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ORIGINAL ARTICLE

The relationship between bladder storage function and frequent micturition after TURP

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Abstract

Purpose To investigate the relationship between preoperative bladder function and frequent micturition after transurethral resection of prostate in patients with benign prostatic hyperplasia.

Methods We retrospectively included 80 eligible patients aged 54–87 years (mean age 69.8 years) who underwent transurethral resection of the prostate at our hospital from January 2019 to October 2021. Patients were divided into detrusor overactivity positive and negative groups, and according to bladder compliance, they were divided into: low (G1), normal (G2), and high (G3) bladder compliance groups.

Results The incidence and score of postoperative frequent micturition in the detrusor overactivity positive group were higher than those in the detrusor overactivity negative group. The incidence and score of postoperative frequent micturition in the low bladder compliance group were higher than those in the normal and high bladder compliance groups. There was no significant difference in the score of frequent micturition between the normal and high bladder compliance groups. Multivariate logistic regression analysis indicated that frequent micturition was significantly correlated with detrusor overactivity, bladder compliance, maximum cystometric capacity, and maximum flow rate.

Conclusion This study confirmed that patients with abnormal bladder storage functions (detrusor instability and low bladder compliance) before transurethral resection of the prostate were likely to have frequent and severe urination after transurethral resection of the prostate. Therefore, preoperative urodynamic examination to evaluate the urinary storage function of patients with benign prostatic hyperplasia is of great significance to predict the occurrence and degree of postoperative frequent micturition.

Keywords Benign prostatic hyperplasia · Detrusor overactivity · Low compliance bladder · Frequent micturition · Urodynamics

Introduction

Benign prostatic hyperplasia (BPH) is a common disease worldwide, and often associated with lower urinary tract symptoms (LUTS) and managed solely based on symptoms [1]. There are few previous studies on the etiologies of LUTS related to bladder storage, such as frequent micturition. The incidence of frequent micturition after BPH is high, and it is a principal factor influencing surgical outcomes. Presently, studies regarding LUTS, including frequent micturition are not in-depth.

Transurethral resection of the prostate (TURP) remains the gold standard for the treatment of BPH, and has been shown to significantly and consistently reduce lower urinary tract symptoms (LUTS) [2]. In clinical practice, we observed that TURP mainly alleviated voiding symptoms in BPH patients, but produced limited improvement in urinary symptoms, such as frequent urination. However, for some BPH patients, symptoms during the urination storage period are the main reason for deciding to see a doctor, and seriously affect their quality of life. If the symptoms of frequent

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urination do not improve after surgery, the surgical results will be significantly affected.

Therefore, through this retrospective study, we hope to comprehensively analyze the data of patients and their preoperative urodynamic examination parameters to explore the factors related to the incidence and degree of postoperative urinary frequency. This will inform the selection of treatment methods for BPH and evaluation of the effects of TURP.

Materials and methods

Clinical data

We retrospectively collected the data of 80 patients, aged 54–87 years (mean age 69.8 years), who underwent transurethral resection of prostate (TURP) in our hospital from January 2019 to October 2021. We included patients diagnosed with BPH before operation. BPH was confirmed by pathology after operation. We excluded patients with: (1) neurogenic bladder or nervous system diseases; (2) prostate cancer; (3) diabetes mellitus; (4) urinary tract infection; (5) urethral stricture; (6) bladder stones; (7) bladder cancer; (8) invasive operation of the lower urinary tract before urodynamic examination; and (9) undergoing LUTS treatment within 1 week before or after the operation. This study complied with the Helsinki declaration, and was approved by the Ethical Review Board of Shanxi Medical University. All patients gave written informed consent before examination and surgery.

Methods

All 80 patients underwent filling bladder manometry using the Canadian Laborie urodynamic tester uds-600 before operation. The operation and diagnosis were performed according to the standards of the international urinary control association. The urodynamic examination was used to measure the pressure of the filling bladder. The bladder pressure and detrusor force were recorded. All patients then underwent TURP, performed by skilled operators. The catheter was removed on postoperative day 5, and frequent urination was investigated 48 h after catheter removal.

Bladder detrusor function was determined using the bladder pressure map during the filling period. Detrusor overactivity (DO) was defined as the non-random contraction during the urine storage phase. Periodic pressure fluctuations caused by detrusor contraction were observed on the pressure map; pressure rise waves of > 15 cmH_2O.

Low compliance bladder was defined as: lower volume increase during the bladder filling period accompanied by a significant pressure increase, and bladder compliance (BC) less than around 20 ml/cmH_2O. High compliance bladder: bladder pressure remains low and does not rise when approaching maximum volume. Normal BC: absence of the above two abnormalities on the bladder pressure map, and the BC was > 20 ml/cmH_2O.

The patients were divided into the DO positive and DO negative groups, and low BC, normal BC, and high BC groups. Frequent micturition was defined as frequent micturition in the absence of infection or other factors. The urinary frequency score in each group was classified using the urination frequency self-test scale as follows: no frequent micturition: 0 point; different degrees of frequent micturition: 1–10 points; mild frequent micturition: 1–3 points, moderate frequent micturition: 4–6 points; and severe frequent micturition: 7–10.

Statistical method

R software version 4.1.3 (R Foundation for Statistical Computing, Vienna, Austria) was used for data analysis. Normally distributed continuous variables were presented as mean ± SD, and continuous variables not normally distributed were presented as median (interquartile spacing). Categorical variables were presented as frequencies and percentages (%). The Chi-square test was used for qualitative data comparison; *t* test was used for quantitative analysis of normally distributed data. The rank-sum test was used for quantitative data not normally distributed. The analysis of variance was used for multi-group comparisons, and LSD-*t* test was used for inter group comparisons. The forest map was constructed according to the results of univariate logistic regression analysis, P values < 0.05 were considered statistically significant.

Result

We included a total of 80 patients aged 54–87 years (mean 69.84 ± 7.54 years; median 69.50 years). The BMI ranged from 14.96 to 33.33 kg/m^2 (mean 23.77 ± 3.34 kg/m^2, median 23.88 kg/m^2). Prostate volumes ranged from 20.31 to 104.46 ml (mean 58.08 ± 21.78 ml, median 55.90 ml). Residual urine ranged from 0 to 1300 ml [median 76.00 (37.50, 275.00) ml]. The PSA value ranged from 0.32 to 46.17 ng/ml [median 4.00 (1.71, 7.94) ng/ml]. The preoperative frequent micturition score was 0–10 [median 4 [0.00, 8.00)]. The postoperative frequent micturition score was 0–7 [median 1 (0.00, 4.00)]. The postoperative indwelling time of urinary catheter was 4–7 days [median 6 (5.00, 6.00) days]. There were no significant differences in the age, BMI, prostate volume, PSA, and postoperative indwelling catheter days, length of stay in the hospital, bladder detrus or

Table 1 Baseline and urodynamics characteristics of the studied group

Baseline characteristics					UD characteristics				
Variables	Total cohort ($n=80$)	Frequent micturition		*P* value	Variables	Total cohort ($n=80$)	Frequent micturition		*P* value
		Positive ($n=43$)	Negative ($n=37$)				Positive ($n=43$)	Negative ($n=37$)	
Age	69.84 (±7.54)	70.09 (±6.68)	69.54 (±8.51)	0.7	Storage stage				
BMI	23.77 (±3.34)	23.33 (±3.08)	24.27 (±3.60)	0.2	Pdet (S)	22.00 [11.75, 38.25]	37.00 [24.00, 63.00]	13.00 [5.00, 16.00]	< 0.001*
PV	58.08 (±21.78)	58.34 (±21.83)	57.77 (±22.02)	0.9	IC	1.00 [1.00, 2.00]	1.00 [1.00, 2.00]	1.00 [0.00, 1.00]	< 0.001*
RU	76.00 [37.50, 275.00]	100.00 [43.50, 415.00]	50.00 [20.00, 120.00]	0.04*	FD	160.00 [110.00, 234.75]	142.00 [85.00, 180.00]	200.00 [137.00, 260.00]	< 0.001*
PSA	4.00 [1.71, 7.94]	3.68 [1.74, 6.56]	5.16 [1.73, 9.28]	0.2	UD	200.00 [154.50, 322.50]	160.00 [105.00, 200.00]	300.00 [230.00, 400.00]	< 0.001*
LOS	14.00 [11.75, 18.00]	14.00 [12.00, 17.50]	13.00 [11.00, 19.00]	0.8	MCC	300.00 [180.00, 435.00]	190.00 [142.50, 325.00]	382.00 [300.00, 600.00]	< 0.001*
					Compliance	23.24 [18.65, 48.62]	20.88 [14.35, 27.98]	43.35 [21.40, 78.18]	< 0.001*
DO				< 0.001*	Voiding stage				
Positive	28 (35.0)	25 (89.3)	3 (10.7)		Pdet (V)	71.50 [42.75, 96.25]	91.00 [62.00, 100.75]	56.00 [40.00, 84.00]	0.02*
Negative	52 (65.0)	12 (23.1)	40 (76.9)		Qmax (Catheter)	4.45 [2.00, 7.00]	4.00 [2.00, 6.90]	5.00 [2.00, 7.00]	0.7
BC				0.001*	BCI	123.00 [97.50, 153.00]	134.00 [106.50, 155.00]	108.00 [90.00, 144.00]	0.08
G1	22 (27.5)	3 (13.6)	19 (86.4)		BOOL	33.00 [7.50, 57.00]	32.00 [8.00, 70.00]	34.00 [6.00, 54.00]	0.6
G2	46 (57.5)	25 (54.3)	21 (45.7)		Flow rate				
G3	12 (15.0)	9 (75.0)	3 (25.0)		Qmax	11.15 [8.20, 17.80]	9.40 [7.95, 11.60]	16.70 [11.00, 19.70]	< 0.001*
preFMS	4.00 (0.00–8.00)	7.00 (6.00–8.00)	0.00 (0.00–0.00)	< 0.001*	AFR	3.65 [2.98, 4.73]	3.10 [2.60, 3.65]	4.60 [3.80, 5.00]	< 0.001*
postFMS	1.00 (0.00–4.00)	4.00 (3.00–6.00)	0.00 (0.00–0.00)	< 0.001*	UO	118.30 [78.30, 160.88]	107.70 [74.20, 155.35]	129.60 [80.70, 162.60]	0.4
LOI	6.00 [5.00, 6.00]	6.00 [5.00, 6.00]	6.00 [6.00, 6.00]	0.4	VT	51.25 [43.30, 64.95]	54.90 [42.40, 64.25]	50.30 [44.30, 66.30]	0.7

Baseline characteristics				UD characteristics				
Variables	DO		*P* value	Variables	DO			*P* value
	Positive (n=28)	Negative (n=52)			Positive (n=28)	Negative (n=52)		
Age	70.00 (±6.87)	69.54 (±8.77)	0.8	Storage stage				
BMI	23.96 (±3.13)	23.42 (±3.74)	0.5	Pdet (S)	34.50 [22.00, 55.50]	7.00 [4.00, 12.25]		< 0.001*
PV	58.89 (±21.47)	56.57 (±22.67)	0.7	IC	1.00 [1.00, 2.00]	0.50 [0.00, 1.00]		< 0.001*
RU	90.00 [40.00, 500.00]	50.00 [20.00, 105.00]	0.07	FD	150.00 [97.50, 205.00]	191.00 [135.25, 252.25]		0.03*
PSA	3.87 [1.95, 6.40]	5.16 [1.66, 9.64]	0.3	UD	170.00 [123.75, 285.00]	280.00 [219.50, 353.25]		0.001*
LOS	13.00 [11.00, 17.00]	14.00 [12.00, 19.00]	0.3	MCC	235.00 [157.50, 382.50]	375.00 [292.50, 531.50]		< 0.001*
				Compliance	21.87 [15.70, 28.78]	54.16 [21.18, 84.94]		< 0.001*
DO			< 0.001*	Voiding stage				

Table 1 (continued)

Baseline characteristics				UD characteristics			
Variables	DO		*P* value	Variables	DO		*P* value
	Positive (*n*=28)	Negative (*n*=52)			Positive (*n*=28)	Negative (*n*=52)	
Positive	28 (100.0)	0 (0.0)		Pdet (V)	81.50 [42.75, 98.70]	59.50 [42.25, 85.00]	0.2
Negative	0 (0.0)	52 (100.0)		Qmax (Catheter)	4.00 [2.00, 6.85]	5.00 [2.00, 7.25]	0.6
BC			0.002*	BCI	133.00 [103.00, 155.00]	112.50 [73.25, 142.50]	0.06
G1	3 (13.6)	19 (86.4)		BOOL	36.79 [7.50, 60.75]	30.00 [6.00, 47.75]	0.3
G2	16 (34.8)	30 (65.2)		Flow rate			
G3	9 (75.0)	3 (25.0)		Qmax	10.45 [8.15, 15.45]	14.00 [9.12, 19.00]	0.2
preFMS	7.00 [5.00, 8.00]	0.00 [0.00, 0.00]	< 0.001*	AFR	3.30 [2.88, 4.20]	4.45 [3.30, 4.90]	0.07
postFMS	4.00 [1.25, 5.75]	0.00 [0.00, 0.00]	< 0.001*	UO	100.85 [73.33, 147.07]	144.65 [110.62, 163.55]	0.02*
LOI	6.00 [5.00, 6.00]	6.00 [6.00, 6.00]	0.3	VT	51.30 [40.30, 65.62]	51.25 [46.13, 59.17]	0.8

Baseline characteristics					UD characteristics				
Variables	BC			*P* value	Variables	BC			*P* value
	Low (*n* = 22)	Normal (*n* = 46)	High (*n* = 12)			Low (*n* = 22)	Normal (*n* = 46)	High (*n* = 12)	
Age	71.05 ± 7.24	70.15 ± 7.79	66.42 ± 6.60	0.2	Storage stage				
BMI	23.94 ± 3.50	23.42 ± 3.11	24.81 ± 3.95	0.4	Pdet (S)	33.00 [19.00, 39.25]	18.00 [10.50, 52.25]	10.00 [4.75, 33.25]	0.5
PV	60.29 ± 20.87	55.27 ± 22.37	64.80 ± 20.89	0.3	IC	2.00 [1.00, 3.00]	1.00 [1.00, 2.00]	1.00 [0.00, 1.00]	0.001*
RU	390 [157.50, 723.50]	58 [40.00, 105.00]	10 [6.25, 38.75]	< 0.001*	FD	150.00 [100.00, 227.50]	160.00 [107.50, 221.75]	214.50 [121.00, 412.50]	0.03*
PSA	3.91 [2.25, 6.12]	3.51 [1.47, 7.96]	6.76 [1.83, 9.49]	0.8	UD	195.00 [143.75, 328.25]	200.00 [159.00, 305.75]	241.50 [139.00, 537.50]	0.08
LOS	13 [11.00, 18.00]	14 [12.00, 18.00]	13 [9.25, 19.00]	0.7	MCC	265.00 [150.00, 438.50]	304.50 [195.00, 415.00]	290.00 [168.25, 772.50]	0.09
					Compliance	12.00 [7.43, 16.37]	27.98 [21.75, 42.18]	138.45 [85.79, 287.62]	< 0.001*
DO				0.002*	Voiding stage				
Positive	3 (13.6)	16 (34.8)	9 (75.0)		Pdet (V)	80.50 [40.00, 98.70]	66.00 [39.50, 95.25]	69.50 [57.25, 128.25]	0.3
Negative	19 (86.4)	30 (65.2)	3 (25.0)		Qmax (Catheter)	4.00 [1.75, 6.85]	4.00 [2.00, 8.00]	5.50 [4.25, 6.60]	0.4
BC				< 0.001*	BCI	133.00 [90.75, 157.25]	121.00 [95.75, 150.75]	130.50 [103.75, 162.00]	0.9
G1	22 (100.0)	0 (0.0)	0 (0.0)		BOOL	35.50 [6.25, 68.50]	29.50 [1.50, 57.25]	34.50 [20.50, 51.00]	0.7
G2	0 (0.0)	46 (100.0)	0 (0.0)		Flow rate				
G3	0 (0.0)	0 (0.0)	12 (100.0)		Qmax	11.20 [8.90, 16.15]	11.60 [7.98, 18.75]	9.95 [6.03, 13.63]	0.3
preFMS	6.50 [4.50, 8.00]	0.00 [0.00, 8.00]	0.00 [0.00, 2.25]	0.004*	AFR	3.40 [2.85, 4.73]	3.95 [2.98, 5.00]	3.30 [2.60, 4.03]	0.4
postFMS	3.00 [0.75, 6.00]	0.00 [0.00, 4.00]	0.00 [0.00, 0.75]	0.027*	UO	108.85 [87.20, 140.18]	117.35 [74.35, 165.55]	141.00 [88.95, 163.68]	0.9

Table 1 (continued)

Baseline characteristics					UD characteristics				
Variables	BC			*P* value	Variables	BC			*P* value
	Low ($n=22$)	Normal ($n=46$)	High ($n=12$)			Low ($n=22$)	Normal ($n=46$)	High ($n=12$)	
LOI	6.00 [5.00, 6.00]	6.00 [5.00, 6.00]	6.00 [5.25, 6.00]	0.9	VT	53.60 [44.45, 68.78]	51.15 [43.30, 62.25]	48.15 [35.20, 69.90]	0.6

Data were described as median [interquartile range (IQR)] or mean (± standard deviation) for continuous variables depending on normality. Comparisons between continuous variables were performed using the Wilcoxon rank-sum test or independent samples *t* test depending on normality. Data are presented as *n* (%) for categorical variables. Comparisons between the categorical variables were made using the Pearson's χ^2 test or Fisher's exact test, depending on expected cell sizes. Differences between multiple groups were assessed by analysis of variance

UD urodynamics, *BMI* body mass index, *PSA* total prostate-specific antigen, *DO* detrusor overactivity, *BC* bladder compliance, *preFMS* preoperative frequent micturition score, *postFMS* postoperative frequent micturition score, *LOS* length of stay in the hospital, *LOI* length of the indwelling catheter after operative, *PV* prostate volume, *RU* residual urine, *Pdet(S)* detrusor pressure (storage stage), *Pdet(V)* detrusor pressure (voiding stage), *IC* involuntary contraction, *FD* first desire to void, *UD* urgency desire to void, *MCC* maximum cystometric capacity, *Qmax(Catheter)* maximum flow rate with catheter, *BCI* bladder detrusor contractility index, *BOOL* bladder outlet obstruction index, *Qmax* maximum flow rate, *AFR* average flow rate, *UO* urine output volume, *VT* voiding time

*$P < 0.05$

contractility index, bladder outlet obstruction index, urine output volume, or voiding time (Table 1).

There were 52 and 28 cases in the DO positive and negative groups, respectively. The incidence and score of postoperative urinary frequency in the DO positive group were higher than those in the DO negative group. There were 40 and 3 patients with postoperative frequent micturition in the DO positive and DO negative groups (incidence: 76.9% and 10.7%), respectively, and the difference in the incidence was statistically significant ($P<0.001$). The postoperative frequent micturition score in the DO positive group [4.00 (1.25, 5.75)] was significantly higher than that in the DO negative group [0.00 (0.00, 0.00)] ($P<0.001$).

There were 22, 46, and 12 cases of BC in the low, normal, and high BC groups, respectively. The incidence and degree of frequent micturition in the different BC groups were compared before operation. The number of frequent micturition cases in the low, high, and normal BC groups was 19, 21, and 3 cases, respectively. The incidence of postoperative frequent micturition in the low BC group was higher than that in the normal and high BC groups (86.4% vs 45.7% vs 25.0%) ($P=0.001$). The score of postoperative frequent micturition in the low BC group was [3.00 (0.75, 6.00)], higher than that in the normal [0.00 (0.00, 4.00)] and high [0.00 (0.00, 0.75)] BC groups ($P<0.001$). There was no significant difference in the frequent micturition score between the normal and high BC groups ($P=0.027$).

Univariate logistic analysis (Table 2) showed that postoperative frequent micturition was significantly correlated with RU (OR 1.002; 95% CI 1.001–1.004, $P=0.042$), DO (OR 27.778; 95% CI 8.071–131.984, $P<0.001$), BC (OR 0.213; 95% CI 0.079–0.487, $P=0.001$), Pdet (S) (OR 1.084; 95% CI 1.046–1.135, $P<0.001$), IC (OR 2.324; 95% CI 1.419–4.228, $P=0.002$), FD (OR 0.992; 95% CI 0.986–0.997, $P=0.004$), UD (OR 0.991; 95% CI 0.986–0.995, $P<0.001$), MCC (OR 0.993; 95% CI 0.989–0.996, $P<0.001$), compliance (OR 0.97; 95% CI 0.947–0.988, $P=0.004$), Qmax (OR 0.842; 95% CI 0.757–0.919, $P=0.001$), and AFR (OR 0.584; 95% CI 0.391–0.818, $P=0.004$) (Fig. 1).

Multivariate logistic regression analysis (Table 2) showed that frequent micturition significantly correlated with DO (OR 45.681; 95% CI 3.533–590.577, $P=0.003$), BC ($P=0.039$: G2 compared with G1: OR 0.012; 95% CI 0.001–0.368, $P=0.011$. G3 compared with G1: OR 0.008; 95% CI 0.001–0.879, $P=0.044$), MCC (OR 0.989; 95% CI 0.981–0.998, $P=0.013$), and Qmax (OR 0.779; 95% CI 0.664–0.913, $P=0.002$).

Discussion

BPH is one of the causes of LUTS. Most patients experience symptoms during the urination and urine storage periods [3]. The manifestations of the LUTS in male patients are usually urgent urination, frequent urination, or nocturia (LUTS in the urine storage period). These are usually the main symptoms motivating consultation. Evaluation and treatment should focus on the most disturbing LUTS. Even if the LUTS during urine storage is the main complaint of the patient, treatment should focus on micturition LUTS, which could be challenging during treatment [4]. TURP can treat bladder outlet obstruction and improve symptoms of micturition. The reason postoperative symptoms of some patients, especially in the urine storage period, do not improve significantly is unclear. Although LUTS of most patients improve after surgery, approximately 35% of patients still have LUTS after TURP [5]. Several factors contribute to the pathophysiology of LUTS caused by BPH, including prostatitis and

Table 2 Logistic regression of characteristics on frequent micturition

Univariate	OR	95% CI	*P*
Baseline characteristics			
Age	1.010	0.952–1.072	0.742
BMI	0.917	0.793–1.048	0.212
PV	1.001	0.981–1.022	0.906
RU	1.002	1.001–1.004	0.042*
PSA	0.989	0.913–1.065	0.753
LOS	1.009	0.922–1.108	0.84
DO	27.778	8.071–131.984	< 0.001*
BC	0.213	0.079–0.487	0.001*
LOI	0.776	0.404–1.453	0.432
UD characteristics			
Storage stage			
Pdet (S)	1.084	1.046–1.135	< 0.001*
IC	2.324	1.419–4.228	0.002*
FD	0.992	0.986–0.997	0.004*
UD	0.991	0.986–0.995	< 0.001*
MCC	0.993	0.989–0.996	< 0.001*
Compliance	0.97	0.947–0.988	0.004*
Voiding stage			
Pdet (V)	1.013	0.999–1.026	0.051
Qmax (Catheter)	0.994	0.891–1.109	0.912
BCI	1.006	0.999–1.015	0.111
BOOL	1.001	0.992–1.009	0.882
Flow rate			
Qmax	0.842	0.757–0.919	0.001*
AFR	0.584	0.391–0.818	0.004*
UO	1.001	0.996–1.005	0.799
VT	0.997	0.977–1.017	0.747
Multivariate	OR	95% CI	*P*
DO	45.681	3.533–590.577	0.003*
BC			0.039*
G1	1		–
G2	0.012	0.001–0.368	0.011*
G3	0.008	0.001–0.879	0.044*
MCC	0.989	0.981–0.998	0.013*
Qmax	0.779	0.664–0.913	0.002*

*$P < 0.05$

fibrosis, increased androgen/testosterone ratio, diabetes, and metabolic syndrome [6]. Because a change in bladder detrusor function may affect the surgical treatment of BPH, it is important to understand detrusor function before operation, especially when the main LUTS are in the preoperative urine storage period.

Among patients with BPH, more than 50% are diagnosed with DO, and prevalence increases with increasing bladder outlet obstruction (BOO) [7]. DO is divided into: phase DO and terminal DO, and with or without urine leakage in the storage and micturition periods [8]. Approximately 1/3 of BOO patients will develop abnormal BC [9]. These conditions are often related to the morphological and functional changes of the bladder detrusor, and their mechanisms are unclear. It is believed that the impairment of detrusor function caused by BPH is a process from compensation to decompensation. Detrusor sensitivity increases in the early and middle stages, leading to detrusor overactivity, bladder wall fibrosis, and decreased compliance in the late stage of decompensation [10]. Frequent urination is the most common complaint during the consultation and the postoperative periods. One study found that the primary symptoms were

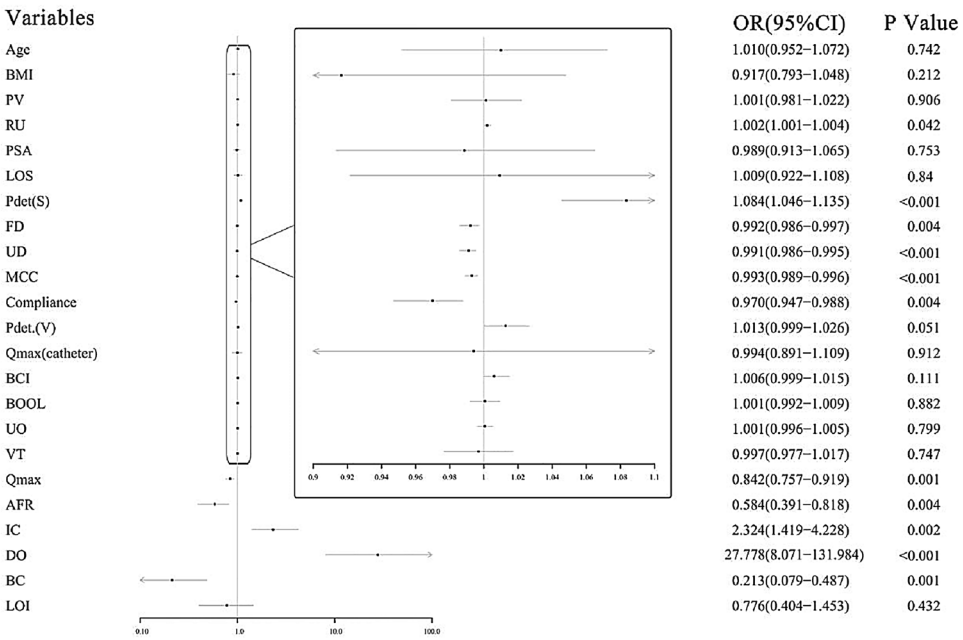

Fig. 1 Forest plot of risk factors and frequent micturition

frequent urination and nocturia. Approximately 66.2% of the patients had urinary frequency [11]. Traditionally, urinary frequency has been the primary outcome measure for evaluation of LUTS storage symptoms. More storage variables need to be captured in one measure for a better understanding of the impact of treatment on patients [12].

Urodynamic examination accurately evaluates the functional state of the urine storage period. Presently, there are few etiological studies on postoperative urinary frequency symptoms. The relationship between preoperative detrusor function and outcomes of prostate surgery is still controversial. A systematic review of 932 patients found that preoperative urodynamic DO was not correlated with improvements in all outcome parameters. Preoperative urodynamic DO seemed to have no diagnostic role in predicting treatment outcomes in transurethral surgery in patients with LUTS [13]. However, another study found significant improvements in IPSS, detrusor contractility, and urine flow after TURP in patients with BPH and weak bladder contractility or acontractile bladder [14]. Another study found that TURP provides significant improvement in storage and voiding symptoms. Preoperative urine storage period symptom score and postoperative urine storage period symptoms were strongly correlated [15].

A study found that LUTS is more common than LUTS in the urination period. The proportion of people over 60.2 years old was 74% and 37%, respectively. DO is common in men with BPO/LUTS, with an incidence rate of 60%. DO persists in approximately 30–50% of patients after TURP [16]. Another study found that 33.5% of patients developed prostate obstruction and 6% of developed DO, and there was no difference in preoperative overactive bladder symptom score (OABSS) between the patients with DO and those without. Although the presence of DO does not affect the improvement of OABSS, the overall cure rate (> 50% improvement) of patients with DO was lower than that of patients without DO [17]. Our results showed that the incidence of postoperative urinary frequency in the DO positive group was higher than that in DO negative group. The postoperative urinary frequency score of the DO positive group was higher than that of the DO negative group. This indicates a close relationship between DO before BPH and the occurrence and degree of postoperative urinary frequency. In addition, our results showed that the postoperative incidence and urinary frequency score of the patients in G1 were 86.4% and 3.00 [0.75, 6.00], respectively, and was higher than those in G2 and G3, but the difference between G2 and G3 was not significant. Thus, low BC increased the incidence and degree of urinary frequent, while normal or high compliance bladder did not. The pathological and pathophysiological basis of this relationship requires further study.

Conclusion

Preoperative bladder detrusor function of patients with BPH was related to the clinical symptoms after TURP. Understanding changes in bladder function before operation will assist BPH operation, as well as objective evaluation of the curative effects of operations and adjuvant treatments. We found that preoperative DO and low BC in postoperative patients with BPH tend to cause severe urinary frequency. Therefore, to some extent, preoperative urodynamic examination can predict the occurrence and degree of postoperative urinary frequency in patients with BPH. However,

since this is a retrospective study, the relationship between research factors and our conclusions is exploratory, and the causality needs to be further confirmed by prospective research.

Author contributions JW: project development and manuscript writing. BY: project development and manuscript writing. WZ and SS: data collection, data management, and manuscript writing. JW and YZ: manuscript editing. All authors contributed to data analysis, drafting, or revising the article, have agreed on the journal to which the article will be submitted, gave final approval of the version to be published, and agreed to be accountable for all aspects of the work.

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Availability of data and materials The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Code availability Not applicable.

Declarations

Conflict of interest The authors have declared that no conflict of interest exists.

Ethical approval This study was approved by the Ethical Review Board of Shanxi Medical University. The research complies with the provisions of the Declaration of Helsinki (as revised in 2013).

Consent to participate All patients provided written informed consent for inclusion of their data in this research.

Consent for publication Written informed consent for publication was obtained from all study participants.

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