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ORIGINAL ARTICLE

Outcome of coexistent overactive bladder symptoms in women with urodynamic urinary incontinence following anti-incontinence surgery

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Abstract
Introduction and hypothesis The objective was to investigate the outcome of stress urinary incontinence (SUI) and overactive bladder (OAB) symptoms in women with urodynamic stress incontinence (USI) after transobturator sling procedures (TOTs).
Methods We evaluated 109 consecutive patients with USI, who had undergone TOT in a tertiary hospital between 2012 and 2014. All patients received evaluations, including structured urogynecological questionnaires and pelvic organ prolapse quantification examination before, and 3 and 12 months after surgery. One-hour pad test and urodynamic testing were performed before and 3–6 months postoperatively. Patient demographics, lower urinary tract symptoms, and urodynamic results were analyzed between pure USI and USI with OAB symptoms.
Results Persistent SUI occurred in 8 patients at 3 months (7.3 %) and 7 patients at 12 months (6.4 %) postoperatively. The most common OAB symptom was frequency (54.1 %), followed by urgency urinary incontinence (52.3 %), urinary urgency (42.2 %), and nocturia (33 %). Most of these OAB symptoms were resolved at the 3-month and 12-month follow-ups both in patients treated with TOT only and in those treated with TOT combined with other pelvic surgeries. There was no significant difference in the preoperative urodynamic changes between patients with pure USI and USI without OAB groups. However, postoperative urodynamic results showed a significant decrease in the maximal urethral closure pressure in the group of patients with USI and OAB symptoms, but no significant urodynamic changes in the group with pure USI.
Conclusions Coexistent OAB symptoms are common in women who were diagnosed with USI and most of these symptoms may resolve 3 and 12 months after TOT.

Keywords Anti-incontinence surgery · Overactive bladder · Stress urinary incontinence · Transobturator sling

Abbreviations

DO	Detrusor overactivity
IIQ-7	The short form of the Incontinence Impact Questionnaire
LUTS	Lower urinary tract symptoms
MUCP	Maximal urethral closure pressure
MUI	Mixed urinary incontinence
OAB	Overactive bladder
POP	Pelvic organ prolapse
SUI	Stress urinary incontinence
TOT	Transobturator sling procedure
TVT	Tension-free vaginal tape
UDI-6	The short form of the Urogenital Distress Inventory
USI	Urodynamic stress incontinence
UUI	Urgency urinary incontinence

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Introduction

Stress urinary incontinence (SUI) and overactive bladder (OAB) symptoms are common physical conditions that may have a negative impact on women's quality of life [1, 2]. Many women with SUI often present with other lower urinary tract symptoms (LUTS), including frequency, nocturia, urgency, and/or urgency urinary incontinence (UUI), suggesting OAB [3, 4]. In fact, mixed urinary incontinence (MUI), SUI combined with UUI symptoms, has been reported to cause more discomfort than pure incontinence subtypes [5]. The prevalence of MUI among women suffering from urinary incontinence varies from 29 to 69 % [6]. Treatment of UUI and detrusor overactivity (DO) may involve drugs, behavioral therapy or biofeedback [7], but some investigators suggest that operative cure of SUI has a beneficial effect on UUI symptoms and DO [6, 8–18]. It has been reported that 50–74 % of patients with MUI are cured of UUI after anti-incontinence surgery [17, 18]. However, more than half of the patients with preoperative DO who underwent transobturator or retropubic mid-urethral sling cannot resolve their DO [16–18]. Presence of DO has been reported to be associated with a higher failure rate of UUI treatment after mid-urethral sling in patients with MUI [19]. Therefore, in the past decade, patients diagnosed with preoperative DO are routinely excluded from undergoing any type of mid-urethral sling in our institute.

Many mid-urethral sling procedures for relieving SUI have been introduced recently; the transobturator sling procedure (TOT) is performed frequently and has shown favorable clinical outcomes [20, 21]. Additionally, most studies on SUI focus on the cure of incontinence after mid-urethral slings rather than the effect of these procedures on coexistent LUTS. We hypothesize that TOT might resolve coexistent OAB symptoms postoperatively in women with SUI. The purpose of this study is to demonstrate the outcome of LUTS among women who underwent TOT for urodynamic stress incontinence (USI) 3 months and 1 year after surgery.

Materials and methods

In this cohort study, we reviewed the medical records of consecutive patients with USI, who underwent TOT (Align Urethral Support Systems; Bard, Covington, GA, USA) at our institute, a tertiary hospital, between November 2012 and October 2014. We included all patients with USI who received the Align sling. None of the patients took anti-muscarinics to improve preoperative OAB symptoms before TOT was performed. Patients with urodynamic evidence of DO were excluded because of surgical exclusion guidelines, which have been implemented for many years in our institute. The ethics committee of our university hospital approved the study protocol (no. 104-1172B).

The preoperative evaluation included general and obstetric histories, a voiding diary, 1-h pad test, urinalysis and urine culture, pelvic examination utilizing the Pelvic Organ Prolapse (POP) Quantification System [22], and a full urodynamic evaluation. The urodynamic studies included provocative sitting water cystometry (at a filling rate of 50 ml/min), urethral profilometry at rest and with repeated coughing, and the bladder at maximum cystometric capacity in the sitting position. Upon entry and at the out-patient department, patients were interviewed using a structured urogynecological questionnaire regarding the presence of LUTS [23], in which LUTS was defined based on International Continence Society definitions [24]. The questionnaire included eight questions that described the symptoms of SUI, the frequency of micturition, nocturia, urgency, UUI, incomplete emptying, voiding difficulty, and straining. All answers to questions were in yes/no dichotomy. Other validated questionnaires, the short form of the Urogenital Distress Inventory (UDI-6) and the short form of the Incontinence Impact Questionnaire (IIQ-7), were also completed at the same time to assess the effect of surgery on urinary incontinence.

Either regional or general anesthesia was used according to patients' and surgeons' preferences. All patients with USI underwent the Align procedure, using a tunneler from outside the entrance point to adjust the tape without tension. The Align anti-incontinence system comprises halo introducers and a polypropylene mesh sling implant encased in a protective sheath with green guide tubes at each end. Connectors designed to attach to the tip portion of the introducer needles are attached to the distal ends of the guide tubes. Patients in the combined pelvic surgery group received TOT and additional pelvic reconstructive surgeries for the treatment of USI and POP. Additional surgical procedures for prolapse repair included vaginal hysterectomy, anterior and/or posterior colporrhaphy, sacrospinous suspension, and transvaginal mesh procedure.

The Foley catheter was removed within 24 h after surgery. Patients were discharged once they were able to void spontaneously, with residual urine less than 20 % of the self-voiding volume. They then underwent postoperative follow-up at 1 week, 1 month, 3 months, 6 months, and 1 year after surgery. Urodynamic studies were performed at 3–6 months after surgery to detect the objective postoperative continence rate. The same questionnaires were conducted 12 months after surgery.

A diagnosis of pure USI was made if the patient exhibited symptoms of SUI, observable leakage with stress, no simultaneous detrusor activity when undergoing cystometry and urethral profilometry studies; the diagnosis of postoperative SUI was established if the patient lost urine on coughing, sneezing, or physical exertion after surgery. Patients who had complaints of involuntary loss

Table 1 Patient characteristics

Variable	USI + OAB ($n = 77$)	Pure USI ($n = 32$)	Total ($n = 109$)	p value
Age (years)	55.9 ± 9.7	54.7 ± 10.8	55.5 ± 9.7	0.785
Parity	2.8 ± 1.1	2.9 ± 1.1	2.8 ± 1.1	0.683
BMI (kg/m^2)	25.3 ± 3.8	25.7 ± 3.9	25.4 ± 3.5	0.815
Duration (months)	52.5 ± 46.5	42.3 ± 41.0	49.6 ± 44.5	0.272
Menopause	46 (59.7 %)	16 (50.0 %)	62 (56.9 %)	0.241
Diabetes	10 (13.0 %)	4 (12.5 %)	14 (12.8 %)	0.760
Previous hysterectomy	17 (22.1 %)	6 (18.8 %)	23 (21.1 %)	0.497
Previous pelvic surgery	7 (9.1 %)	2 (6.2 %)	9 (8.3 %)	0.318
Operating time (min)	73.8 ± 35.2	70.1 ± 33.9	72.7 ± 33.7	0.823
Blood loss (mL)	59.1 ± 82.4	60.3 ± 104.0	59.5 ± 89.1	0.843
TOT only	51 (66.2 %)	19 (59.4 %)	70 (64.2 %)	0.394
TOT + prolapse repair	26 (33.8 %)	13 (40.6 %)	39 (35.8 %)	0.408
IIQ-7	13.9 ± 5.6	8.2 ± 3.9	12.2 ± 4.9	0.001
UDI-6	14.5 ± 3.1	9.3 ± 7.4	13.0 ± 3.3	0.001

Data are presented as mean ± standard deviation and n (%)

USI urodynamic stress incontinence, *OAB* overactive bladder, *BMI* body mass index, *TOT* transobturator sling procedure, *IIQ-7* Incontinence Impact Questionnaire, *UDI-6* Urogenital Distress Inventory

of urine associated with urgency were considered to have UUI. MUI was defined as involuntary loss of urine associated with urgency and also with effort or physical exertion or upon sneezing or coughing. Unless otherwise stated, the terminology used in this article conforms to the recommendations of the International Continence Society and International Urogynecological Association [25].

Statistical analysis was completed using SPSS version 20. Fisher's exact test was used to assess categorical data, and Student's t test was applied to evaluate continuous variables. To compare preoperative and postoperative responses to individual questions, a generalized McNemar's test was performed. A p value of < 0.05 was considered statistically significant.

Results

A total of 109 patients (77 with and 32 without OAB symptoms) met the criteria and were included for analysis. UDI-6 and IIQ-7 scores were significantly increased in OAB group before surgery ($p = 0.001$), compared with non-OAB group (Table 1). Seventy patients received TOT only and 39 patients underwent TOT combined with pelvic surgeries. Additional pelvic reconstructive procedures in the combined pelvic surgery group included sacrospinous ligament suspension in 5 patients, transvaginal mesh in 11 patients, vaginal hysterectomy in 15 patients, anterior colporrhaphy in 22 patients and posterior colporrhaphy in 21 patients.

Table 2 Prevalence of lower urinary tract symptoms (*LUTS*) before, and 3 and 12 months after TOT surgery

LUTS	Before surgery	3 months after surgery	12 months after surgery	p value
SUI ($n = 109$)	109/109 (100 %)	8/109 (7.3 %)	7/109 (6.4 %)	P1: 0.001 P2: 0.001
Urgency ($n = 46$)	46/46 (100 %)	12/46 (26.1 %)	6/46 (13.0 %)	P1: 0.001 P2: 0.001
UUI ($n = 57$)	57/57 (100 %)	9/57 (15.8 %)	7/57 (12.3 %)	P1: 0.001 P2: 0.001
Frequency ($n = 59$)	59/59 (100 %)	14/59 (23.7 %)	11/59 (18.6 %)	P1: 0.001 P2: 0.001
Nocturia ($n = 36$)	36/36 (100 %)	17/36 (47.2 %)	11/36 (30.6 %)	P1: 0.003 P2: 0.001
IIQ-7	12.2 ± 4.9	8.6 ± 4.7	8.3 ± 3.5	P1: 0.001 P2: 0.001
UDI-6	13.0 ± 3.3	9.3 ± 2.9	8.9 ± 4.1	P1: 0.001 P2: 0.001

Data are presented as n (%). All P3 values are < 0.05 and not shown in the table

SUI stress urinary incontinence, *UUI* urgency urinary incontinence

P1: to compare preoperative and 3-month postoperative data

P2: to compare preoperative and 12-month postoperative data

P3: to compare 3- and 12-month postoperative data

Table 3 Pre- and postoperative LUTS prevalence in patients who underwent TOT only or combined pelvic surgery

	TOT only, $n = 70$ (%)	TOT + prolapse repair, $n = 39$ (%)	Total, $n = 109$ (%)	p value
Before operation				
SUI	70 (100)	39 (100)	109 (100)	
Urgency	32 (45.7)	14 (35.9)	46 (42.2)	0.465
UUI	40 (57.1)	17 (43.6)	57 (52.3)	0.388
Frequency	39 (55.7)	20 (51.3)	59 (54.1)	0.314
Nocturia	22 (31.4)	14 (35.9)	36 (33.0)	0.299
3-month LUTS				
SUI	7 (10.0)	1 (2.6)	8 (7.3)	0.198
Urgency	6 (8.6)	6 (15.4)	12 (11.0)	0.490
UUI	5 (7.1)	4 (10.3)	9 (8.3)	0.299
Frequency	6 (8.6)	8 (20.5)	14 (12.8)	0.017
Nocturia	9 (12.9)	8 (20.5)	17 (15.6)	0.038
12-month LUTS				
SUI	5 (7.1)	2 (5.1)	7 (6.4)	0.645
Urgency	4 (5.7)	2 (5.1)	6 (5.5)	0.557
UUI	5 (7.1)	2 (5.1)	7 (6.4)	0.731
Frequency	8 (11.4)	3 (7.7)	11 (10.1)	0.563
Nocturia	9 (12.9)	2 (5.1)	11 (10.1)	0.287

Data are presented as n (%)

In Table 2, the most common coexistent OAB symptom was frequency (54.1 %), followed by UUI (52.3 %), urinary urgency (42.2 %), and nocturia (33 %). Postoperative SUI was found in 8 (7.3 %) and 7 (6.4 %) patients at 3 months and 12 months respectively. The prevalence of postoperative OAB symptoms declined to 13 % in urgency, 12.3 % in UUI, 18.6 % in frequency, and 30.6 % in nocturia at the 12-month follow-up. Both UDI-6 and IIQ-7 scores were significantly improved postoperatively. The prevalence of frequency and nocturia were higher in the combined pelvic surgery group than in the TOT only group at 3 months after surgery, but most of the OAB symptoms had resolved by the 12-month follow-up regardless of operating methods (Tables 2, 3). Four patients with postoperative OAB symptoms (2 persistent UUI and 2 de novo UUI) received anti-muscarinic drugs for 4 months at the 3-month follow-up, which improved their urological problems thereafter. The de novo LUTS at the 12-month follow-up included urgency in 4 (3.7 %), UUI in 4 (3.7 %), frequency in 3 (2.8 %), and nocturia in 4 (3.7 %). All these patients improved their OAB symptoms after a 4-month anti-muscarinic treatment.

Table 4 Comparison of urodynamic values of patients with pure USI and those with USI and OAB symptoms before TOT surgery

	Mean ± SD		p value
	USI + OAB ($n = 77$)	Pure USI ($n = 32$)	
Qmax (ml/s)	25.2 ± 11.3	25.4 ± 10.0	0.876
Vresidual (ml)	40.4 ± 54.9	28.6 ± 27.0	0.391
FDV (ml)	165.6 ± 70.9	165.1 ± 70.4	0.804
MCC (ml)	387.9 ± 123.7	426.2 ± 167.4	0.127
MUCP (cm H_2O)	66.1 ± 28.7	56.3 ± 20.8	0.092
FL (mm)	24.1 ± 6.7	24.2 ± 5.9	0.986
Pdet Qmax (cm H_2O)	18.4 ± 10.5	15.2 ± 10.3	0.294
Pdet Max (cm H_2O)	30.7 ± 17.9	27.8 ± 12.5	0.247
Pad test (g)	19.8 ± 9.5	19.9 ± 6.8	0.491

Qmax maximum flow rate, *Vresidual* residual urine, *FDV* first desire to void, *MCC* maximum cystometric capacity, *MUCP* maximal urethral closure pressure, *FL* functional urethral length, *Pdet Qmax* detrusor pressure at maximum flow, *Pdet Max* maximum detrusor pressure

Eighty-two patients (56 patients with USI and OAB, and 26 patients with pure USI) received postoperative urodynamic testing. The remaining 27 patients noted improvement of incontinence after TOT and refused to receive postoperative urodynamic examination. There was no significant difference in urodynamic changes between the pure USI group and the group of patients with USI and OAB symptoms (Table 4). With subsequent analyses, however, postoperative urodynamic results showed a significant decrease in the maximal urethral closure pressure (MUCP) in the group with USI and OAB symptoms (Table 5), but no significant urodynamic changes in the pure USI group (Table 6).

Discussion

Our results showed an overall cure rate of 93 % for SUI after TOT, which is compatible with previously reported results

Table 5 Urodynamic results of patients with USI and OAB symptoms before and after TOT surgery

	Mean ± SD		*p* value
	Before operation (*n* = 56)	After operation (*n* = 56)	
Qmax (ml/s)	24.2 ± 9.4	22.0 ± 9.9	0.228
Vresidual (ml)	39.2 ± 57.1	47.1 ± 53.6	0.444
FDV (ml)	164.2 ± 69.6	170.8 ± 78.2	0.634
MCC (ml)	384.4 ± 104.8	387.1 ± 119.7	0.896
MUCP (cm H_2O)	69.0 ± 26.9	55.4 ± 21.0	0.003
FL (mm)	25.5 ± 6.3	25.2 ± 5.1	0.770
Pdet Qmax (cm H_2O)	16.7 ± 11.3	18.9 ± 16.9	0.413
Pdet Max (cm H_2O)	31.4 ± 17.3	41.8 ± 43.8	0.097
Pad test (g)	30.7 ± 30.0	1.2 ± 4.8	0.001

[20, 21], and confirmed that TOT is effective in correcting the SUI component in patients with MUI [8]. Some reports indicated a substantial resolution of OAB symptoms in women with MUI after anti-incontinence surgeries, but with lower cure rates than for pure SUI [8, 12, 26]. A meta-analysis study revealed that the overall cure rates of urgency and UUI symptoms were 30 to 85 % after mid-urethral slings [8]. TOT was demonstrated to have the highest resolution of preoperative DO and UUI among mid-urethral slings, including TOT, tension-free vaginal tape (TVT), and suprapubic arch sling [10, 16, 17]. In addition, the presence of preoperative DO and concomitant pelvic surgeries showed a wide range of variation in the cure rate of OAB symptoms in women with MUI.

The treatment of OAB with DO can involve anticholinergic medications, behavioral therapy or biofeedback [7], but the role of surgery for MUI with DO on urodynamics is still controversial. The prevalence of DO in patients with MUI varies from 29.4 % to 67.6 % [16–18]. The presence of preoperative DO in patients with USI receiving mid-urethral slings, TVT or TOT, has been reported to be an independent risk factor for persistent urgency or UUI [10, 16–18]. Choe et al. [18] separated 549 patients with SUI receiving TVT into patients with and without DO, and reported that the group with DO had a significantly higher resolution rate than the group without DO with regard to OAB symptoms (37 % vs 18 %). Another study on MUI and OAB symptoms reported by Gamble et al. [17] described the resolution of preoperative DO in 31.5 % of patients and the resolution of preoperative UUI in 56 % after the application of mid-urethral slings. Because many patients who suffer from MUI symptoms do not demonstrate DO on urodynamics, this may complicate the relationship between OAB symptoms and DO [7]. Therefore, some authors suggest that SUI patients with significant symptoms and signs of DO are not suitable for mid-urethral slings [11]. In the current study, the women were assessed preoperatively with urodynamic testing, and those with DO were excluded because of surgical exclusion guidelines in our institute. Preoperatively, 33–53 % of patients complained of UUI and other OAB symptoms, but most of the coexistent OAB symptoms resolved 3 months after TOT surgery. We found the rates of postoperative urgency, UUI, frequency, and nocturia at 12 months following TOT to be 12–31 %, which is concordant with previous reports [8–10]. To date,

Table 6 Urodynamic results of patients with pure USI before and after TOT surgery

	Mean ± SD		*p* value
	Before operation (*n* = 26)	After operation (*n* = 26)	
Qmax (ml/s)	25.9 ± 10.5	20.4 ± 9.9	0.068
Vresidual (ml)	28.6 ± 27.2	46.0 ± 45.2	0.084
FDV (ml)	168.0 ± 71.2	181.5 ± 80.0	0.539
MCC (ml)	429.8 ± 181.8	393.5 ± 136.3	0.438
MUCP (cm H_2O)	59.2 ± 22.9	52.3 ± 20.9	0.655
FL (mm)	23.1 ± 5.7	23.9 ± 4.3	0.590
Pdet Qmax (cm H_2O)	14.0 ± 10.9	17.5 ± 11.5	0.273
Pdet Max (cm H_2O)	26.1 ± 13.1	37.8 ± 27.3	0.065
Pad test (g)	32.9 ± 32.6	1.3 ± 3.3	0.001

studies that reveal the surgical result of MUI without DO after mid-urethral sling have rarely been published [11]. The results of this study may provide physicians with a valuable reference in the treatment of urinary incontinence.

Some women with MUI along with advanced POP or uterine diseases required prolapse repair or hysterectomy. Under these circumstances, it might be worthwhile performing a concomitant anti-incontinence procedure for SUI, even with less than 50 % improvement in DO and UUI symptoms. Women with POP often present with SUI and a variety of LUTS [27], but only a few studies have been conducted to investigate the effect of concomitant pelvic reconstructive surgery on persistent SUI and OAB symptoms in women with MUI undergoing anti-incontinence surgery [8, 10]. A prospective cohort study demonstrated that concomitant prolapse surgery and use of TOT feasibly decrease the risks of persistent urgency and UUI in patients with MUI [10]. It is conceivable that apical and anterior vaginal wall prolapse might distort the bladder base or cause outlet obstruction and thereby induce OAB symptoms, which are likely corrected by concomitant pelvic surgeries [10]. Our results showed no significant difference in the prevalence of postoperative SUI and other LUTS between patients who had undergone TOT only and those who had undergone TOT combined with pelvic reconstructive surgery. Persistent symptoms of MUI were present in 12–31 % of women at 12 months after TOT.

There are still limitations to the use of preoperative urodynamic parameters for predicting the outcomes of mid-urethral sling in women with MUI [9]. In the present study, there was no significant difference in preoperative urodynamic changes between patients with pure USI and MUI. However, postoperative urodynamic results showed a significant decrease in the MUCP in the MUI group after TOT operation. Sun et al. [28] compared preoperative and postoperative urodynamic changes in 42 patients undergoing an TVT-obturator, an inside–out TOT, and found a significant decrease in the MUCP after surgery. Lower MUCP after TOT may be due to tissue dissections resulting in the disruption of the peri-urethral supportive tissue. A cohort study demonstrated that anti-incontinence surgery is a risk factor for lower MUCP in women with MUI [29].

The limitations of this study include its retrospective nature, a relatively small sample size, a lack of a more objective tool to demonstrate the anatomical change, and that the findings in Asian women may not be generalizable to other groups such as Caucasians and African–Americans. In addition, we did not use a bladder diary to investigate patients' urological problems. Our data showed 11 patients who had UUI, but did not experience urgency before the operation. It is possible that some patients did not fully comprehend the meaning of UUI when they answered a yes/no question regarding LUTS. Furthermore, postoperative urodynamic studies in our patients were not performed at 12 months after continence surgery, which may have provided more information regarding urodynamic changes. However, Black et al. [30] advocated that outcomes need to be assessed only once and at any time 3 to 12 months after continence surgery because of the stability of the outcome measures over the first postoperative year. They conducted a longitudinal study to determine the effect of timing on the assessment of outcome in 442 women undergoing surgery for SUI and came to the above conclusion [30]. In our institute, it is routine to arrange urodynamic studies 3–6 months after continence surgery to detect the objective postoperative continence rate in the past decade. It is essential to conduct a longer urodynamic study to demonstrate the objective success rate of anti-incontinence surgery in the near future. Its strengths include urodynamic testing performed in a single laboratory, with operations performed by the primary surgeons using the same synthetic tape and techniques, and the assessment of patient-reported urological symptoms with validated, structured questionnaires.

In conclusion, our results show that the use of TOT to correct USI has favorable clinical outcomes. Coexistent OAB symptoms are common in women who were diagnosed with USI and most of these symptoms resolve after anti-incontinence surgery.

Compliance with ethical standards

Conflicts of interest None.

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