Perioperative predictors for post-prostatectomy urinary incontinence in prostate cancer patients following robotic-assisted radical prostatectomy: Long-term results of a Canadian prospective cohort

Emad Rajih[1]; Malek Meskawi[2]; Abdullah M. Alenizi[2]; Kevin C. Zorn[2]; Mansour Alnazari[2]; Marc Zanaty[2]; Naif Alhathal[2]; Assaad El-Hakim[2]
[1]Department of Urology, College of medicine, Taibah University, Madinah, Saudi Arabia; [2] Department of Surgery, Division of Robotic Urology, Hôpital du Sacré-Cœur de Montréal, University of Montreal, Montreal, QC, Canada

Cite as: *Can Urol Assoc J* 2018 October 15; Epub ahead of print.
http://dx.doi.org/10.5489/cuaj.5356

Published online October 15, 2018

***

Abstract

Introduction: We aimed to report the impact of perioperative factors that have not been well-studied on continence recovery following robotic-assisted radical prostatectomy (RARP).
Methods: We analyzed data of 322 men with localized prostate cancer who underwent RARP between October 2006 and May 2015 in a single Canadian centre. All patients were assessed at one, three, six, 12, and 24 months after surgery. We evaluated risk factors for post-prostatectomy urinary incontinence from a prospectively collected database in multivariate Cox regression analysis. The primary endpoint was continence, defined as 0-pad usage per day.
Results: 0-pad continence rates were 126/322 (39%), 187/321 (58%), 222/312 (71%), 238/294 (80%), and 233/257 (91%) at one, three, six, 12, and 24 months, respectively. Bladder neck preservation (hazard ratio [HR] 0.71; 95% confidence interval [CI] 0.5–0.99; p=0.04), and prostate size (HR 0.99; 95% CI 0.98–0.99; p=0.02) were independent predictors of continence recovery after RARP. Smoking at time of surgery predicted delayed continence recovery on multivariate analysis (HR 1.42; 95% CI 1.01–1.99; p=0.04). Neurovascular bundles preservation was associated with continence recovery after 24 months. No statistically significant correlation was found with other variables, such as age, body mass index, Charlson comorbidity index, preoperative oncological baseline parameters, presence of median lobe, or thermal energy use.
Conclusions: Our results confirmed known predictors of post-prostatectomy incontinence (PPI), namely bladder neck resection and large prostate volume. Noteworthy, cigarette smoking at the time of RARP was found to be a possible independent risk factor for PPI. This study is hypothesis-generating.

Introduction

Robotic surgery in organ confined prostate cancer has rapidly evolved since 2002 and achieved worldwide acceptance.[1,2] Alongside oncological results, quality of life outcomes are of major concern to patients after robotic-assisted radical prostatectomy (RARP).[2] Several studies and systematic meta-analyses have examined the impact of various preoperative and intraoperative technical variables on post prostatectomy incontinence (PPI) recovery after RARP.[3-5] Reported predictive variables for continence recovery include age, surgeon experience and hospital volume, prostate size, neurovascular bundles (NVBs) preservation, preoperative erectile function, cancer characteristics, and preoperative urinary function.[3,4,6-8] Herein, we sought to examine the impact of preoperative variables and potential intraoperative variables that may affect continence recovery post RARP, within a large Canadian cohort. Explicitly in the current report, we focused on the effect of current active smoking status and bladder neck preservation on urinary continence recovery after RARP.

Methods

Study population

After institutional review board approval, data were analyzed retrospectively from our prospectively collected database. The study included all consecutive 322 patients with organ confined prostate cancer who underwent RARP from October 2006 to May 2015 by a single surgeon (AEH) at Hôpital du Sacré Cœur de Montréal. Patients were not preselected; any patient who was a surgical candidate was offered RARP. All men were followed at 1, 3, 6, 9, 12 months, and then every 6 months for 5 years, and yearly thereafter, by the same surgeon.

Data collection

Patient demographics and baseline parameters were collected, including age, prostate volume, prostate specific antigen (PSA), Gleason score, and pathological stage. Detailed intra-operative data were recorded on a standardized abstraction sheet simultaneously during surgery. Postoperatively pads number were collected at each visit and recorded prospectively in the database.

Definition of continence

The primary endpoint of the study was time to continence defined as 0-pad. Continence was assessed by a modified question added to the usual international prostate symptom index score: *"How many pads per 24 hours on average did you use in the past month for urinary incontinence: 0, 1 security liner, 1 pad, 2 pads, 3 pads, 4 pads or more"*. We used a strict definition of PPI whereby patients were considered incontinent if they reported the use of a security liner or any number of pads per day.

*Covariates*Age at surgery, PSA, and prostate size were coded as continuous variables. Pathological stage was categorized into 4 groups: T2a-b, T2c, T3a, and T3b-T4, using TNM 7th edition classification system. Pathological Gleason grade was categorized into 4 groups: ≤6, 3+4, 4+3, and 8-10. Body mass index (BMI), Charlson comorbidity index (CCI), year of surgery, operative time, current smoking status at the time of RARP, presence of median lobe, perineal pressure during anastomosis (which is a surrogate for difficult pelvic anatomy; narrow and deep), thermal energy use during NVB dissection, BN sparing, and NVB preservation were also included.

Surgical technique
All cases were performed using our previously reported RARP surgical technique.[9] Bladder neck (BN) preservation was defined as tight BN dissection that allowed minimal but sufficient visualization of the bladder interior mucosa and ureteral orifices, with preservation of circular BN fibers. BN preservation was performed whenever feasible based on preoperative oncological characteristics and intraoperative anatomy. NVBs preservation was performed when oncologically appropriate even in patients with documented erectile dysfunction. A risk-stratified graded approach to nerve sparing was used similar to the Pasadena consensus.[10] Pedicle control was performed with Hem-o-lok® clips, and minimal or no thermal energy around the NVBs. Maximal urethral stump length preservation was attempted in all cases. Bi-directional continuous anastomotic suture was used with mucosa-to-mucosa apposition. All men had single running anastomotic layer without a separate posterior or anterior reconstruction. All anastomoses were tested with 120-180 ml of normal saline to rule out leak prior to case completion. A 20 Fr silicone urethral catheter was inserted with removal on postoperative day 7 without cystogram.

Statistical analyses
Descriptive statistics were used to report patients' baseline characteristics and proportions of different risk factors. The Mann-Whitney test and chi-square test were used to compare differences in medians and proportions, respectively. Multivariate Cox logistic regression analysis was performed to examine the association between status of urinary continence and the factors described above. All statistical tests were performed using R software environment for statistical computing and graphics (Vienna, Austria, version 3.0.1). All tests were 2-sided with a significance level set at $p<0.05$.

Results
Baseline clinical and pathological characteristics (n=322) are summarized in Table 1. Overall continence recovery rates (0-pad) were 39.1% (126/322), 58.2% (187/321), 71.1% (222/312), 80.9% (238/294), and 90.7% (233/257) at 1, 3, 6, 12, and 24 months, respectively. Mean follow-up ± standard deviation (SD) was 49 ± 25 months, and 80% of men had ≥24-months follow-up.

Within our cohort 44 (13.7%) and 90 (27.9%) patients were active smokers and ex-smokers, respectively. Among the ex-smokers, 81.1% of patients withheld smoking more than 10 years prior to surgery. Median lobe was present in 45 (13.9%) patients. BN sparing was performed in 245 (76%) and 18 (5.6%) patients required BN reconstruction, either with separate interrupted stitches laterally at 3 and 9 o'clock position or with continuous anterior running suture. Nerve sparing was performed in 285 (88.5%) patients; unilaterally in 85 (26.4%) and bilateral in 200 (62.1%) patients. Thermal energy use around NVBs was reported in 99 (30.7%) patients. Perineal pressure during anastomosis was required in 27 (8.3%) patients. There was one anastomotic stricture treated with direct vision internal urethrotomy, and one self-contained urine leak managed with prolonged Jackson-Pratt drainage for 1 week. No patient in this cohort had surgical intervention for PPI.

Baseline patients' characteristics stratified according to current smoking and bladder neck status are shown in table 2. There were no significant differences between active smokers and non-smokers (ex-smokers and never smokers). BN preservation was observed in group of patients with smaller prostate size and healthier patients.

Studied risk factors are presented in table 3 and figure 1. On univariable analysis, active smoking was significantly associated with PPI at 6 months after surgery. Additionally, BN preservation and prostate size were predictors of continence recovery during the first year after surgery. NVB status was significant at 24 months (Table 3). Multivariable Cox-regression analysis after controlling for potential confounders is shown in table 4.

Discussion

Continence recovery is a major concern in patients treated with RARP for clinically localized prostate cancer.[11] In general, urinary continence following prostatectomy is multifactorial in origin. Several perioperative risk factors have been studied extensively.[12] More specifically, pelvic floor integrity, including neural and vascular integrity, seems to play a crucial role for urinary function recovery.[13] Reeves and associates reported the incidence of urinary function improvement in nerve sparing prostatectomy in a large meta-analysis.[4] Overall, 42.2%, 64.8%, 88.9%, and 83,9% of patients with NVB preservation were continent at 6 weeks, 3 months, 6 months, and 12 months, respectively. Our overall continence rates are in keeping with those results, considering that 88.5% of patients had either unilateral or bilateral nerve sparing.

Identifying perioperative predictors of delayed functional recovery allows appropriate counseling and implementation of rehabilitation programs to hasten recovery. Traditionally recognized risk factors do not discriminate sufficiently between patients; therefore, any additional independent new predictive factor will contribute for better prognostication and personalize patients' care. In our cohort, we documented three independent prognostic risk factors responsible for delayed continence recovery including current cigarette smoking [HR 1.42 (CI 95% 1.01-1.88, p=0.04)], BN resection [HR 1.41 (CI 95% 1.01-1.96, p=0.04)], and larger prostate size [HR 0.99 (CI 95% 0.98-0.99, p=0.02)] at different intervals post-RARP, up to 24-months. We further studied other potential operation-specific factors such as thermal energy uses around NVB, and perineal pressure during vesico-urethral anastomosis. None of the latter demonstrated statistically significant relation.

With regards to smoking, there is paucity of data on its role in post prostatectomy incontinence. To our knowledge, our study is the first to report negative effect of active smoking on continence recovery in RARP patients. Mao et al. studied 3-months continence recovery in 446 patients who underwent open radical prostatectomy in a recent retrospective cohort. In their study, age, preoperative pelvic floor muscle exercise, and BMI were predictors of continence recovery, but smoking was not.[14] Similarly, Wille et al. a decade ago, did not show a significant role for smoking on continence recovery in univariate analysis after open radical prostatectomy in a cohort of 742 patients.[12]

The absence of tactile feedback made BN dissection a more challenging step during RARP. It has been reported that operation time for all steps of the surgery decreased quickly after 12-50 cases, but BN dissection and NVB preservation showed the slowest decrease.[15] Freine and coworkers demonstrated the value of BN sparing on continence recovery 4 months after RARP.[16] In their cohort, they studied 619 patients who underwent RARP in a prospectively collected database and they compared BN sparing with standard technique. Continence recovery at 4, 12, and 24 months were 65.6% versus 26.5% ($p<0.001$), 86.4% versus 81.4% ($p=0.303$), and 100% versus 96.1% ($p=0.308$), respectively. Gacci et al. conducted a multicenter prospective study on 1972 patients who underwent radical prostatectomy (including open retropubic, perineal, laparoscopic and robotic approaches).[17] In a multivariate analysis, they showed significant effect of BN sparing on continence recovery at 1 month after surgery ($p=0.003$). Also, a randomized controlled single blind study was reported by Nyarangi-Dix et al. showing the significant effect of BN sparing, without compromising the oncological outcome at 0, 3, 6, and 12 months ($p <0.001$).[18] In fact, our results showed superior improvement in continence recovery in BN sparing up to 12 months after surgery on multivariate analysis with a strict definition of continence. However, the presence of median lobe did not correlate with delayed continence recovery in our study. Similarly, Jenkins et al. noted that median lobe had no effect on continence recovery after RARP in a cohort of 345 patients.[19] The effect of prostate size on urinary continence post RARP is mixed according to available studies. In a retrospective study by Skolarus et al., recovery of continence in larger prostates (> 100g) was delayed compared to patients with smaller prostates (< 50 g); the 3 months' continence rate after RARP was 44.0% compared to 62.2%, respectively ($p=0.03$). The latter results were limited by low number of large prostates and short follow-up.[8] Interestingly, in our cohort, the cut-off for prostate size that was found to correlate with delayed continence recovery was 47 grams; which is in keeping with previous reports. In another retrospective analysis of a large cohort by the group of Patel VR, the 1-year continence rate in 280 patients with prostate weight of ≥80 g was 85.8% compared to 95.1% in 2447 controls but was not statistically different. However, time to continence (SD) was delayed to 3.3±4.4 months compared to 2.4±3.2 months ($P < 0.001$).[20] On the other hand, Link BA et al. retrospectively analyzed 1,847 patients who underwent RARP and subdivided them into 4 groups; prostate size < 30 g, 30-50g, 50-70g, and >70g or greater. One-year continence rates were not statistically different across all groups.[21] In another retrospective study by

Labanaris et al. from a high-volume center in Germany, 85 men had a pathologic prostate specimen weight ≥100g. A matched pairs analysis was performed using a 4000-case RARP database to identify men with a pathologic prostate specimen weight ≤50 g. Patients with larger glands had no difference regarding continence rates when compared to patients with smaller glands but exhibited significantly lower potency rates. The authors concluded that these results may not be generalized to a lower volume center.[22] All the aforementioned studies considered various cutoffs for prostate volume grouping, in a categorical manner. In multivariate analysis we used prostate volume as a continuous variable. Our results showed that prostate volume is an independent predictor of continence recovery, albeit the effect was small [HR 0.99 (CI 95% 0.98-0.99, p=0.02)]. In further sub-analysis, we found that large prostate size and bladder neck resection are two closely related variables and they act as confounders for each other, but each can delay continence recovery as an independent predictor in a multivariate analysis.

Older age is a commonly reported risk factor for urinary incontinence post prostatectomy. Different studies described the increasingly risk of urinary incontinence following radical prostatectomy with older age. On the other hand, other studies showed that aging was not associated with delayed continence recovery.[23] In our study, the majority of patient were young, with a mean age of 60 years, and narrowly distributed with an interquartile range of 56-66 years. Therefore, age was not found to be an independent predictor.

Future perspectives should include special investigations such as urodynamic studies to better understand the pathophysiology PPI in active smokers undergoing RARP. Those investigations may differentiate whether the mechanism behind this particular type of incontinence is at the level of the bladder wall, sphincter level, pelvic support system, or a combination of the above. Further studies are also needed to assess if smoking cessation for a certain period before the intervention would mitigate the detrimental effect. In general, better understanding of risk factors may improve counseling and help patients prepare, cope, and work harder to recuperate functional outcomes. Implementation of pre- and post-operative rehabilitation strategies may be particular benefit in patients at risk. Our study is complementary to existing literature. It has examined new variables over a longer follow up. However, it is not without limitations. This is a single center, single surgeon observational study, with a retrospective analysis of albeit prospectively collected data. The sample size under investigation is small and the case load per year is limited by scarce resources in Canadian public health system. Continence was assessed by non-validated questionnaire, although definition used (0-pad) is commonplace. PPI was not further characterized (urge versus stress) with urodynamic studies and no pad-weight was noted. We also did not record the use of overactive bladder medications. Furthermore, we could not calculate a dose effect of smoking on PPI due to missing data on the amount of smoking per patient. Lastly, the definition of some intraoperative variables was inherently subjective, including BN sparing and extent of NVBs preservation. In an effort to minimize inconsistency, the lead investigator recorded all intraoperative variables on an established data collection sheet in real-time manner prospectively.

Conclusion

The association between active smoking and postoperative urinary incontinence has not been well documented following RARP. Our results demonstrate that smoking might be an independent risk factor for delayed continence recovery after RARP. Active smokers who have other risk factors for delayed continence recovery such as large prostate glands and non-bladder neck sparing should be counseled about the increased risk of urinary incontinence postoperatively. Other studies are required to further investigate the pathophysiological mechanisms involved in post prostatectomy urinary incontinence in relation with smoking.

References

1- Novara G, Ficarra V, Rosen RC, et al. Systematic review and meta-analysis of perioperative outcomes and complications after robot-assisted radical prostatectomy. *Eur Urol* 2012;62:405-17.
2- Allan C, Ilic D. Laparoscopic versus Robotic-Assisted Radical Prostatectomy for the Treatment of Localised Prostate Cancer: A Systematic Review. *Urol Int* 2015;96:373-78.
3- Ficarra V, Novara G, Rosen RC, et al. Systematic review and meta-analysis of studies reporting urinary continence recovery after robot-assisted radical prostatectomy. *Eur Urol* 2012;62:405-17.
4- Reeves F, Preece P, Kapoor J, et al. Preservation of neurovascular bundles is associated with improved time to continence after radical prostatectomy but not long-term continence rates: Results of a systematic review and meta-analysis. *Eur Urol* 2015;68:692-704.
5- Porpiglia F, Bertolo R, Manfredi M, et al. Total Anatomical Reconstruction During Robot-assisted Radical Prostatectomy: Implications on Early Recovery of Urinary Continence. *Eur Urol* 2015;69:485-95.
6- Lavigueur-Blouin H, Noriega AC, Valdivieso R, et al. Predictors of early continence following robot-assisted radical prostatectomy. *Can Urol Assoc J* 2015;9:93-7.
7- Hatiboglu G, Teber D, Tichy D, et al. Predictive factors for immediate continence after radical prostatectomy. *World J Urol* 2016;34:113-20.
8- Skolarus TA, Hedgepeth RC, Zhang S, et al. Does robotic technology mitigate the challenges of large prostate size? *Urology* 2010;76:1117-21.
9- Al-Hathal N, El-Hakim A. Perioperative, oncological and functional outcomes of the first robotic prostatectomy program in Quebec: Single fellowship-trained surgeon's experience of 250 cases. *Can Urol Assoc J* 2013;7:326-32.
10- Montorsi F, Wilson TG, Rosen RC, et al. Pasadena Consensus Panel. Best practices in robot-assisted radical prostatectomy: recommendations of the Pasadena Consensus Panel. *Eur Urol* 2012;62:368-8
11- Meyer JP, Gillatt DA, Lockyer R, et al. The effect of erectile dysfunction on the quality of life of men after radical prostatectomy. *BJU Int* 2003;92:929-31.
12- Wille S, Heidenreich A, Von knobloch R, et al. Impact of comorbidities on post-prostatectomy incontinence. *Urol Int* 2006;76:223-6.
13- Sohn DW, Hong CK, Chung DJ, et al. Pelvic floor musculature and bladder neck changes before and after continence recovery after radical prostatectomy in pelvic MRI. *J Magn Reson Imaging* 2014;39:1431-35.
14- Mao Q, Lin Y, Chen H, et al. Preoperative risk factors for early postoperative urinary continence recovery after non-nerve-sparing radical prostatectomy in Chinese patients: a single institute retrospective analysis. *Int J ClinExp Med* 2015;8:14105-9.

15- Ahlering TE, Skarecky D, Lee D, et al. Successful transfer of open surgical skills to a laparoscopic environment using a robotic interface: initial experience with laparoscopic radical prostatectomy. *J Urol* 2003; 170:1738-41.
16- Freire MP, Weinberg AC, Lei Y, et al. Anatomic Bladder Neck Preservation During Robotic-Assisted Laparoscopic Radical Prostatectomy: Description of Technique and Outcomes. *Eur Urol* 2009; 56:972-80.
17- Gacci M, Carini M, Simonato A, et al. Factors predicting continence recovery 1 month after radical prostatectomy: Results of a multicenter survey. *Int J Urol* 2011;18:700-8.
18- Nyarangi-Dix JN, Radthe JP, Hadaschik B, et al. Impact of Complete Bladder Neck Preservation on Urinary Continence, Quality of Life and Surgical Margins After Radical Prostatectomy: A Randomized, Controlled, Single Blind Trial. J Urol 2013; 189:891-8.
19- Jenkins LC, Nogueira M, Wilding, et al. Median lobe in robot-assisted radical prostatectomy: evaluation and management. *Urology* 2008;71:810-3.
20- Kumar A, Samavedi S, Bates AS, et al. Continence outcomes of robot-assisted radical prostatectomy in patients with adverse urinary continence risk factors. *BJU Int* 2015; 116:764-70.
21- Link BA, Nelson R, Josephson DY, et al. The impact of prostate gland weight in robotic assisted laparoscopic radical prostatectomy. *J Urol* 2008;180:928-32.
22- Labanaris AP, Zugor V, Witt JH. Robot-assisted radical prostatectomy in patients with a pathologic prostate specimen weight ≥100 grams versus ≤50 grams: surgical, oncologic and short-term functional outcomes. *Urol Int* 2013;90:24-30.
23- Campodonico F, Manuputty EE, Campora S, et al. Age is predictive of immediate postoperative urinary continence after radical retropubic prostatectomy. *Urol Int* 2014; 92:276–81.

Figures and Tables

Fig. 1. (A) Current smoker status has inferior continence recovery at all followup time points and reaches significant difference at six months; ***(B)*** bladder neck sparing statistically improves continence recovery throughout the first year.

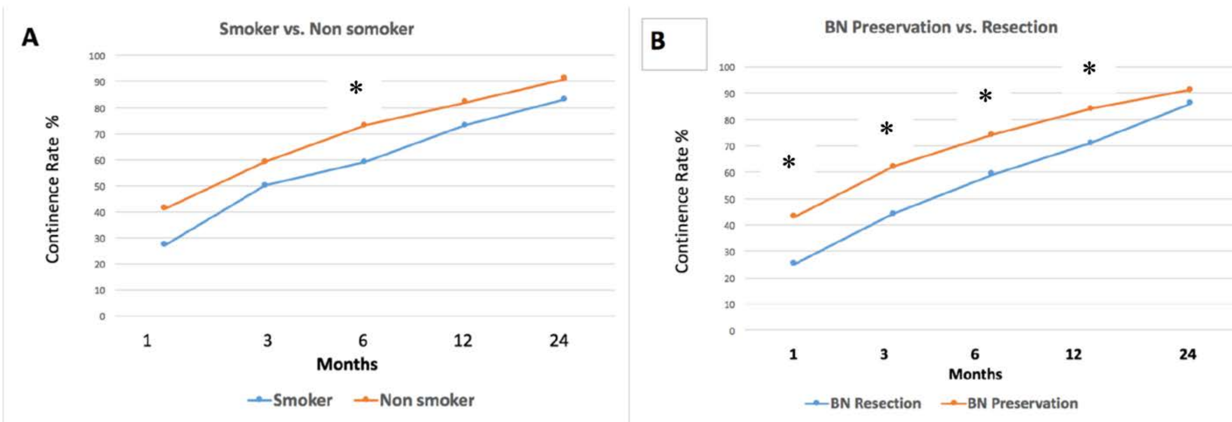

Table 1. Baseline characteristics	
Variables	**n (%)**
Age, year Mean (median) IQR	 60.8 (61) 56- 66
Charlson comorbidity index	
0–2	124 (38.5)
≥3	198 (61.5)
Body mass index	
Normal (≤25 kg/m^2)	62 (19.3)
Overweight (> 25– 30 kg/m^2)	134 (41.6)
Obese (>30 kg/m^2)	70 (21.7)
Unknown	56 (17.4)
Year of surgery	
2006– 2010	140 (43.5)
2011–2015	182 (56.5)
PSA Mean (median) IQR	 6.8 (5.7) 4.58- 7.65
Prostate volume, g Mean (median) IQR	 49.6 (47) 38- 57

Pathological stage	
T2a–b	73 (22.7)
T2c	169 (52.5)
T3a	61 (18.9)
T3b–T4	19 (5.9)
Pathological Gleason score	
3+3	50 (15.5)
3+4	201 (62.4)
4+3	28 (8.7)
≥8	43 (13.4)

IQR: interquartile range; PSA: prostate-specific antigen

Table 2. Baseline patients' characteristics stratified according to current smoking and bladder neck status

Variables	**Non-smokers (and ex-smokers)** n=278	**Active smokers** n=44	**p**	**BN resection** n=77	**BN preservation** n=245	**p**
Age, years Mean (median) IQR	60.9 (61) 57–66	60 (60) 56–65	0.3	61.6 (62) 59–66	60.6 (61) 56–66	0.2
Charlson comorbidity index, n (%)						
0–2	103 (37.1)	21 (47.7)	0.2	20 (26)	104 (42.4)	**0.01**
≥3	175 (62.9)	23 (52.3)		57 (74)	141 (57.6)	
Body mass index, n (%)						
Normal (≤25 kg/m^2)	50 (18)	12 (27.3)		9 (11.7)	53 (21.6)	
Overweight (25–30 kg/m^2)	115 (41.4)	19 (43.2)	0.4	37 (48.1)	97 (39.6)	0.2
Obese (>30 kg/m^2)	62 (22.3)	8 (18.2)		18 (23.4)	52 (21.2)	
Unknown	51 (18.3)	5 (11.4)		13 (16.9)	43 (17.6)	
Year of surgery, n (%)						
2006–2010	123 (44.2)	17 (38.6)	0.6	30 (39)	110 (44.9)	0.4
2011– 2015	155 (55.8)	27 (61.4)		47 (61)	135 (55.1)	
PSA Mean (median) IQR	6.9 (5.8) 4.6–7.7	6 (5.5) 4.5–6.9	0.5	6.6 (6.2) 4.9–7.9	6.9 (5.6) 4.6–7.5	0.1
Prostate volume, g Mean (median)	49 (46)	53.4 (49)	0.2	60 (56)	46 (44)	**<0.001**

IQR	38- 57	40- 58		44- 74	37- 54	
Pathological stage, n (%)						
T2a–b	60 (21.6)	13 (29.5)		16 (20.8)	57 (23.3)	
T2c	153 (55)	16 (36.4)	0.1	39 (50.6)	130 (53.1)	0.8
T3a	49 (17.6)	12 (27.3)		16 (20.8)	45 (18.4)	
T3b–T4	16 (5.8)	3 (6.8)		6 (7.8)	13 (5.3)	
Pathological Gleason score, n (%)						
6	42 (15.1)	8 (18.2)	0.8	13 (16.9)	37 (15.1)	0.4
3+4	176 (63.3)	25 (56.8)		49 (63.6)	152 (62)	
4+3	23 (8.3)	5 (11.4)		3 (3.9)	25 (10.2)	
≥8	37 (13.3)	6 (13.6)		12 (15.6)	31 (12.7)	

IQR: interquartile range; PSA: prostate-specific antigen.

Table 3. Predictive factors and continence rates (n [%]) of all patients at different time intervals during the first two years of followup

Variables	**1 month (n=322)**		**3 months (n=321)**		**6 months (n=312)**		**12 months (n=294)**		**24 months (n=257)**	
	C (n=126)	**I (n=196)**	**C (n=187)**	**I (n=134)**	**C (n=222)**	**I (n=90)**	**C (n=238)**	**I (n=56)**	**C (n=233)**	**I (n=24)**
Smoking										
No	114 (90.5)	164 (83.7)	165 (88.2)	112 (83.6)	**197 (88.7)**	**72 (80)**	207 (87)	45 (80.4)	202 (86.7)	18 (75)
Yes	12 (9.5)	32 (16.3)	22 (11.8)	22 (16.4)	**25 (11.3)**	**18 (20)**	31 (13)	11 (19.6)	31 (13.3)	6 (25)
BN preservation										
No	**20 (15.9)**	**57 (29.1)**	**34 (18.2)**	**42 (31.3)**	**44 (19.8)**	**30 (33.3)**	**49 (20.6)**	**20 (35.7)**	51 (21.9)	8 (33.3)
Yes	**106 (84.1)**	**139 (70.9)**	**153 (81.8)**	**92 (68.7)**	**178 (80.2)**	**60 (66.7)**	**189 (79.4)**	**36 (64.3)**	182 (78.1)	16 (66.7)
NVB preservation										
No	8 (6.3)	29 (14.8)	17 (9.1)	20 (14.9)	22 (9.9)	15 (16.7)	25 (10.5)	11 (19.6)	**6 (11.2)**	**8 (33.3)**
Unilateral	36 (28.6)	49 (25)	49 (26.2)	35 (26.1)	60 (27)	20 (22.2)	61 (25.6)	13 (23.2)	**58 (24.9)**	**2 (8.3)**
Bilateral	82 (65.1)	118 (60.2)	121 (64.7)	79 (59)	140 (63.1)	55 (61.1)	152 (63.9)	32 (57.1)	**149 (63.9)**	**14 (58.3)**
Prostate size (g)										
≤47	**77 (61.1)**	**87 (44.4)**	**109 (58.3)**	**55 (41)**	**129 (58.1)**	**33 (36.7)**	**136 (57.1)**	**22 (39.3)**	131 (56.2)	11 (45.8)
>47	**49 (38.9)**	**109 (55.6)**	**78 (41.7)**	**79 (59)**	**93 (41.9)**	**57 (63.3)**	**102 (42.9)**	**34 (60.7)**	102 (43.8)	13 (54.2)
Thermal use										
No	90(71.4)	133(67.9)	133(71.1)	90 (67.2)	153(68.9)	63 (70)	171(71.8)	42(75)	170(73)	17(70.8)
Yes	36(28.6)	63(32.1)	54 (28.9)	44 (32.8)	69 (31.1)	27 (30)	67 (28.2)	14 (25)	63 (27)	7 (29.2)
Perineal pressure										
No	116(92.1)	179(91.3)	174(93)	120(89.9)	205(92.3)	82(91.1)	220(92.4)	52(92.9)	213(91.4)	22(91.7)
Yes	10(7.9)	17 (8.7)	13(7)	14 (10.4)	17 (7.7)	8 (8.9)	18(7.6)	4(7.1)	20(8.6)	2(8.3)
Median lobe										
No	112(88.9)	165(84.2)	164(87.7)	112(83.6)	191(86)	76(84.4)	203(85.3)	47(83.9)	197(84.5)	20(83.3)
Yes	14(11.1)	31(15.8)	23(12.3)	22(16.4)	31(14)	14(15.6)	35(14.7)	9(16.1)	36(15.5)	4(16.7)

BN: bladder neck; C: continent; I: incontinent; NVB: neurovascular bundle. Bold numbers=statistically significant difference ($p<0.05$).

Table 4. Multivariable Cox regression analysis		
	Multivariable Cox regression	
	HR (95% CI)	**p**
Age	0.99 (0.96–1.02)	0.3
Charlson comorbidity index		
0–2	Reference	0.5
≥3	1.12 (0.79–1.59)	
BMI		
≤25	Reference	
>25–30	0.99 (0.7–1.39)	0.9
>30	0.83 (0.56–1.22)	0.3
Unknown	0.85 (0.56–1.28)	0.4
PSA	0.99 (0.96–1.02)	0.5
Prostate size	0.99 (0.98–0.99)	**0.02**
Pathological stage		
T2a–b	Reference	
T2c	1.06 (0.78–1.43)	0.7
T3a	0.93 (0.61–1.41)	0.7
T3b–T4	1.41 (0.73–2.72)	0.3
Gleason score		
6	Reference	
3+4	0.82 (0.58–1.17)	0.3
4+3	0.83 (0.48–1.46)	0.5
≥8	0.96 (0.55–1.67)	0.9
Operative time	1.001 (1.001–1.01)	**0.03**
Smoking history		
No	Reference	
Yes	1.42 (1.01–1.99)	**0.04**
Median lobe		
No	Reference	
Yes	1.18 (0.82–1.69)	0.4
Perineal pressure		
No	Reference	
Yes	1.1 (0.68–1.77)	0.7
Thermal use		
No	Reference	
Yes	0.9 (0.69–1.19)	0.5
BN sparing		
No	Reference	
Yes	1.41 (1.01–1.96)	**0.04**

NVB preservation		
No	Reference	
Unilateral	1.53 (0.96–2.44)	0.08
Bilateral	1.41 (0.91–2.2)	0.1

BMI: body mass index; BN: bladder neck; CI: confidence interval;
HR: hazard ratio; NVB: neurovascular bundles; PSA: prostate-specific antigen.
Bold numbers=statistically significant difference ($p<0.05$).