

# Analysis of voiding dysfunction after transobturator tape procedure for stress urinary incontinence

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**Purpose:** The definition of posttransobturator tape procedure (post-TOT) voiding dysfunction (VD) is inconsistent in the literature. In this study, we retrospectively investigated the risk factors for post-TOT VD by applying various definitions in one cohort.

**Materials and Methods:** The medical records of 449 patients were evaluated postoperatively. Acute urinary retention requiring catheterization, subjective feeling of voiding difficulty during follow-up, and postoperative postvoid residual (PVR) greater than 100 mL or PVR greater than 50% of voided volume (significant PVR) were adopted for the definition of VD. With these categories, multivariate analysis was performed for risk factors of postoperative VD.

**Results:** Ten patients (2.2%) required catheterization, 47 (10.5%) experienced postoperative voiding difficulty, and 63 (14.7%) showed significant PVR. In the multivariate logistic analysis, independent risk factors for postoperative retention requiring catheterization were previous retention history ( $p=0.06$ ) and preoperative history of hysterectomy. Risk factors for subjective postoperative voiding difficulty were underactive detrusor ( $p=0.04$ ) and preoperative obstructive voiding symptoms ( $p<0.01$ ). Previous urinary retention history ( $p<0.01$ ) was an independent risk factor for concomitant postoperative voiding difficulty and significant PVR. Spinal anesthesia ( $p=0.02$ ) and previous urinary retention history ( $p=0.02$ ) were independent risk factors for significant postoperative PVR.

**Conclusions:** With the use of several definitions of VD after the midurethral sling procedure, postoperative peak flow rate and PVR were significantly different between groups. Although there were no independent risk factors consistent with various definitions of VD, preoperative obstructive voiding symptoms and objective parameters suggesting impaired detrusor tend to have predictive power for post-TOT VD.

**Keywords:** Suburethral slings; Urethral obstruction; Urinary incontinence; Urodynamics

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## INTRODUCTION

Midurethral sling (MUS) surgery is the most frequently performed procedure to treat stress urinary incontinence (SUI) in women. Although incontinence is resolved in most patients, some patients experience voiding dysfunction (VD)

[1], which is a common complication of MUS surgery for SUI [2]. VD clinically represents subjective voiding difficulties and objective significant postvoid residual (PVR) and decreased flow rate.

In the literature, VD after MUS surgery represents a wide spectrum of postoperative voiding problems. In one

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study, post-MUS VD was investigated under strict criteria defined as the need for urethral catheterization for at least 3 days [3]. Other authors defined post-MUS VD as transient voiding difficulty, which included subjective voiding difficulty or a straining pattern [4]. Although VD is a well-recognized complication, there are no clear criteria to define VD.

Symptoms of VD may vary in type and severity in a range between a feeling of incomplete emptying and prolonged urinary retention. The definition of VD includes the need for reoperation, acute urinary retention that requires transient catheterization, and subjective symptoms with or without objective voiding parameters [5]. Subjective discomfort of emptying is represented by a reduced stream or incomplete emptying. Objective voiding parameters include significant PVR with a decreased urinary flow rate (as assessed by uroflowmetry). The need for an additional procedure for bladder emptying after urethral catheter removal is also regarded as post-MUS VD [6,7].

The incidence of VD is variable and is difficult to compare owing to the various procedures and definitions of VD. Surgical intervention for VD and urinary retention has been reported in 0% to 5% of patients undergoing the MUS procedure [8]. Postoperative voiding difficulties lasting longer than 4 weeks occur in 3% to 7% of patients undergoing Burch procedures [8]. Therefore, the risk factors of post-MUS VD appear to be related to diverse parameters [6]. In addition, the various definitions of post-MUS VD can cause confusion during the explanation of informed consent and how to manage postoperative VD. Such confusion could lead a clinician to overlook the patients' complaint or overstate the risk of postoperative VD [9]. Thus, it is meaningful to analyze the risk factors for post-MUS VD with the use of various definitions for VD.

In the MUS era, surgery methods have evolved to improve the results of surgery and decrease the complications. The definitions of and methods for evaluating VD are still controversial, however. In this study, we retrospectively analyzed patients in a single institutional cohort to investigate the incidence and risk factors of VD after the transobturator tape procedure (TOT) by applying various criteria for VD.

## MATERIALS AND METHODS

From June 2006 to December 2014, a total of 467 patients underwent a transvaginal MUS operation for SUI at a single institution. Excluding the cases of surgery for MUS-related complications, the medical records of 449 patients

were reviewed retrospectively. Pre- and postoperative voiding symptoms were evaluated retrospectively. Voiding symptoms were evaluated by history taking and patient reports. Obstructive voiding symptoms included slow stream, intermittency, incomplete emptying, and hesitancy. Preoperative urodynamic studies were performed as well as uroflowmetry and measurement of PVR. The urodynamic study included cystometrogram, pressure-flow study, and measurement of urethral closure pressure and leak point pressure. The urodynamic study was performed with an MMS International model solar silver urodynamic system (MMS International, Dover, NH, USA). By use of pressure-flow study parameters, we discriminated between patients with an underactive detrusor or female bladder outlet obstruction (BOO). Underactive detrusor was defined as less than 20 cmH<sub>2</sub>O in detrusor pressure at maximal flow rate (PdetQ<sub>max</sub>) and less than 15 mL/s in peak flow rate (Q<sub>max</sub>). Female BOO was defined as more than 20 cmH<sub>2</sub>O in PdetQ<sub>max</sub> and less than 15 mL/s in Q<sub>max</sub> [10]. Specific evaluations of SUI such as the pad test for urine leakage, Q-tip test, and pelvic examination for pelvic organ prolapse were performed preoperatively.

The TOT operation was performed with the patients under spinal anesthesia and in some cases under general anesthesia. The Monarc Subfascial Hammock System (American Medical Systems, Minnetonka, MN, USA) was used for the vaginal tape. The tension of the indwelled tape was adjusted to a tension-free state taking into account the condition of the sphincter and detrusor. At the end of the operation, a 16-Fr Foley catheter was indwelled and was removed the next day in most patients. After removal of the urethral catheter, the patients' voiding state was recorded with uroflowmetry and measurement of PVR. Uroflowmetry was performed at the second voiding after Foley catheter removal. Voiding parameters and voiding symptoms were evaluated during routine check-ups at postoperative 1 week and 1 month. Incontinence state and satisfaction with the operation were surveyed at postoperative 1 year. The procedures were described in a previous study [11].

Several postoperative voiding parameters representing VD were adopted for analysis. Acute urinary retention was regarded in cases requiring catheterization for failure to void or PVR of more than 200 mL after Foley catheter removal. Subjective voiding symptoms and storage symptoms from the day of catheter removal through the follow-up period were surveyed. Voiding difficulty was regarded as patients' subjective complaints such as straining, slow stream, and feeling of incomplete emptying. Significant PVR was defined as greater than 100 mL or PVR of more

than 50% of voided volume. Patients were divided into two groups by use of the various categories to investigate the risk factors of VD. In addition, relationships between postoperative subjective symptoms and objective voiding parameters were analyzed.

In the statistical analysis, the patients were divided into two groups by the aforementioned categories. The two groups were compared by use of the Pearson chi-square test and Student t-test for differences in categorical and continuous variables, respectively. To analyze risk factors, a multivariate logistic regression analysis was adopted for factors with a p-value of than 0.1 in the univariate analysis. Statistical analysis was performed with IBM SPSS ver. 19.0 (IBM Co., Armonk, NY, USA). Statistical significance was defined as  $p < 0.05$ .

## RESULTS

The mean patient age was 52.2 years (range, 30–82 years). Three hundred eighty-four patients (87.3%) had 2 or more deliveries. Ninety-nine patients (25.3%) experienced preoperative obstructive voiding symptoms and 5 patients (1.1%) had a history of urinary retention. The number of patients with a preoperative Qmax less than 15 mL/s and with significant PVR was 48 (10.9%) and 22 (5.1%), respectively. Urodynamic study detected underactive detrusor and female BOO in 69 (17.9%) and 98 patients (25.5%), respectively. The operation was performed under spinal anesthesia in 57.9% of patients, and 9.6% underwent concomitant gynecology operations. The subjective cure rate was 92.3% and the satisfaction rate was 77.7% after 1 year. The perioperative demographics of the patients are shown in Table 1.

Of the 449 patients, 10 (2.2%) experienced retention requiring additional catheterization and 2 (0.4%) underwent tape cutting for prolonged postoperative voiding difficulty. Forty-seven patients (10.5%) experienced subjective postoperative voiding difficulty until 3 months. On the day of catheter removal, 18 patients (4.0%) complained of voiding difficulty; 36 patients (11.8%) complained of voiding difficulty at 1 week, and 29 (11.6%) did so at 1 month. Significant postoperative PVR appeared in 63 patients (14.7%). Forty patients (3.3%) complained of voiding difficulty and significant PVR simultaneously. Of the patients who experienced retention with additional catheterization, none underwent reoperation for VD or recurrent incontinence. Patients with postoperative VD showed more postoperative obstructive voiding symptoms as well as a greater decrease in Qmax and more significant PVR (Table 2). In most follow-

up periods, there were significant differences in Qmax and PVR between the groups created by use of the various criteria.

Comparative analysis was performed to determine the risk factors for post-TOT VD. In a multivariate logistic analysis, the independent risk factors for postoperative retention requiring catheterization were previous retention history (odds ratio [OR], 8.93; 95% confidence interval [CI], 1.17–68.1) and a preoperative history of hysterectomy. Risk factors for postoperative voiding difficulty were underactive detrusor (OR, 2.52; 95% CI, 1.03–6.13) and preoperative obstructive voiding symptoms (OR, 8.20; 95% CI, 2.04–32.9). For concomitant postoperative voiding difficulty and significant PVR, a previous urinary retention history (OR, 5.86; 95% CI, 5.05–68.0) was an independent risk factor. The independent risk factors for significant postoperative PVR were spinal anesthesia (OR, 0.46; 95% CI, 0.24–0.89) and previous urinary retention history (OR, 1.78; 95% CI, 1.52–20.9). Preoperative medical disease related to neuropathic bladder and preoperative urgency symptoms were not correlated

Table 1. Preoperative patient demographics and postoperative results

Parameter	Value
Demographics	
Age (y)	52.2±9.5
Body mass index (kg/m <sup>2</sup> )	25.0±3.4
Menopause	169 (44.4)
Hysterectomy	49 (11.5)
Incontinence grade (Stamey) 2	130 (30.2)
Preoperative obstructive symptoms	54 (13.8)
Previous retention history	5 (1.1)
Nonspinal anesthesia	189 (42.1)
Concomitant pelvic surgery	57 (12.7)
Urodynamic parameters	
Preoperative Qmax under 15 mL/s	48 (10.9)
Significant PVR <sup>a</sup>	22 (5.1)
Underactive detrusor <sup>b</sup>	69 (17.9)
Female BOO <sup>c</sup>	98 (25.5)
Schafer contraction grade under 4	162 (44.4)
Postoperative results	
Postoperative dissatisfaction rate	49 (22.3)
Cure rate	203 (92.3)

Values are presented as mean±standard deviation or number (%).

Qmax, peak flow rate; PVR, postvoid residual; BOO, bladder outlet obstruction.

<sup>a</sup>:Significant PVR was defined as greater than 100 mL or PVR of more than 50% of voided volume. <sup>b</sup>:Underactive detrusor was defined as less than 20 cmH<sub>2</sub>O in detrusor pressure at maximal flow rate and lower than 15 mL/s in Qmax. <sup>c</sup>:Female BOO was defined as more than 20 cmH<sub>2</sub>O in detrusor pressure at maximal flow rate and lower than 15 mL/s in Qmax.

Table 2. Postoperative voiding symptoms and voiding parameters of patient groups divided by various voiding dysfunction definitions

Variable	Postoperative retention			Subjective voiding difficulty			Voiding difficulty with significant PVR			Significant PVR		
	(-)	(+)	p-value	(-)	(+)	p-value	(-)	(+)	p-value	(-)	(+)	p-value
No. (%)	436 (97.1)	10 (2.2)		399 (89.5)	47 (10.5)		414 (96.7)	14 (3.3)		365 (81.3)	63 (14.0)	
Postoperative Qmax under 15 mL/s			0.007			0.002			<0.001			0.001
(+)	267 (63.7)	2 (20.0)		251 (65.4)	19 (41.3)		267 (64.3)	2 (14.3)		241 (66.0)	27 (42.9)	
(-)	152 (36.3)	8 (80.0)		133 (34.6)	27 (58.7)		148 (35.7)	12 (85.7)		124 (34.0)	36 (57.1)	
Postoperative PVR			<0.001			0.003			<0.001			***
(+)	361 (86.6)	3 (30.0)		333 (87.2)	32 (69.6)		364 (88.1)	0 (0)		-	-	
(-)	56 (13.4)	7 (70.0)		49 (12.8)	14 (30.4)		49 (11.9)	14 (100)		-	-	
Postoperative voiding difficulty			<0.01			***			<0.001			0.003
(+)	397 (91.9)	2 (20.0)		-	-		384 (92.3)	0 (0)		333 (91.2)	49 (77.8)	
(-)	39 (8.9)	8 (80.0)		-	-		32 (7.7)	14 (100)		32 (8.8)	14 (22.2)	
Reoperation			1.000			0.009			0.020			0.502
(+)	420 (95.7)	10 (100)		389 (96.5)	41 (87.2)		400 (96.2)	11 (78.6)		350 (95.9)	59 (93.7)	
(-)	19 (4.3)	0 (0)		14 (3.5)	6 (12.8)		16 (3.8)	3 (21.4)		15 (4.1)	4 (6.3)	
Cure rates			0.490			0.476			0.445			0.243
(+)	47 (22.0)	2 (40.0)		14 (7.3)	3 (10.3)		16 (7.7)	1 (14.3)		12 (6.5)	4 (13.8)	
(-)	167 (78.0)	3 (60.0)		177 (92.7)	26 (89.7)		191 (92.3)	7 (3.3)		173 (93.5)	25 (86.2)	
Satisfaction rates			0.311			0.098			1.000			0.465
(+)	15 (7.0)	2 (40.0)		39 (20.4)	10 (34.5)		46 (22.2)	1 (14.3)		38 (20.5)	8 (27.6)	
(-)	199 (63.0)	3 (60.0)		152 (88.9)	19 (65.5)		161 (77.8)	6 (85.7)		147 (79.5)	21 (72.4)	
Postoperative SUI			1.000			0.329			1.000			0.828
(+)	375 (88.9)	8 (88.9)		344 (89.4)	39 (84.8)		354 (88.7)	13 (92.9)		310 (88.8)	57 (90.5)	
(-)	47 (11.1)	1 (11.1)		41 (10.6)	7 (15.2)		45 (11.3)	1 (7.1)		39 (11.2)	6 (9.5)	

Values are presented as number (%).

Qmax, peak flow rate; PVR, postvoid residual; SUI, stress urinary incontinence.

Table 3. Multivariate analysis for preoperative risk factors of postoperative voiding dysfunction

Variable	Subjective voiding difficulty			Postoperative retention			Postoperative Qmax<15 & significant PVR			Voiding difficulty with significant PVR			Significant PVR		
	OR (95% CI)	p-value		OR (95% CI)	p-value		OR (95% CI)	p-value		OR (95% CI)	p-value		OR (95% CI)	p-value	
Hysterectomy	0.93 (0.34–2.48)	0.887		8.93 (1.17–68.1)	0.035		2.68 (0.86–8.30)	0.086		0.96 (0.11–8.14)	0.977		1.25 (0.43–3.61)	0.673	
Qmax under 15 mL/s	0.18 (0.10–1.54)	0.411		0.42 (0.01–14.7)	0.639		0.95 (0.91–0.99)	0.018		1.14 (0.12–10.4)	0.906		2.29 (0.79–6.60)	0.125	
Qmax (mL/s)	0.98 (0.95–1.01)	0.261		1.01 (0.93–1.10)	0.784		0.94 (0.90–0.98)	0.002		0.99 (0.93–1.05)	0.788		0.98 (0.95–1.01)	0.280	
Underactive detrusor	2.52 (1.03–6.13)	0.042		0.95 (0.05–15.8)	0.976		0.82 (0.25–2.60)	0.736		0.81 (0.14–4.76)	0.824		0.47 (0.15–1.40)	0.177	
Spinal anesthesia	1.27 (0.73–2.21)	0.390		1.49 (0.19–11.2)	0.698		0.37 (0.15–0.87)	0.023		1.13 (0.14–8.83)	0.810		0.47 (0.24–0.89)	0.026	
Preoperative obstructive symptoms	3.71 (1.51–9.10)	0.004		1.84 (0.18–18.0)	0.595		2.05 (0.76–5.55)	0.155		2.29 (0.24–21.1)	0.464		1.62 (0.70–3.75)	0.253	
Previous retention history	11.6 (0.89–152)	0.061		415 (20.0–8,619)	<0.001		18.0 (1.41–231)	0.026		58.6 (5.0–680)	0.001		17.8 (1.52–209)	0.020	

Qmax, peak flow rate; PVR, postvoid residual; OR, odds ratio; CI, confidence interval.

with postoperative VD (Table 3).

## DISCUSSION

The risk factors for VD after MUS surgery remain controversial, and this inconsistency in risk factors may have several causes. The pathophysiology of post-MUS VD is not well understood [12]. Various operative methods affect the rate of postoperative complications [1]. Furthermore, the definition of postoperative VD is inconsistent among studies [5]. The inconsistent definitions of VD after MUS may be responsible for the wide spectrum of VD reported in various studies. The types of VD evaluated and the timing of symptom presentation can influence the definitions adopted in the literature [13].

The operative methods used to treat SUI have evolved. The various operations differ in the incidence of postoperative VD. Over several decades, colposuspension and pubovaginal sling operations have been replaced by midurethral synthetic slings, which are currently accepted as the gold standard for the management of SUI [14]. Voiding difficulties appear to be more likely after colposuspension than after the transvaginal tape (TVT) procedure [15]. TOT procedures appear to cause a lower incidence of postoperative VD than retropubic TVT [16]. Furthermore, as operative methods evolve, the severity of VD tends to be reduced [1]. The TOT procedure appears to have a lower incidence of postoperative retention than does retropubic TVT [17].

In studies on Burch colposuspension and pubovaginal slings, many authors investigated post-MUS VD with use of the criteria of the need for surgical revision or the need for catheterization for several weeks [1,18]. In one pooled meta-analysis, the rates of reoperation for urinary retention were reported as 3.0% (range, 2.3%–3.9%) of the population who received a pubovaginal sling compared with 1.2% (range, 0.9%–1.7%) and 1.1% (range, 0.7%–1.5%) of the TVT and TOT populations, respectively [1]. In the era of MUS surgery, many studies have investigated VD under the criteria of objective voiding parameters or subjective voiding symptoms [17]. In the present study, compared with the TVT group, the TOT group had a lower frequency of VD (4% vs. 7%; risk ratio, 0.53; 95% CI, 0.43–0.65).

Another pitfall of the study of VD is the lack of consensus on which parameters are important voiding problems. The method used for the voiding trial just after catheter removal can influence the incidence of VD. Furthermore, intervention methods such as indwelling bladder catheterization or intermittent catheterization



for retention affect the recovery period [19]. In one study, urinary retention was acknowledged when catheterization lasted at least 4 weeks, whereas in another study this parameter was at least 1 day [20,21]. In the present study, significant PVR was considered to be a PVR of more than 50% of voided volume, whereas others have adopted a cutoff of 100 mL PVR [19]. It is also debated whether to catheterize for obstructive voiding symptoms or not [22].

In the TVT population, catheterization over several days was applied for VD. Patients with prolonged catheterization made up 2.8% to 8.5% of the population [3,23]. More severe cases underwent a releasing operation, which occurs in 1.2% of the population with TVT [1]. In studies of TOT, the majority definitions applied for VD are decreased objective voiding parameters or subjective voiding difficulties. In the TOT population, 7.6% to 26% show mild postoperative VD [4,24,25].

The diversity and complexity of VD after SUI correction require various criteria to evaluate postoperative obstructive voiding problems. We applied several criteria to elucidate the incidence and risk factors of VD. In our cohort, all patients underwent the TOT procedure as opposed to pubovaginal sling or TVT. Therefore, there were few severe complications such as reoperation for releasing (0.4%) or retention requiring catheterization (2.2%). Subjective postoperative voiding difficulty occurred in 10.5% of patients, and 3.3% had simultaneous voiding difficulty and significant PVR. The various VD rates in our cohort were comparable to those of other previous studies on TOT.

Many studies have been performed to investigate preoperative urodynamic and clinical parameters for predicting VD after sling surgery. In one study, concomitant vaginal surgeries did not affect the rates of VD in terms of retention or requiring a releasing operation [26]. Preoperative urodynamic findings indicating impaired detrusor contractility may predict postoperative VD. High preoperative PVR, low preoperative Q<sub>max</sub>, and low detrusor pressure during a pressure-flow study have been indicated as significant risk factors for postoperative VD after anti-incontinence surgeries [3,27,28]. In another study, however, there were no definite risk factors for post-MUS VD among the urodynamic parameters [25,29]. In our study, preoperative Q<sub>max</sub> and underactive detrusor appeared to predict postoperative VD by use of some criteria. Preoperative urodynamic parameters did not demonstrate consistently reproducible prediction for VD in this study. On the whole, our data showed subjective preexisting obstructive voiding symptoms (eg, urinary hesitancy, slow stream, intermittent flow, and incomplete emptying) to be risk factors.

With regard to other risk factors excluding urodynamic study parameters, spinal anesthesia compared with general anesthesia appeared to be a risk factor for significant PVR in our results. However, the type of anesthesia did not affect postoperative retention. Moreover, hysterectomy was a risk factor for retention but not for significant PVR. These inconsistencies may originate from our incomplete data, which were retrospectively collected, and the small number of patients with a history of preoperative retention. In terms of satisfaction, there was a report that a high level of satisfaction with operative results is associated with greater cure rates and fewer complications [30]. In our study, however, there were no significant differences in cure rates or satisfaction rates between the VD group and the non-VD group except for the criterion of retention.

Our study had several drawbacks. Follow-up loss after 3 months was seen in up to half of the patients. This was compensated for by use of a telephone survey at 1 year postoperatively. During the follow-up period, the examinations performed were diverse, including cystoscopy, radiologic study, and postoperative urodynamic study. Therefore, the pathophysiology of postoperative VD could not be considered properly. Compared with other studies, there were lower rates of retention requiring catheterization. The low retention rates made it difficult to estimate the preoperative risk factors. Furthermore, it was impossible to examine the optimal timing for the proper management of prolonged retention or voiding difficulties.

## CONCLUSIONS

Several criteria can be adopted to investigate VD after MUS surgery. These criteria represent the wide spectrum of post-MUS VD from mild subjective complaints to severe obstructive voiding symptoms requiring prolonged catheterization. With these various criteria, postoperative VD can be predicted and managed more efficiently. Although there were no consistent preoperative risk factors in our study, our data suggest that preoperative obstructive voiding symptoms, preoperative retention history, and objective voiding parameters suggesting impaired detrusor function may predict VD. A more sophisticated analysis in a large, single population could reveal more precise parameters predicting various postoperative voiding conditions.

## CONFLICTS OF INTEREST

The authors have nothing to disclose.