Original Article

The impact of catheter removal time on urinary continence and overactive bladder symptoms after robot-assisted radical prostatectomy: a retrospective analysis of consecutive 432 cases from a single institution

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Background: After radical prostatectomy, the optimal length of postoperative catheterization time remains to be determined. This study investigates the impact of catheter removal time on urinary continence and overactive bladder (OAB) symptoms after robot-assisted radical prostatectomy (RARP).

Methods: Four hundred and thirty-two consecutive patients underwent RARP by a single surgeon between Nov 2020 and Oct 2021. Time to catheter removal was categorized into 7, 10, and ≥14 days. Continence was defined as no more than 1 pad used or no more than 20 g of urine leakage per 24 hours. The patients' continence rates and overactive bladder symptom score (OABSS) were assessed at 48 hours, 1 week, 4, 12, and 24 weeks after catheter removal.

Results: Overall, continence rates were 37.3% 48 hours after catheter removal, 54.4% 1 week, 77.5% 4 weeks, 92.1% 12 weeks, and 97.9% 24 weeks after catheter removal. The median time to regain continence was 1 week. At 4 weeks after catheter removal, the continence rate in the ≥14 days group (70.5%) was significantly lower than the 7 days group (86.3%) and 10 days group (83.0%) (P=0.001). In a univariate Cox regression analysis, the presence of diabetes, higher pre-operative OABSS, and a catheterization time of 10 days were associated with worse continence recovery. The mean OABSS of patients in the continent group were significantly lower than the incontinent group at 48 hours, 4, 12 and 24 weeks after catheter removal. At 24 weeks after catheter removal, the mean OABSS in the 7 days group was significantly lower than in other groups.

Conclusions: Early catheter removal (7 days) was associated with better continence results and lower OABSS at 4 and 24 weeks after catheter removal respectively.

Keywords: Robot-assisted radical prostatectomy (RARP); catheter removal time; urinary continence; overactive bladder symptoms (OAB symptoms)

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Introduction

For patients with localized prostate cancer, robot-assisted radical prostatectomy (RARP) is a reliable treatment option. After radical prostatectomy, the catheter was indwelling for 7 to 14 days to ensure the vesicourethral anastomosis healing, while several studies have reported that removing the catheter within 7 days is also safe and feasible (1-3). There are conflicting data as to whether the length of catheterization time has an impact on urinary continence recovery (4-7). Prolonged catheterization increases the risk of urinary tract infection and may cause patient discomfort (2,8,9), and it has been reported that prolonged catheterization can adversely affect short- and intermediate-term continence recovery (4). However, Patel *et al.* have reported that early removal of the urinary catheter 3 or 4 days after surgery was associated with a significant increase in the incidence of acute urinary retention (10). Therefore, the optimal length of postoperative catheterization remains to be determined.

Post-prostatectomy overactive bladder (OAB) symptoms are common, which may negatively affect continence recovery (11). However, whether early removal of the urinary catheter will result in more pronounced bladder irritation symptoms due to functional changes of the bladder is still unknown.

The present retrospective study was designed to determine whether different catheterization time has an impact on continence recovery. Overactive bladder symptom score (OABSS) was assessed to evaluate the degree of bladder irritation after catheter removal. We present the following article in accordance with the STROBE reporting checklist (available at https://tau.amegroups.com/article/view/10.21037/tau-22-397/rc).

Methods

Patient population

From Nov 2020 to Oct 2021, 474 patients with localized prostate cancer underwent RARP by the same experienced surgeon at the Department of Urology, Peking University First Hospital. Patients who met the enrollment criteria were included. The inclusion criteria were localized prostate cancer (cT1-3, cN0, cM0). Exclusion criteria were as follows: (I) other type of urinary diversion was performed (n=1); (II) incontinence prior to RARP (n=1); (III) patients who were lost to follow-up or died within 6 months after surgery (n=40). The study was conducted in accordance with the Declaration of Helsinki (as revised in 2013). The study was approved by the clinical research ethics committee of Peking University First Hospital (protocol number: 2020[278]), and individual consent for this retrospective analysis was waived.

Surgical methods

All RARP cases were performed using the transabdominal approach. Total periurethral reconstruction was routinely performed in all cases to improve early continence. The vesicourethral anastomosis is performed by using a 3-0 self-locking running suture. For low-risk patients, a neurovascular bundle (NVB) sparing procedure is performed. Bilateral pelvic lymph node dissection was routinely performed in high-risk patients. The pelvic drains were removed when the drainage was less than 200 mL during a 24-hour period.

Catheter removal time

After surgery, all patients were instructed to undergo proper pelvic floor rehabilitation. When patients were scheduled for urinary catheter removal, they were evaluated by a specialized nurse. Cystography was routinely performed to confirm that there was no anastomotic leak. If the cystogram showed evidence of extravasation, the catheter would be retained for at least 14 days. And in some patients requiring extensive bladder neck reconstruction, or with great tension in the urethral anastomosis, the catheter was also recommended to retain for more than 14 days. One patient had previous pelvis radiation history, which might lead to severe scarring around the urethra, and he had an unhealthy appearance of the surrounding tissue during the operation. He had kept the catheter for 3 weeks. If none of the above occurred, we would inform the patient that the catheter can be removed on 7/10/14 days after surgery, and the patient would make an appointment for catheter removal through the online outpatient appointment system. Patients could choose the appointment time at their own willingness.

Follow-up

Self-administered questionnaires were used at different times (48 hours, 1 week, 4, 12, and 24 weeks) after catheter

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Table 1 Clinical characteristics

Patients' characteristics	Overall data (n=432)	Catheterization time (days)			P value
		7 (n=124)	10 (n=88)	≥14 (n=220)	
Age, years	66.5 [62.0–71.0]	66.0 [61.0–71.0]	65.0 [61.3–71.0]	67.0 [62.0–71.0]	0.216
BMI, kg/m^2	24.6 [23.1–26.5]	24.9 [23.1–27.4]	24.7 [23.1–26.4]	24.5 [23.0–26.2]	0.198
PSA, ng/mL	9.20 [5.10–15.58]	9.52 [5.04–16.13]	8.62 [4.07–14.59]	9.20 [5.29–15.68]	0.467
Pre-operative IPSS	7 [3–14]	5 [2–13]	6 [3–12]	8 [3–15]	0.279
Pre-operative OABSS	3 [2–4]	3 [1–4]	3 [1–4]	3 [2–5]	0.503
Prostate volume, mL	35.0 [24.2–48.2]	34.7 [24.0–46.5]	34.6 [24.0–44.1]	35.0 [24.1–50.2]	0.451

Data are presented as median [IQR]. BMI, body mass index; PSA, prostate specific antigen; IPSS, International Prostate Symptom Score; OABSS, overactive bladder symptom score; IQR, interquartile range.

removal, including the number of pads used per 24 hours and OABSS. The patients were also instructed to perform the 24-hour pad weight test to accurately record the severity of incontinence. Continence was defined as no more than 1 pad used or no more than 20 g of urine leakage per 24 hours.

Statistical analysis

All continuous variables were presented as the median and interquartile range (IQR), and the frequencies and proportions were reported as percentages. The Student's *t*-test and Mann-Whitney U test were used to assess quantitative parametric and nonparametric variables, respectively. The chi-square test was used to assess differences in distributions between categorical parameters. All reported P values were obtained using the two-sided exact method at the conventional 5% significance level or less than 0.05. The patients' continence rates were assessed at 48 hours, 1 week, 4, 12, and 24 weeks after catheter removal. Kaplan-Meier curves were used to determine the incontinence probability among the patients. Variables associated with continence recovery were analyzed using the Cox proportional hazards model, adjusted for age, body mass index (BMI), prostate volume, pre-operative International Prostate Symptom Score (IPSS), pre-operative OABSS, prostate specific antigen (PSA), diabetes mellitus, NVB preservation, margin status. All analyses were performed using IBM® SPSS® Statistics Version 23.0 (International Business Machines Corporation, New York, USA).

Results

Clinical and pathological data

A total of 432 patients were enrolled in this study. Clinical information of the patient population is detailed in *Table 1*, stratified by catheterization time. The median age was 66.5 years (IQR, 62.0–71.0) and the median PSA level was 9.20 ng/mL (IQR, 5.10–15.58).

Of all patients enrolled, a total of 107 had bilateral lymph node dissection (24.8%), and 68 had NVB sparing surgery (15.7%). Postoperative pathology information is detailed in *Table 2*. One hundred and six patients had positive margins (24.5%). Among all patients who underwent lymph node dissection, lymph node metastasis was found in 10 cases (2.3%).

Continence outcomes

Overall, continence rates were 37.3% 48 hours after catheter removal, 54.4% 1 week, 77.5% 4 weeks, 92.1% 12 weeks, and 97.9% 24 weeks after catheter removal (*Figure 1*). The median time to regain continence was 1 week. No cases of acute urinary retention occurred. The number of safety pads used per 24 hours and the 24-hour pad weight at different times after catheter removal are detailed in *Table 3*. At 4 weeks after catheter removal, the continence rate in the ≥14 days group (70.5%) was significantly lower than the 7 days group (86.3%) and 10 days group (83.0%) (P=0.001) (*Figure 2*). Continence rates at different times are detailed in *Table 4*.

Kaplan-Meier curves were used to demonstrate

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Table 2 Patients' histopathological data

Pathological findings	Overall data (n=432)	Catheterization time (days)			P value
		7 (n=124)	10 (n=88)	≥14 (n=220)	
Positive margins, n (%)	106 (24.5)	40 (32.3)	18 (20.5)	48 (21.8)	0.061
Stage, n (%)					
≤pT2	172 (39.8)	45 (36.3)	40 (45.5)	87 (39.5)	0.417
≥pT3	232 (53.7)	72 (58.1)	41 (46.6)	119 (54.1)	
Unable to stage	28 (6.5)	7 (5.6)	7 (8.0)	14 (6.4)	
Gleason score, n (%)					
6	19 (4.4)	2 (1.6)	3 (3.4)	14 (6.4)	0.580
7	248 (57.4)	76 (61.3)	53 (60.2)	119 (54.1)	
8–10	124 (28.7)	35 (28.2)	22 (25.0)	67 (30.5)	
Unclassified	41 (9.5)	11 (8.9)	10 (11.4)	20 (9.1)	

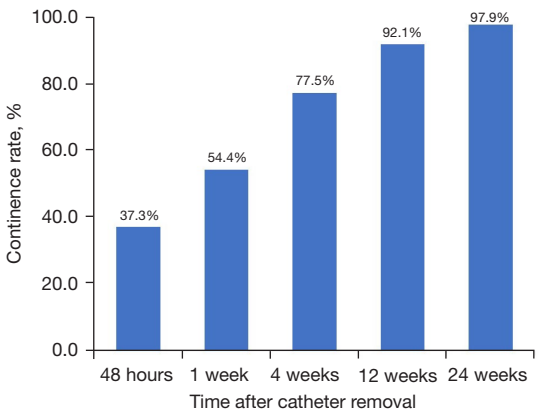

Figure 1 Continence rates at different times after catheter removal.

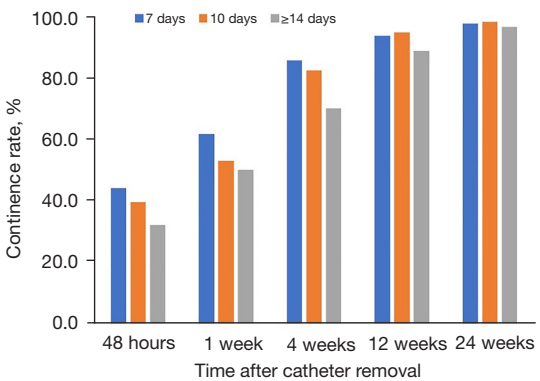

Figure 2 Continence rates at different times stratified by catheterization time.

Table 3 Number of safety pads and 24-h pad weight per day

Time after catheter removal	24-h pad weight, g/day, median [Q_1–Q_3]	Number of safety pads, n/day, median [Q_1–Q_3]
48 hours	70 [4–445]	2 [1–4]
1 week	20 [0–200]	1 [1–3]
4 weeks	10 [0–50]	1 [0–2]
12 weeks	0 [0–10]	0 [0–1]
24 weeks	0 [0–5]	0 [0–1]

Q_1, first quartile; Q_3, third quartile.

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Table 4 Continence rates at different times stratified by catheterization time

Time after catheter removal	Overall	Catheterization time (days)			P value
		7	10	≥14	
48 hours	37.3%	44.4%	39.8%	32.3%	0.073
1 week	54.4%	62.1%	53.4%	50.5%	0.112
4 weeks	77.5%	86.3%	83.0%	70.5%	0.001*
12 weeks	92.1%	94.4%	95.5%	89.5%	0.122
24 weeks	97.9%	98.4%	98.9%	97.3%	0.616

*, with statistical significance.

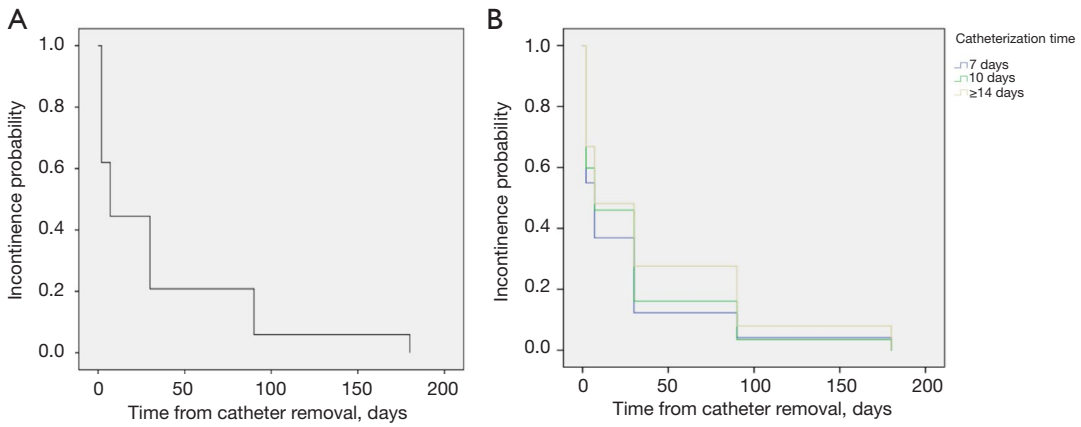

Figure 3 Kaplan-Meier curves of incontinence probability after catheter removal. (A) Kaplan-Meier curves of incontinence probability in all patients. (B) Kaplan-Meier curves of incontinence stratified by different catheterization times.

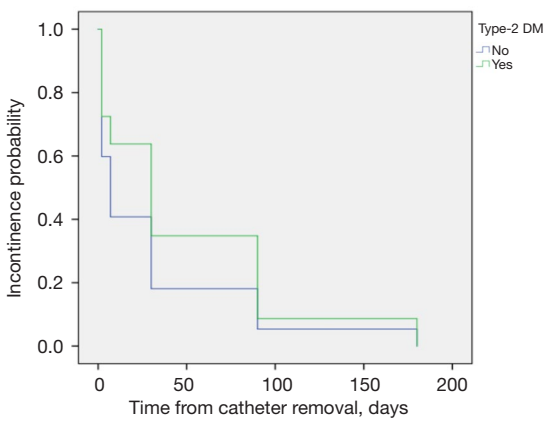

Figure 4 Impact of diabetes on incontinence probability. DM, diabetes mellitus.

incontinence probability stratified by different catheterization times (*Figure 3A*,*3B*). In a univariate Cox regression analysis, the presence of diabetes [odds ratio (OR) =1.330; 95% confidence interval (CI): 1.027–1.723; P=0.031], pre-operative OABSS (OR =0.959; 95% CI: 0.922–0.998; P=0.041), and a catheterization time of 10 days (OR =1.285; 95% CI: 1.027–1.608; P=0.028) were associated with continence recovery (*Figure 4*, *Table 5*). However, only the presence of diabetes (OR =1.302; 95% CI: 1.000–1.696; P=0.050) was borderline significant in multivariate Cox regression analysis (*Table 6*). Patients' age, BMI, pre-operative prostate volume, pre-operative PSA, pre-operative IPSS, pre-operative OABSS, NVB preservation, lymph node dissection, and margin status

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Table 5 Univariate Cox regression, risk factors for continence recovery

Variable	P value	OR (95% CI)
Age, years	0.079	0.987 (0.973–1.002)
BMI, kg/m^2	0.621	0.992 (0.962–1.024)
Diabetes	0.031*	1.330 (1.027–1.723)
Prostate volume, mL	0.675	0.999 (0.994–1.004)
PSA, ng/mL	0.357	0.997 (0.990–1.003)
NVB preservation	0.327	0.877 (0.674–1.141)
Lymph node dissection	0.444	1.097 (0.866–1.389)
Pre-operative IPSS	0.637	0.997 (0.984–1.010)
Pre-operative OABSS	0.041*	0.959 (0.922–0.998)
Catheterization time		
7 days	0.077	Reference
10 days	0.028*	1.285 (1.027–1.608)
≥14 days	0.215	1.172 (0.912–1.505)

*, with statistical significance. OR, odds ratio; CI, confidence interval; BMI, body mass index; PSA, prostate specific antigen; NVB, neurovascular bundle; IPSS, International Prostate Symptom Score; OABSS, overactive bladder symptom score.

Table 6 Multivariate Cox regression, risk factors for continence recovery

Variable	P value	OR (95% CI)
Diabetes	0.050	1.302 (1.000–1.696)
Pre-operative OABSS	0.051	0.961 (0.924–1.000)
Catheterization time		
7 days	0.143	Reference
10 days	0.057	1.247 (0.994–1.565)
≥14 days	0.262	1.159 (0.895–1.501)

OR, odds ratio; CI, confidence interval; OABSS, overactive bladder symptom score.

were not associated with continence recovery. The results are detailed in *Table 5*.

OAB symptoms and continence recovery

The results showed that the mean OABSS of patients in the continent group were significantly lower than the incontinent group at 48 hours, 4, 12 and 24 weeks after catheter removal (*Table 7*). At 24 weeks after catheter removal, the mean OABSS in the 7 days group was significantly lower than in other groups. The results are shown in *Table 8*.

Discussion

The "*Trifecta*" of radical prostatectomy is cancer control, preservation of erectile function, and urinary continence (12). Although there have been technological advances in recent years, incontinence remains a major complication after radical prostatectomy. The incidence of urinary incontinence ranges from 4% to 31% at 12 months postoperatively, with an average of 16% (13). Postoperative incontinence affects patients' quality of life and reduces their postoperative satisfaction (14). After radical prostatectomy, the catheter was indwelling for 7 to 14 days to ensure the vesicourethral anastomosis healing. There is no objective evidence regarding the catheter indwelling time after radical prostatectomy, and in most centers, catheterization time was based on individual surgeons' decisions as well as individual patients' factors. The need for more prolonged catheterization is based on the perceived advantage of catheterization in preventing urine extravasation, minimizing scar formation, and potentially improving continence. However, there is currently no evidence to support the use of indwelling catheters for prolonged periods. There are conflicting data as to whether the length of catheterization time has an impact on urinary continence recovery. Some studies demonstrated that early catheter removal was associated with a significantly higher continence rate after radical prostatectomy (3,6). Tilki *et al.* had reported that longer catheterization was associated with worse short- and intermediate-term continence but had no adverse impact on long-term continence (4). However, Matsushima *et al.* demonstrated that early catheter removal on postoperative day 2 after laparoscopy radical prostatectomy might increase the risk of incontinence in a randomized controlled trial of 113 cases (7). At the same time, early removal of the indwelling catheter on postoperative day 3 or 4 might increase the risk of urinary retention and extravasation (10,15). In cases of anastomosis leakage, catheter removal may then be deferred to allow further healing of the anastomosis. Delayed removal of the catheter, on the other hand, has the potential to aggravate urinary tract infections while increasing patient discomfort (2,8). It is also suspected that prolonged catheterization may lead to mechanical damage and inflammation of

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Table 7 Mean OABSS at different times after catheter removal according continency

Time after catheter removal	OABSS (mean)		P value
	Continent	Incontinent	
48 hours	5.71	6.71	0.026*
1 week	5.51	6.39	0.073
4 weeks	4.43	6.63	<0.001*
12 weeks	3.73	6.56	<0.001*
24 weeks	2.94	6.89	0.027*

*, with statistical significance. OABSS, overactive bladder symptom score.

Table 8 Mean OABSS at different times after catheter removal stratified by catheterization time

Time after catheter removal	Catheterization time (days)			P value
	7	10	≥14	
48 hours	5.75	6.55	6.59	0.145
1 week	5.77	5.99	5.96	0.641
4 weeks	4.66	5.05	5.02	0.554
12 weeks	3.58	4.14	4.09	0.092
24 weeks	1.66	3.21	3.73	<0.001*

*, with statistical significance. OABSS, overactive bladder symptom score.

the urethral and bladder mucosa, which may adversely affect continence outcomes and causing bladder irritation symptoms. Therefore, the optimal length of postoperative catheterization time remains to be determined.

Robotic surgery has greatly reduced the technical difficulty of radical prostatectomy (16). With the advancement of robotic surgery and the use of total anatomical reconstruction, the quality of vesicourethral anastomosis has gained significant improvement, resulting in better recovery of early urinary continence (17). In the era of open surgery, urologists prefer to keep the catheter for a more prolonged period. With the advancement of robotic technique, earlier removal of the catheter is tried in order to improve continence recovery and the quality of life.

At the same time, post-prostatectomy OAB symptoms are common. The prevalence of OAB after radical prostatectomy ranges from 15.2% to 37.8% and may adversely affect continence recovery (11). Recent studies have highlighted the role of the urethra-genic mechanism in the genesis of post-prostatectomy OAB symptoms (18-20). There is currently no data on how postoperative management may prevent post-prostatectomy OAB. Whether early removal of the urinary catheter will result in less pronounced OAB symptoms is not clear.

Our present study was designed to compare the impact of catheter removal on urinary continence outcomes and OAB symptoms. Favorable continence results were reported for patients undergoing RARP with overall 3- and 6-month continence rates of 92.1% and 97.9%. The results showed that removal of the catheter at different times had no significant effect on the patients' early continence (48 hours, 1 week), and long-term continence (24 weeks). But early catheter removal (7 days) was associated with better mid-term continence (4 weeks). Therefore, early removal of the catheter can be attempted to reduce complications associated with prolonged catheterization, provided that there is no urine extravasation.

The question of whether early removal of the catheter exacerbates bladder irritation symptoms in patients was also explored in this study. We measured OABSS at different times after catheter removal. The results showed that the mean OABSS of patients in the continent group was significantly lower than the incontinent group at 48 hours, 4, 12 and 24 weeks after catheter removal, which implies

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that OAB symptoms adversely impact continence recovery. This result suggests that, in addition to anatomical factors, functional changes in the bladder may also be related to the occurrence of postoperative incontinence and merits further exploration. In the present study, the results showed that at 24 weeks after catheter removal, the mean OABSS in the 7 days group was significantly lower than in other groups, suggesting that early removal of the catheter might lead to less pronounced OAB symptoms. To the best of our knowledge, our retrospective study is the first to identify a relationship between the catheterization time and OAB symptoms.

In the present study, the presence of diabetes significantly affected continence recovery. Diabetes seems to be a significant disadvantage in gaining urinary continence compared with nondiabetic patients. Our results collaborate with those described in the recent literature (21,22). Diabetes is a systemic disease that can have multiple system involvement, and local recovery of nerve and muscle function after radical prostatectomy may be affected by diabetes. Therefore, diabetic patients should be informed about possible late recovery of postoperative urinary continence compared with nondiabetic patients after RARP.

Various surgical techniques are thought to impact urinary continence recovery in patients undergoing RARP (23). When evaluating early continence after radical prostatectomy, details regarding nerve sparing, bladder neck sparing, and bladder neck reconstruction is important. A systematic review by Reeves *et al.* showed that preservation of the NVBs is associated with improved time to continence after radical prostatectomy but not long-term continence rates (24). In our study, a NVB sparing procedure was performed for low-risk patients. However, due to the predominance of middle-high risk patients in the enrolled group, the percentage of nerve-sparing was only 15.7%. And in the univariate analysis, nerve-sparing did not influence continence recovery in this study (OR =0.877; 95% CI: 0.674–1.141). A recent study by Sood *et al.* showed that bladder neck preservation is the most important and probably the only factor responsible for early continence (25). With regard to bladder neck preservation, we did not intentionally perform bladder neck preservation during the procedure, and therefore, it was not included in the analysis. Furthermore, according to Porpiglia *et al.*, performing total periurethral reconstruction improves early urinary control outcomes (17), and therefore, in our study, a total periurethral reconstruction was routinely performed in all patients.

The present study also has certain limitations. First, this study is a retrospective design with some inherent selection bias. Also, the sample size of this study was relatively small and, the number of cases between each catheterization group was not well matched. The number of patients who had their catheters removed ≥14 days was higher than in the 7- and 10-day groups. In addition, all RARP procedures were performed by an experienced high-volume surgeon in a single center. Therefore, our results might not be directly transferable to other centers. However, to the best of our knowledge, our study is not only one of the limited studies evaluating the impact of catheterization time on continence outcomes but also one of the few that focused especially on the impact of catheterization on OAB symptoms.

In conclusion, our study demonstrated that early catheter removal (7 days) was associated with better continence results at 4 weeks after catheter removal and lower OABSS at 24 weeks. The patients with better continence recovery had lower OABSS.

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Footnote

Reporting Checklist: The authors have completed the STROBE reporting checklist. Available at https://tau.amegroups.com/article/view/10.21037/tau-22-397/rc

Data Sharing Statement: Available at https://tau.amegroups.com/article/view/10.21037/tau-22-397/dss

Peer Review File: Available at https://tau.amegroups.com/article/view/10.21037/tau-22-397/prf

Conflicts of Interest: All authors have completed the ICMJE uniform disclosure form (available at https://tau.amegroups.com/article/view/10.21037/tau-22-397/coif). The authors have no conflicts of interest to declare.

Ethical Statement: The authors are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. The study was conducted in accordance with the Declaration of Helsinki (as revised in 2013). The study was approved by the clinical research ethics committee of Peking University First

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Hospital (protocol number: 2020[278]) and individual consent for this retrospective analysis was waived.

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