Detrusor underactivity is prevalent after radical prostatectomy: A urodynamic study including risk factors

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Cite as: *Can Urol Assoc J* 2013;7(1):E33-E37. http://dx.doi.org/10.5489/cuaj.11038. Epub 24 Jan 2012.

Abstract

Introduction: The objective was to determine the prevalence of, and factors that predict, detrusor underactivity (DU) in patients presenting with incontinence or lower urinary tract symptoms (LUTS) following radical prostatectomy (RP). We also determined the prevalence of bladder outlet obstruction (BOO) and detrusor overactivity (DO) in this population.

Methods: Patients who underwent urodynamics post-RP were identified. Detrusor underactivity was defined as a maximum flow rate (Qmax) of ≤15 mL/s and detrusor pressure (Pdet) Qmax <20 cmH20 or maximum Pdet <20 cmH20 during attempted voiding. Abdominal voiding (AV) was defined as sustained increase in abdominal pressure during voiding. Bladder outlet obstruction and DO were identified using the Abrams-Griffiths nomogram and the International Continence Society criteria. Univariate logistic regression was used to determine factors predicting DU. The following factors were analyzed: age, year of RP, procedure type (minimally-invasive surgery [MIS] or open), postoperative radiation, nerve-sparing, clinical stage, biopsy Gleason grade and interval between RP and evaluation.

Results: Between 2005 and 2008, 264 patients underwent urodynamics post-RP. Detrusor underactivity was observed in 108 patients (41%; 95% CI 35%, 47%), of whom 48% demonstrated AV. Overall, BOO and DO were present in 17% (95% CI 12%, 22%) and 27% (95% CI 22%, 33%), respectively. On univariate analysis, only MIS RP was predictive of DU (univariate odds ratio 2.05 for MIS vs. open; $p = 0.009$).

Conclusions: Detrusor underactivity and AV are common in patients presenting for evaluation of incontinence or LUTS following RP. The etiology of DU in this setting is likely related to the surgical approach. Because DU may affect the success of male incontinence treatment with the male sling or artificial urinary sphincter, it is useful to document its presence prior to treatment. More studies are needed to elucidate the influence of DU on treatment success for male urinary incontinence following RP.

Introduction

After radical prostatectomy (RP), the anatomy and function of the bladder and bladder outlet are altered.[1] For example, a significant proportion of post-RP patients use abdominal voiding (AV) to empty their bladder.[2-4] Abdominal straining during voiding may indicate detrusor underactivity (DU).[3] This is important because DU might affect the efficacy of various surgical treatments for male stress urinary incontinence (UI).[5]

The International Continence Society (ICS) defines DU as "contraction of reduced strength and/or duration resulting in prolonged bladder emptying and/or failure to achieve complete bladder emptying within a normal time span."[6] However, no precise definition is widely accepted.[7] Several definitions have been used in post-RP patients. Groutz and colleagues defined impaired detrusor contractility as maximum flow rate (Qmax) ≤12 mL/sec with detrusor pressure at Qmax (PdetQmax) ≤30 cm H20. Kielb and Clemens used a definition of Qmax ≤15 mL/sec with PdetQmax ≤25 cm H20. In a prospective study, the incidence of impaired contractility following RP was 25%.[8] In retrospective studies, including only incontinent men, the prevalence was 29% to 34%.[2,4]

Following RP, many patients complain of UI and about 8% to 14% seek treatment.[9,10] Detrusor contractility may play a role in selecting treatment for UI. The main treatments, the artificial urinary sphincter (AUS) and male sling, differ in mechanism. With the AUS, bladder outlet resistance from the cuff is high during storage, but is markedly reduced during voiding. The mechanism of the male sling is not well-understood, but likely relies on increased bladder outlet resistance during the storage phase or valsalva.[11,12] Unlike the AUS, success of the male sling may depend on the ability to generate detrusor contraction of adequate strength and the duration to empty the bladder, without valsalva.

The objective was to determine the prevalence of, and factors that predict, DU in patients presenting with incontinence

or lower urinary tract symptoms (LUTS) following RP. We also determined the prevalence of bladder outlet obstruction (BOO) and detrusor overactivity (DO) in this population.

Methods

This study included data on 264 patients with UI or LUTS post-RP. After institutional review board approval, patients who had undergone RP and video-urodynamic studies between August 2005 and December 2008 were identified. All patients were evaluated with detailed history, physical examination, urodynamics and cystoscopy. Incontinence was defined as involuntary leakage of any amount of urine requiring protection. For patients who had surgery at our institution, additional prostate cancer and follow-up data were obtained. We identified 307 urodynamic studies. Studies on patients with AUS and duplicate studies on a single patient were excluded (n = 26).

Prior to urodynamics, free uroflow data were obtained and all patients discontinued antimuscarinics for ≥1 week. Post-void residual urine (PVR) was measured by catheterization. Urodynamics testing was conducted according to ICS guidelines using Laborie (Toronto, ON) equipment. At 200 mL, patients coughed and performed valsalva to record valsalva leak point pressure (VLPP). These maneuvers were repeated at capacity. We defined PdetQmax as detrusor pressure at time of Qmax. Bladder outlet obstruction was determined by Abrams-Griffiths nomogram. Criterion for AV was sustained increase in abdominal pressure during voiding. After voiding, the bladder was refilled to 200 mL, the catheter was removed and VLPPs were repeated. Abdominal pressure was used to record VLPP (as opposed to ICS guidelines) to allow the recording of VLPP without a catheter in place. This is often necessary to document VLPP in patients with anastomotic strictures (AS) and UI. Fluoroscopic images were obtained throughout. After urodynamics, all patients underwent flexible (14 Fr) cystoscopy. The presence of AS, AV and DO was recorded.

The criteria for DU were Qmax ≤15 mL/sec and PdetQmax ≤20 cm H20. For patients unable to void, the criterion was maximum Pdet ≤20 cm H20 during attempted voiding.

To determine which factors were predictive of DU, we used logistic regression. Factors examined were age at prostatectomy, year of prostatectomy, procedure type (minimally-invasive surgery [MIS] vs. open RP), nerve-sparing status (none, unilateral, bilateral), clinical stage (≤T2A and ≥T2B), biopsy Gleason grade (<7, =7 and >7), postoperative radiation and time between prostatectomy and first clinic visit. We tested for differences in the rates of incontinence and AS by detrusor activity using Fisher's exact test. Sensitivity analyses were conducted in the subgroup that had prostatectomy at our institution. Statistical analyses were performed using Stata software 10.0 (Stata Corp., College Station, TX). The p values <0.05 were considered statistically significant.

Results

The median age at RP was 61 years. Of the 264 patients, 238 (90%) patients were incontinent. The mean PVR was 15 ± 42 mL and did not differ significantly in patients with or without DU (7 ± 3 mL vs. 19 ± 3 mL, p = 0.222). The mean bladder capacity (314 ± 140 mL) was also not significantly different between patients with and without DU (304 ± 123 mL vs. 320 ± 150 mL, p = 0.655). The remaining 26 (10%) patients were continent, but had LUTS. We observed BOO in 17% (95% CI 12%, 22%; n = 44) of patients and DO in 27% (95%CI 22%, 33%; n = 71). Of continent patients, BOO was present in 31% (n = 8); in incontinent patients, BOO was present in 15% (n = 36) (p = 0.053). We observed DO in 46% (n = 12) of continent patients and 25% (n = 59) of incontinent patients (p = 0.035). Moreover, DU was observed in 108 patients (41%; 95% CI 35%, 47%). Of these 108, AV was seen in 48% (95% CI 38%, 58%).

We tallied the baseline characteristics according to detrusor activity (Table 1). The median time between surgery and evaluation was slightly shorter in the DU (25 months) than in the non-DU group (38 months), but not statistically significant (p = 0.13). A greater proportion of patients with DU had undergone MIS (39%) than those without DU (24%), which was the only significant univariate predictor of DU (odds ratio 2.05 for MIS vs. open; 95% CI 1.20, 3.49; p = 0.009; absolute risk difference 15%; 95% CI 4%, 27%). A multivariable model, including all predictor variables, gave similar results, however, type of surgery did not reach conventional statistical significance (Table 2) (p = 0.08). There were no other differences between groups, including prostatectomy year, clinical stage, Gleason grade and nerve-sparing status.

The presence or absence of UI and AS at the time of evaluation, by DU status, was detailed (Table 3). The proportion of patients with DU was lower among continent versus incontinent patients (19% vs. 43%; absolute risk difference -24%, 95% CI -40%, -8%; p = 0.020). The prevalence of AS was similar in patients with and without DU (26% vs. 25%; absolute risk difference 1%; 95% CI -10%, 12%).

We conducted post-hoc analyses to further explore the association between type of surgery and DU, by examining the subgroup treated at our institution. As with the full cohort, patients at our institution (n = 196) who had MIS (n = 76, 39%) were more likely to experience DU (univariate odds ratio 2.02; 95% CI 1.13, 3.63; p = 0.018) than those who had open surgery (n = 120, 61%).

Discussion

Our study supports previous studies in demonstrating that DU is common following RP.[2,4,8] Although not well-studied,

DU may contribute to difficulty emptying following male sling placement.[5] One reason this topic has not been studied extensively is that some urologists are reluctant to place a sling in patients with DU for fear of causing urinary retention. Slings are designed to prevent incontinence during times of abdominal stress, a situation which exists during AV.

There is evidence of this phenomenon in the female incontinence literature. In women, lower preoperative Qmax, which is associated with DU, is predictive of urinary retention following placement of a transvaginal tape (TVT) for stress UI.[13,14] Furthermore, female patients who experience retention following an incontinence procedure report lower satisfaction.[13]

Hong and colleagues conducted a multivariate analysis to determine the risk factors for postoperative retention in 375 women who underwent TVT.[13] Preoperative Qmax ($p = 0.007$) was the only factor predictive of retention. Miller and colleagues reviewed records of 98 women who had undergone pubovaginal sling to determine which urodynamic parameters best predicted postoperative voiding dysfunction.[15] Urinary retention developed in 23% of women who voided with a Pdet <12 cm H2O compared to 0% in patients who voided with a Pdet of ≥12 cm H2O ($p = 0.007$).

The prevalence of DU and AV in our population is consistent with that in other studies with similar subjects, although comparisons are difficult due to dissimilar definitions. Detrusor underactivity was seen in 108 (41%) patients and 52 (48%) of these patients had AV. Chao and Mayo found that 31 (42%) of 74 patients, with incontinence post-RP, voided by straining without demonstrable detrusor contraction[3] and 38% of patients with mixed and urge incontinence did so. Gomha and Boone assessed urodynamic and AUS outcomes in 61 patients with incontinence from RP and TURP and found that 29.5% voided by straining with minimal detrusor contraction (<10 cm H20).[16] Their subsequent analysis found that 49% of men who underwent AUS placement were "valsalva voiders."[17] Lai and colleagues did a retrospective study of 129 patients with UI following RP. The incidence of low bladder contractility index (<100) was 64.8%.[18] The prevalence of BOO and DO in our patient population is also consistent with previously reported series. In men with post-RP incontinence, the published prevalence of DO is 13% to 61%.[2-4,16]

In this study, the only factor predictive of DU on univariate logistic regression was type of surgery (open vs. MIS) and this approached significance in the multivariate analysis. Detrusor denervation is a plausible explanation for DU.[3] The best example of this mechanism is neurogenic voiding following bilateral extravesical ureteral,[19] possibly due to damage to detrusor innervation which arises from the pelvic plexus dorsomedial to the ureterovesical junction into the bladder.[20]

Nerve-sparing had no impact on DU; however, these nerves are likely responsible for erectile function as opposed to detrusor contraction.[21] The most probable step during RP where pelvic nerves supplying the bladder are injured is during seminal vesicle dissection.[22] During MIS cases, the seminal vesicles are approached through a posterior approach,[23] whereas during an open case they are approached through an anterior approach.[21] During open RP, dissection can be performed in close proximity to the seminal vesicles due to traction on the prostate, sparing nerves at the base of the bladder. This difference in dissection could explain the differences in DU between approaches. If this is the case, then the rate of DU will likely rise as the percentage of MIS RP increases.[24]

While this study showed a higher rate of DU in incontinent versus continent patients, this is likely artifact. Our cohort includes select continent patients and those with LUTS. These patients have higher rates of DO and BOO supporting this assertion. The prevalence of DO was 46%

Table 1. Baseline characteristics of 264 men who underwent primary radical prostatectomy

	Detrusor underactivity	
	No (n=156)	**Yes (n=108)**
Age at RP, year	61 (56, 66)	61 (57, 66)
Pre-RP PSA, ng/mL	6.6 (4.4, 9.2)	5.7 (4, 8.9)
Type of surgery		
Open	119 (76%)	66 (61%)
Laparoscopic or robotic	37 (24%)	42 (39%)
Year of RP		
before 1990	3 (2%)	1 (1%)
1990-1995	18 (12%)	8 (7%)
1995-2000	18 (12%)	16 (15%)
2000-2005	54 (35%)	30 (28%)
2005-2008	57 (37%)	53 (49%)
Missing	6 (4%)	0 (0%)
Clinical stage		
≤T2A	88 (56%)	66 (61%)
≥T2B	23 (15%)	25 (23%)
Missing	45 (29%)	17 (16%)
Nerve sparing status		
None	21 (13%)	18 (17%)
Unilaterally	12 (8%)	9 (8%)
Bilaterally	72 (46%)	53 (49%)
Missing	51 (33%)	28 (26%)
Biopsy Gleason grade		
≤6	63 (40%)	47 (44%)
=7	44 (28%)	35 (32%)
≥8	18 (12%)	8 (7%)
Missing	31 (20%)	18 (17%)
Time between RP to UDS evaluation (months) to clinic visit, months	38 (16, 89)	25 (15, 75)
Pelvic radiation	34 (22%)	19 (18%)

Data are given as frequency (percentage) or median (interquartile range).
RP: radical prostatectomy; PSA: prostate-specific antigen; UDS: urodynamic studies.

Table 2. Univariate and multivariable logistic regression for variables associated with detrusor underactivity

Predictor	Univariate model			Multivariate model		
	OR	95% CI	*p*	OR	95% CI	*p*
Age at RP, year	1.01	0.97, 1.05	0.6	1.02	0.97, 1.07	0.5
Pre-RP PSA, ng/mL (n=209)	0.99	0.97, 1.01	0.5	0.99	0.95, 1.03	0.6
Type of surgery (laparoscopic/ robotic vs. open) (n=264)	2.05	1.20, 3.49	0.009	2.02	0.92, 4.44	0.08
Year of RP, year (n=258)	1.04	0.99, 1.10	0.16	1.12	0.80, 1.55	0.5
Clinical stage (≤T2A vs ≥T2B) (n=202)	1.45	0.76, 2.78	0.3	2.27	0.86, 5.97	0.10
Nerve sparing status (n=185)			0.9			0.8
No nerves spared	reference	reference		reference	reference	
Unilaterally spared	0.88	0.30, 2.55		0.83	0.32, 2.15	
Bilaterally spared	0.86	0.42, 1.77		0.71	0.23, 2.14	
Biopsy Gleason grade (n=215)			0.5			0.24
≤6	reference	reference		reference	reference	
=7	1.07	0.59, 1.91		1.05	0.49, 2.24	
≥8	0.60	0.24, 1.49		0.32	0.08, 1.39	
Time between RP and UDS evaluation, per every 6 months (n=258)	0.98	0.95, 1.01	0.13	1.05	0.88, 1.26	0.6
Pelvic radiation (yes vs. no) (n=264)	0.77	0.41, 1.43	0.4	2.80	0.74, 10.6	0.13

RP: radical prostatectomy; UDS: urodynamic studies; PSA: prostate-specific antigen ; OR: odds ratio; CI: confidence interval.

in continent patients and only 25% in incontinent patients. Similarly, rates of BOO in continent patients were higher (31% continent, 15% in incontinent). Detrusor underactivity may actually be related to higher continence rates in post-RP patients because of potentially decreased rates of urge incontinence in this group.

While this study does not directly address the impact of DU on efficacy of different treatments for incontinence post-RP, it does report a very high rate of DU and AV in patients who experienced LUTS or UI after contemporary RP. If, as our analysis implies, DU is higher in patients undergoing MIS, then the rate of DU following RP will continue to rise because of increased adoption of MIS. Male slings might be susceptible to adverse outcomes in patients who void by AV.

The limitations of this study are its retrospective nature and select patient population, a limitation of most urodynamic studies in post-RP patients. This has to do with the fact that it is difficult and potentially cost-prohibitive to evaluate asymptomatic patients with urodynamics following RP in routine clinical practice. Comorbidity that may affect DU was not examined in this study. However, for most disease states the relationship with detrusor contractility is unclear. For example, Kaplan and colleagues examined the urodynamics findings in 182 patients with diabetes.[25] The most common diagnoses were detrusor instability and BOO, not the classic "diabetic cystopathy." Since DU and AV were part of our selection criteria for patients undergoing anti-incontinence surgery, we could not determine the effect of DU or AV on procedure outcomes. Further studies of the efficacy of different anti-incontinence surgeries in patients with DU are warranted. Finally, our definition of DU is arbitrary; however, it should be noted that this definition is easy to apply in a clinical setting, is similar to those used in studies with similar patient population,[2,4] and is very conservative, corresponding to bladder contractility index (BCI) <95 (BCI <100 is consistent with weak contractility).[26]

Conclusions

Detrusor underactivity and AV are common in patients presenting for evaluation of incontinence or LUTS post-RP. The etiology of DU in this setting may be related to surgi-

Table 3. Association between detrusor underactivity and continence

	Detrusor underactivity		Absolute risk difference (95% CI)	*p* value
	No (n=156)	Yes (n=108)		
Continence status (n=264)				
Incontinent	135 (87%)	103 (95%)	9% (2%, 15%)	0.020
Anastomotic stricture (n=262)				
Yes	39 (25%)	28 (26%)	1% (-10%, 12%)	0.9

CI: confidence interval.

cal approach. Because DU may affect the success of male incontinence treatment, particularly with the male sling, it is useful to document its presence prior to treatment. More studies are needed to elucidate the influence of DU on surgical treatment for male UI after RP. Moreover, our findings need to be replicated in a community-based setting.

Competing interests: None declared.

This paper has been peer-reviewed.

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