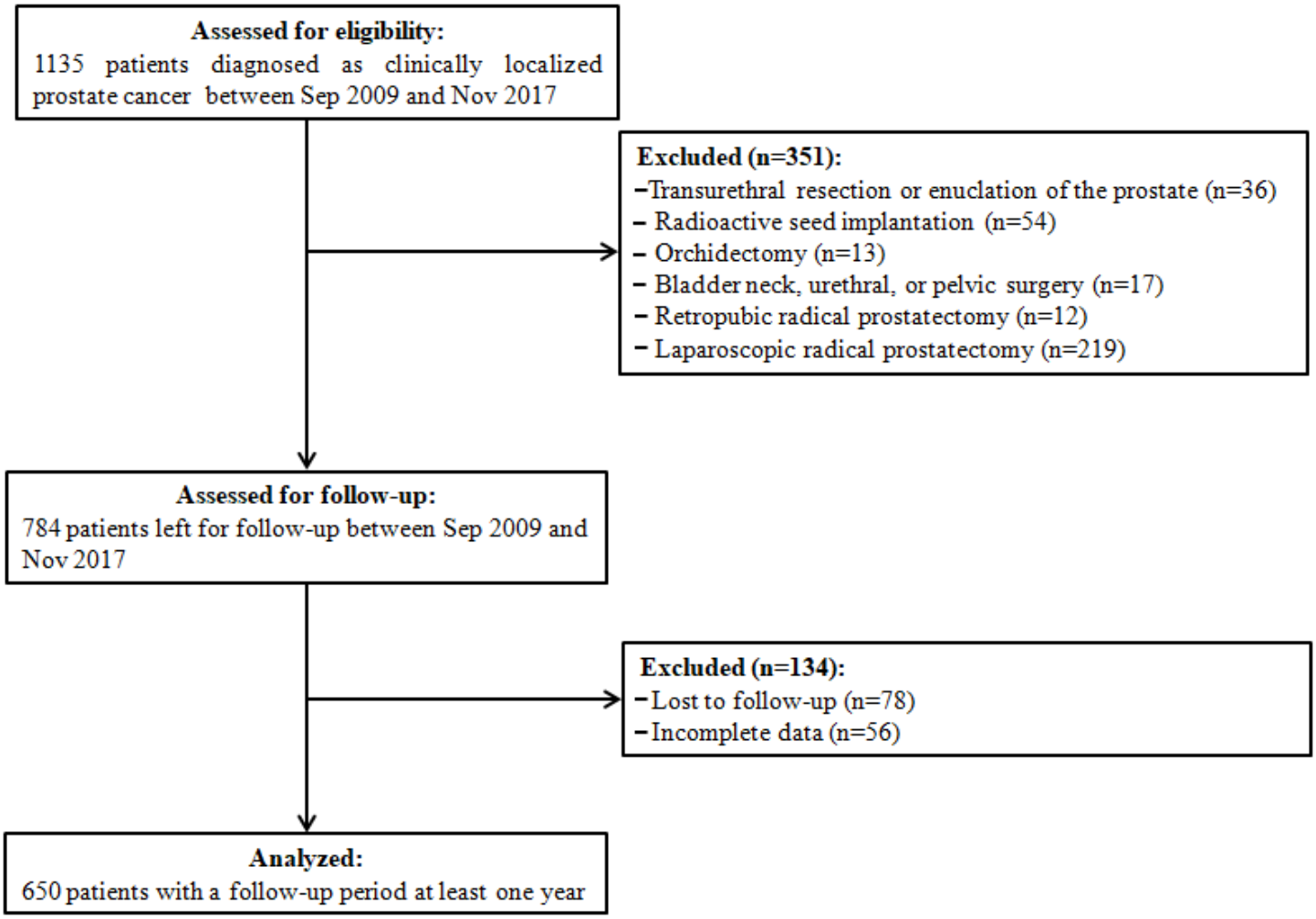

Figure 1

Study flow diagram

Supplementary Files

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- Supplementaryfile.docx