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ORIGINAL ARTICLE

Which women develop urgency or urgency urinary incontinence following midurethral slings?

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Abstract
Introduction and hypothesis De novo urgency has a negative impact on women after midurethral sling (MUS). We aimed to identify risk factors for de novo urgency (dU) and urgency urinary incontinence (dUUI) following MUS, using multivariate analysis.
Methods We investigated 358 consecutive women with only stress urinary incontinence (SUI) [or urodynamic stress incontinence (USI)] and 598 women with both SUI (or USI) and urgency (but not UUI) who underwent MUS with a mean follow-up of 50 months. Women who developed dU or dUUI at long-term follow-up were compared to those who did not.
Results dU occurred in 27.7 % (99/358) and dUUI occurred in 13.7 % (82/598) of women at long-term follow-up after midurethral sling. Intrinsic sphincter deficiency {odds ratio (OR) dU 3.94 [95 % confidence interval (CI) 1.50–10.38]; OR dUUI 2.5 (1.31–4.80)}, previous stress incontinence surgery [sling: OR dU 3.69 (1.45–9.37); colposuspension: OR dUUI 2.5 (1.23–5.07)], previous prolapse surgery [OR dU 2.45 (1.18–5.10)], preexisting detrusor overactivity [OR dU 1.99 (1.15–3.48); OR dUUI 1.85 (1.31–2.60)] increased the risk, whereas performing concomitant apical prolapse surgery [OR dU 0.5 (0.41–0.81); OR dUUI 0.29 (0.087–0.97)] significantly decreased the risk. Women are more likely to not recommend surgery when they experienced dU (18.2 vs 0.8 %, $p<0.0001$) or dUUI (20.7 vs 2.1 %, $p<0.0001$).
Conclusions Urodynamic parameters, history of prior incontinence or prolapse surgery and concomitant apical prolapse operation were important predictors of dU or dUUI following MUS.

Keywords De novo urgency · Midurethral slings · Overactive bladder symptoms · Pelvic organ prolapse · Urodynamic studies

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Introduction

Surgery is a common intervention for stress urinary incontinence (SUI) with midurethral sling (MUS) procedures becoming increasingly popular [1, 2]. Despite its efficacy in treating SUI, there is a concern MUS might lead to de novo urgency (dU) or urgency urinary incontinence (dUUI). Systematic reviews of randomised controlled trials (RCTs) had suggested that the rate of de novo irritative voiding symptoms following MUS is in the order of 11–19 % [3]. Population-based prevalence studies had indicated a greater impact on health-related quality of life from the urgency component of lower urinary tract symptoms [4]. Not surprisingly, de novo overactive bladder (OAB) symptoms have a negative impact and consequently patient dissatisfaction following MUS [5].

Logically the term "de novo urgency" implies that patients did not have urgency symptoms *pre*operatively and subsequently developed urgency *post*operatively [6, 7]. Significant prevalence rates of dU following MUS drew attention to the need to identify patients at risk of developing these postoperative symptoms. This could then facilitate

optimal preoperative counselling directed towards appropriate patients' expectations. Using similar methodology, we had already reported on risk factors associated with persistence of urgency or UUI following MUS [8]. In this study we aim to determine what risk factors lead to the development of both dU and dUUI following MUS procedures in women who previously had no such symptoms.

Materials and methods

We examined and compared 358 consecutive women with only SUI [or urodynamic stress incontinence (USI)] with 598 women who had both SUI/USI and urgency (but not UUI) who underwent MUS surgery from May 1999 till August 2008 with a mean follow-up of 50 months. All women gave consent to undergo urogynaecological assessment and be included in the study to evaluate long-term outcomes following their surgery. The local Hospital Ethics Committee approved the project (R08/08). Comprehensive history was obtained comprising demographics information, medical history, symptoms of lower urinary tract and pelvic floor dysfunction, followed by full physical examination, urodynamic and surgical reports recorded on a detailed pro forma. Methods, definitions and units conform to the standards jointly recommended by the International Continence Society and the International Urogynecological Association, except where specifically noted [7].

Intrinsic sphincter deficiency (ISD) was defined as either a maximum urethral closure pressure (MUCP) of 20 cmH_2O or less [9] and/or a pressure rise from baseline required to cause urinary incontinence (Δ Valsalva or cough leak point pressure) of 60 cmH_2O or less [10].

Placement of all MUS were performed in the standard manner as previously described [11, 12], with the selection of the sling made by individual surgeons based on his/her clinical preference. Routine retropubic hydrodissection using a mixture of local anaesthetic and normal saline was performed in the majority of retropubic slings. Intraoperative cystourethroscopy was also routinely performed on all retropubic and transobturator slings.

Postoperative evaluations were scheduled at 6 weeks, 6 and 12 months and annually thereafter. Women who defaulted from follow-up were interviewed via telephone using structured questionnaires (Appendix) examining urinary symptoms. Given that we were interested in the overactive component of their lower urinary tract symptoms, the questionnaire included relevant questions from previously validated questionnaires: the Urogenital Distress Inventory [13] and Pelvic Floor Distress Inventory [14]. Baseline urinary urgency was graded into no symptoms (0), occasional (1) or frequent (2). In this long-term study, the overall satisfaction of the patient with the operation was assessed by asking whether she would have the operation again or recommend it to a friend.

dU or dUUI was defined as occurring in those women who presented without urgency or UUI and subsequently developed urgency or UUI, respectively, following MUS surgery at long-term follow-up.

This analysis followed a similar methodology to our earlier report [8]. The objective of our earlier report [8] was to identify risk factors for women with preexisting mixed SUI, urgency with or without UUI to have persistence of urgency or UUI symptoms following MUS. The patient population from that particular report [8] consisted of 754 consecutive women with SUI and urgency, of which 240 had SUI and urgency only and 514 had SUI, urgency and UUI. In contrast, this analysis focused on women who reported new onset of urgency and/or UUI (i.e. they did not have preexisting UUI) following MUS procedures. The patient population for this analysis consisted of a total of 598 women, of which 358 had SUI only (i.e. had no urgency or UUI) and 240 had SUI and urgency (i.e. had no UUI). We sought to ask two related clinical questions: what were the independent risk factors for developing dU in the 358 patients who had SUI/USI only at baseline and what were the independent risk factors for developing dUUI (in 598 women who had SUI/USI, SUI/USI/urgency)?

Analysis was performed using the statistical package Stata 9.2 for Windows (StataCorp LP 2007, College Station, TX, USA). Clinical data, including surgical reports, were separated according to presence or absence of (1) dU (n=358) and (2) dUUI (n=598). Chi-square tests, independent t tests and analysis of variance (ANOVA) tests were used to compare two groups (presence or absence of dU and dUUI) by baseline characteristics and clinical factors. Clinical parameters possibly associated with each of the above factors were assessed using multiple logistic regression analysis with a backward stepwise building of an optimal model for prediction. The significance level of entering and removing an explanatory variable were set to 0.30 and 0.05, respectively. The goodness of fit of the model to the observed data in our sample was evaluated using Hosmer-Lemeshow statistic.

Results

The mean age of patients was 59.4±13.3 years and the mean follow-up was 49.68±23.52 months, with a minimum follow-up of 12 months. Of the original cohort of 1,225 patients, 91 % of the patients (n=1,112) completed the follow-up and questionnaire. The remaining patients could not be contacted due to death (n=21) or change of residence (n=92). As stated, our analyses were focused on a subset of this cohort who subsequently developed dU or dUUI. Forty-

nine per cent of the patients (n=598) did not report symptoms of urgency (n=358) or UUI (n=598) at baseline and were included in the analysis. Of the total database, 955 slings (78 %) were retropubic (TVT 87 %, Advantage sling 11 %, SPARC 2 %) and 270 (22 %) were transobturator slings (Monarc 91 %, TVT-O 9 %) (TVT®/TVT-O®, Gynecare, Somerville, NJ, USA; Advantage®, Boston Scientific, Natick, MA, USA; SPARC®/Monarc®, American Medical Systems, Minnetonka, MN, USA). The overall subjective rate for dU and dUUI at long-term review was 27.7 and 13.7 %, respectively.

Tables 1 and 2 show the characteristics of women who reported SUI without urgency or UUI preoperatively and subsequently developed dU or dUUI, respectively, after MUS at long-term follow-up; 99 of 358 (27.7 %) reported dU. Amongst 14 incontinent patients who reported no SUI or urgency at baseline, 12 had USI and 2 had both USI and detrusor overactivity (DO). In

Table 1 Preoperative characteristics of women with dU or dUUI after MUS

Postoperative de novo	Preoperative SUI only, n=358			Preoperative SUI and urgency, n=598		
	Urgency: yes, n=99 (27.7 %)	No, n=259 (72.3 %)	p value	UUI: yes, n=82 (13.7 %)	No, n=516 (86.3 %)	p value
Age (years), mean ± SD	61.3±13.0	60.0±13.2	0.129	59.3 ±12.2	59.4±13.4	0.936
Follow-up (weeks), mean ± SD	219.8±99.5	220.7±103	0.936	216.8±104	215.1±101	0.889
Parity (mean ± SD)	2.54±1.60	2.41±1.15	0.461	2.80±1.82	2.54±1.31	0.21
Lower urinary tract symptoms at baseline						
SUI only	93 (93.9)	251 (96.9)		47 (57.3)	297(57.6)	
SUI and urgency	-	-		25 (30.5)	193 (37.4)	
No SUI and no urgency	6 (6.1)	8 (3.1)	0.194	5 (6.1)	9 (1.7)	0.043
No SUI, urgency only	–	–		5 (6.1)	17 (3.3)	
D. frequency: <6	38 (38.4)	111 (42.9)		32 (39.0)	188 (36.4)	
D. frequency: 6-10	48 (48.5)	125 (48.3)		41 (50.0)	261 (50.6)	
D. frequency: 11-15	12 (12.1)	22 (8.5)		9 (11.0)	59 (11.4)	
D. frequency: >15	1 (1.0)	1 (0.4)	0.607	0	8 (1.94)	0.701
N. frequency: 0	39 (39.4)	117 (45.2)		33 (40.2)	163 (31.6)	
N. frequency: 1-2	48 (48.5)	130 (50.2)		38 (46.3)	285 (55.2)	
N. frequency: 3-4	9 (9.1)	11 (4.3)		6 (7.3)	54 (10.5)	
N. frequency: >4	3 (3.0)	1 (0.4)	0.044	5 (6.1)	10 (1.9)	0.048
Voiding difficulty[a]	3 (3.0)	14 (5.4)	0.345	6 (7.3)	43 (8.3)	0.755
Medical history						
Menopausal	20 (20.2)	59 (22.8)		18 (22.0)	108 (20.9)	
Post hysterectomy	74 (74.8)	184 (71.0)	0.81	62 (75.6)	380 (73.6)	0.58
Use of HRT	6 (6.1)	23 (8.9)	0.382	8 (9.8)	48 (9.3)	0.896
Prev. POP surgery	32 (32.3)	57 (22.0)	0.043	30 (36.6)	133(25.8)	0.041
Prev. SUI surgery	35 (35.4)	34 (13.1)	<0.0001	21 (25.6)	86 (16.7)	0.05
Prev. Burch colposuspension	11 (11.1)	15 (5.8)	0.083	16 (19.5)	39 (7.6)	0.001
Prev. sling	24 (24.2)	19 (7.3)	<0.0001	5 (6.1)	47 (9.1)	0.369
Physical examination						
BMI (mean ± SD)	28.4 ±4.8	26.5±4.0	0.001	29.0 ±5.3	26.8 ±4.4	0.001
BMI >30	34 (34.3)	46 (17.8)	0.004	31 (37.8)	104 (20.2)	0.003
Ant VagPOP stg >I	60 (60.1)	188 (72.6)	0.028	60 (73.2)	375 (72.7)	0.925
Apical VagPOP stg >I	35 (35.4)	137 (52.9)	0.003	46 (56.1)	272 (52.7)	0.568
Post VagPOP stg >I	49 (49.5)	144 (55.6)	0.3	45 (54.9)	306 (59.3)	0.45
CST pos	69 (69.7)	152 (58.7)	0.098	54 (65.9)	307 (59.5)	0.385

dU de novo urgency, *dUUI* de novo urgency urinary incontinence, *SUI* stress urinary incontinence, *HRT* hormone replacement therapy, *POP* pelvic organ prolapse, *BMI* body mass index (kg/m^2), *Ant VagPOP stg >I* anterior vaginal wall prolapse stage >I, *Apical VagPOP stg >I* apical vaginal (or uterine) prolapse stage >I, *Post VagPOP stg >I* posterior vaginal prolapse stage >I, *CST pos* cough stress test positive

[a] Any positive response to symptoms of incomplete emptying, intermittent flow, poor flow, hesitancy

Table 2 Clinical and urodynamic parameters in women with dU or dUUI after MUS

Postoperative de novo	Preoperative SUI only, *n*=358			Preoperative SUI and urgency, *n*=598		
	Urgency: yes, *n*=99 (27.7 %)	No, *n*=259 (72.3 %)	*p* value	UUI: yes, *n*=82 (13.7 %)	No, *n*=516 (86.3 %)	*p* value
Urodynamic parameters						
Capacity (ml), mean ± SD	481.7±69.2	484.5±73.5	0.741	490±104.9	471.2±72.4	0.125
1st Sens (ml), mean ± SD	209±107.2	227±98.8	0.202	219±112.2	228±103.3	0.56
MUCP empty (cmH_2O), mean ± SD	35.86±15.501	38.40±14.575	0.16	33.74±16.185	38.55±15.414	0.014
MUCP full (cmH_2O), mean ± SD	31.67±15.199	34.36±14.017	0.144	28.77±14.846	34.66±14.582	0.001
No leakage	1 (1.0)	9 (3.5)		0 (0)	13 (2.5)	
OSI	6 (6.1)	8 (3.1)		10 (12.2)	26 (5.0)	
USI	76 (76.8)	222 (85.7)		53 (64.6)	433 (83.9)	
DO only	0 (0)	5 (1.9)		0 (0)	7 (1.4)	
USI and DO	16 (16.2)	15 (5.8)	0.005	19 (23.2)	37 (7.2)	<0.0001
ISD	20 (20.2)	27 (10.4)	0.014	20 (24.4)	63 (12.2)	0.003
Q<15 and/or PVR>50	4 (4.0)	15 (5.8)	0.546	6 (7.3)	31 (6.0)	0.692
Surgical operation						
Less experienced surgeon[a]	44 (44.4)	102 (39.4)	0.383	31 (37.8)	207 (40.1)	0.691
General anaesthesia	55 (55.6)	90 (34.8)		37 (45.1)	261 (50.6)	
Regional anaesthesia	14 (14.1)	50 (19.3)		12 (14.6)	94 (18.2)	
Local anaesthesia	30 (30.3)	119 (46.0)	0.24	33 (40.2)	161 (31.2)	0.257
Bladder perforation	2 (2.0)	14 (5.4)	0.166	3 (3.7)	18 (3.5)	0.938
Repeat SUI surgery	35 (35.4)	34 (13.1)	<0.0001	20 (24.4)	85 (16.5)	0.08
Retropubic MUS	60 (60.6)	191 (73.8)		65 (79.3)	364 (70.5)	
Transobturator MUS	39 (39.4)	68 (26.2)	0.015	17 (20.7)	152 (29.5)	0.103
MUS alone	79 (79.8)	186 (71.8)		56 (68.3)	353 (68.4)	
MUS and POP surgery	20 (20.2)	73 (28.2)	0.272	26 (31.7)	163 (31.6)	0.983
Vault suspension	4 (4.0)	17 (6.6)	0.363	4 (4.9)	49 (9.5)	0.172
Apical stg <I no OP	63 (63.6)	116 (44.8)		35 (42.7)	229 (44.4)	
Apical stg >I no OP	32 (32.3)	126 (48.7)		43 (52.4)	238 (46.1)	
Apical stg >I apical OP	3 (3.0)	14 (5.4)	0.016	3 (3.7)	38 (7.4)	0.502
Mesh use	3 (3.0)	8 (3.1)	0.977	2 (2.4)	21 (4.1)	0.476
Patient satisfaction at long-term follow-up						
Would not recommend surgery to friend	18 (18.2)	2 (0.8)	<0.0001	17 (20.7)	11 (2.1)	<0.0001

dU de novo urgency, *dUUI* de novo urgency urinary incontinence, *SUI* stress urinary incontinence, *Capacity* volume at maximum capacity, *1st Sens* volume at first sensation, *MUCP* maximum urethral closure pressure, *OSI* occult stress incontinence, stress incontinence observed (only) after reduction of coexistent prolapse, *USI* urodynamic stress incontinence, *DO* detrusor overactivity, *ISD* intrinsic sphincter deficiency, defined as MUCP<20 cmH_2O and/or Δ Valsalva leak point or cough leak point pressure <60 cmH_2O, *Q< 15 and/or PVR> 50* maximum flow rate <15 m/s and/or post-void residual >50 ml, *MUS* midurethral sling procedure, *POP* pelvic organ prolapse, *Apical stg <I no OP* apical vaginal wall (or uterine) prolapse stage <I with no apical operation, *Apical stg >I no OP* apical vaginal wall (or uterine) prolapse stage >I with no apical operation, *Apical stg >I apical OP* apical vaginal wall (or uterine) prolapse stage >I with apical operation

[a] Fellows, registrars, residents, typically performed <50

this group of women, there was no significant difference in the proportion of those who went on to have dU, or remained free of urgency, at long-term follow-up (6.1 vs 3.1 %, p=0.194). Similarly, 82 of 598 (13.7 %) reported dUUI. Amongst 22 patients who reported urgency (only) without symptomatic SUI preoperatively, at urodynamic assessment, 12 had USI only and 10 had both USI and DO. For women who did not report SUI at baseline, there was an increased risk of developing dUUI (6.1 vs 1.7 %, p=0.043) after MUS at long-term follow-up.

On univariate analysis, women who developed dU or dUUI were more likely to have higher body mass index (BMI) (dU 28.4±4.8 vs 26.5±4.0, p=0.001; dUUI 29.0±5.3 vs 26.8±4.4, p=0.001), report previous prolapse surgery (dU 32.3 vs 22.0 %, p=0.043; dUUI 36.6 vs 25.8 %, p=0.041) and anti-incontinence surgery (dU 35.4 vs 13.1 %, p<0.0001; dUUI

Table 3 Independent risk factors found on multivariate analysis for dU or dUUI in women who had a MUS procedure

	OR	95% CI	*p* value
dU			
ISD	3.94	1.50–10.38	0.007
Prev. sling	3.69	1.45–9.37	0.006
Prev. prolapse surgery	2.45	1.18–5.10	0.016
Urodynamic USI and DO	1.99	1.15–3.48	0.014
Apical POP/apical OP	0.58	0.41–0.81	0.002
dUUI			
ISD	2.5	1.31-4.8	0.006
Prev. colposuspension	2.5	1.23-5.07	0.011
Urodynamic USI and DO	1.85	1.31-2.6	<0.0001
Baseline LUT (no SUI/NoU No UUI, U only)	1.35	1.03-1.78	0.031
Vault suspension	0.29	0.087-0.97	0.045

dU de novo urgency, *dUUI* de novo urgency urinary incontinence, *OR* odds ratio, *CI* confidence interval, *ISD* intrinsic sphincter deficiency, defined as MUCP<20 cmH_2O and/or Δ Valsalva leak point or cough leak point pressure <60 cmH_2O, *USI* urodynamic stress incontinence, *DO* detrusor overactivity, *Apical POP/apical OP* apical vaginal wall (or uterine) prolapse with apical operation, *LUT* lower urinary tract symptoms, *no SUI/NoU No UUI, U only* no stress urinary incontinence, no urgency or UUI or urgency only

25.6 vs 16.7 %, $p=0.05$). Women who developed dU or dUUI were also more likely to have ISD (dU 20.2 vs 10.4 %, $p=0.014$; dUUI 24.4 vs 12.2 %, $p=0.003$) as defined previously [6, 7] and urodynamic (mixed) stress incontinence and DO (dU 16.2 vs 5.8 %, $p=0.005$; dUUI 23.2 vs 7.2 %, $p<0.0001$). There was an inverse relationship between the presence of anterior (60.1 vs 72.6 %, $p=0.028$) or apical vaginal wall prolapse (35.4 vs 52.9 %, $p=0.003$) and women who developed dU after MUS. Further, women who had vault suspension for apical prolapse at the time of their MUS were *less* likely to develop dU (3.0% vs 5.4 %, $p=0.016$). There was no difference between the type of apical prolapse surgery, either via vaginal or abdominal route, and outcome. This suggests that women who had anterior or apical vaginal wall prolapse (and concomitant vault suspension) are *less* likely to develop dU after MUS. Women who developed dU were more likely to be undergoing repeat anti-incontinence surgery (35.4 vs 13.1 %, $p<0.0001$) or transobturator MUS (39.4 vs 26.2 %, $p=0.015$). Not surprisingly, women who developed dU or dUUI were more likely *not* to recommend surgery to a friend (dU 18.2 vs 0.8 %, $p<0.0001$; dUUI 20.7 vs 2.1 %, $p<0.0001$).

The effects of all factors in Tables 1 and 2 on each other were examined using multivariate logistic regression modelling as previously described. Table 3 depicts the results of the multivariate analysis and lists the *independent* risk factors for developing dU or dUUI following MUS procedures. The presence of ISD, report of previous stress incontinence surgery and presence of coexistent DO (with USI) conferred significant odds towards developing dU or dUUI Furthermore, previous prolapse surgery was also an independent risk factor for dU. For women who did not report SUI at baseline, they had increased odds of dUUI following MUS. A concomitant vault suspension procedure at the time of MUS conferred inverse odds (protects) towards developing dU or dUUI. The multivariate analysis did not find that the route of sling application (retropubic or transobturator) was an independent risk factor for either.

Discussion

There have been few studies that have evaluated the development of de novo OAB symptoms following MUS procedures. Holmgren et al.'s study [15] of 463 patients following tension-free vaginal tape had an impressive mean follow-up of 5 years, although it is unclear if the analysis was truly multivariate to elucidate independent risk factors. Alperin et al.'s [16] multivariate analysis of 92 patients has a short follow-up of 6 weeks. The logistic regression analysis performed by Botros et al. [17] involved 276 patients following MUS with follow-up at 14 weeks. Segal et al.'s [18] univariate analysis evaluated OAB symptoms after TVT in 98 patients with an average follow-up of 7 months. This analysis is larger and longer with 598 patients and a mean follow-up of 50 months. In this study, the overall subjective rate for dU and dUUI was 27.7 and 13.7 %, respectively, which was similar to figures reported in a meta-analysis of RCTs of MUS [3].

The presence of ISD on urodynamic investigation conferred significant risks towards development of dU or dUUI, as shown in Table 3. It is well known that the outcomes of surgery in women with ISD stress incontinence are poorer. It would seem that the poorer result is not only caused by the persistence of SUI but also the development of OAB symptoms. The "urethrogenic" theory had been proposed to explain OAB symptoms caused by a weak urethral sphincter mechanism, resulting in the funnelling of the proximal urethra. It had been observed that women with DO had a lower MUCP [19]. It was postulated that when urine enters the proximal urethra, it produces a sensory stimulation resulting in reflex bladder contraction [20], since urethral afferent nerve activity can induce involuntary detrusor activity [21]. Subjected to provocative hand washing, a decrease in urethral pressure immediately followed the onset of urgency and preceded an unstable detrusor contraction. It had been shown that the MUS decreased midurethral mobility without affecting the (mobility of) the bladder neck [22]. The urethrogenic theory suggests that despite good efficacy of the MUS against SUI with support to the *mid*-urethra, the presence of ISD can contribute to dU or dUUI.

However, the presence of ISD could also have led the surgeon to deploying a "tighter" MUS, especially if a cough test was performed intraoperatively. A tighter MUS could lead to obstruction and increased incidence of OAB symptoms, although such speculation ought to be confirmed with objective measures of "tightness", with one option being a dynamic translabial ultrasound evaluation [23].

This study found that the presence of DO (together with USI) on urodynamic assessment was a significant risk factor for developing dU or dUUI, which was consistent with the study by Alperin et al. [16]. dUUI occurred significantly more in women who did not report the presence of SUI at baseline. We could not find evidence in the literature to support this finding and postulate that these women have a higher incidence of latent detrusor activity. The route of application of MUS did not influence the development of dU or dUUI in our multivariate analysis. A retrospective analysis [17] of 276 women (99 TVT, 52 SPARC, 125 Monarc) reported a lower dUUI rate of 8 % at 9 months for Monarc, compared to 17 % for SPARC and 33 % for TVT (p=0.04). Whilst this was consistent with results from meta-analysis of RCTs [24] comparing retropubic (RP) to transobturator (TO) MUS, which showed a lower odds of dU [odds ratio (OR) 0.89 (0.54–1.86) in transobturator MUS], our study did not confirm these findings. It is worth noting that the OR from meta-analysis [24] crossed unity which suggests it did not reach statistical significance. In an RCT [25] of women with USI and ISD comparing retropubic TVT sling to transobturator Monarc sling, the resolution and new development of OAB symptoms at 6 months postoperatively was not significantly different.

A history of prior anti-incontinence surgery was a risk factor for the development of dU or dUUI in our study. Whilst it is plausible that this was caused by a combination of a degree of obstruction and the presence of a sling, our data did not show a significant difference in dU or dUUI in women who had low flow rate (<15 ml/s) and/or high postvoid residual (>50 ml) following MUS. It could be postulated that prior SUI surgery may have caused some denervation during dissection, culminating in excess of dU or dUUI.

Poorer anterior and apical vaginal support was associated with *less* dU on univariate analysis. Further, the multivariate analysis demonstrated that women with apical prolapse and apical prolapse operations (such as uterosacral suspension, sacrospinous fixation, abdominal sacrocolpopexy) had less odds of developing dU. Similarly, a concomitant vault suspension operation conferred a protective effect towards dUUI following MUS. It was postulated that vaginal prolapse of the anterior and apical compartment could cause OAB symptoms, possibly due to distortion of the bladder base or relative outlet obstruction, based on observations from several studies. The BE-DRI study had a multivariate analysis [26] of 307 women to determine predictors of outcome in the treatment of UUI. The investigators found poorer vaginal support predicted successful OAB outcomes after 6 months. de Boer et al. analysed 505 patients who underwent prolapse surgery [27]. They found that postoperative urinary frequency and urgency appeared less common in women with higher preoperative prolapse stage. Resolution of OAB symptoms was also reported in other studies, following surgery for prolapse [28, 29] or utilisation of vaginal support pessaries [30].

The strength of this analysis includes a large cohort of well-described patients, with a mean follow-up of 4 years, who underwent standardised evaluation and had surgery performed by a number of surgeons. This allows for a more robust multivariate analysis in the assessment of predictive preoperative factors for postoperative OAB symptoms. Study limitations were consistent with the retrospective nature of its design, although data collected using the same pro forma during the study period should ensure consistency. Whilst we acknowledge the absence of "objective" parameters in the postoperative evaluation of patients, such as urodynamic assessment, pad test and voiding diaries, we would contend that there are no reliable objective diagnostic criteria for dU or dUUI. We accept that the patient-reported outcomes were collected via a modified questionnaire that has not been formally validated.

Another criticism of our current analysis was related to its perceived similarity to our earlier report [8]. We sought to reveal independent risk factors inherent in patients who reported persistence of urgency/UUI following their MUS in our earlier report [8]. Our current analysis examines a different cohort of women to reveal independent risk factors inherent in women who reported de novo development of urgency (when they have SUI/USI only at baseline) or UUI (when they reported SUI/urgency only). These two analyses asked very different clinical questions and used different patient cohorts. Further, we utilised multilogistic regression to ensure revealed variables are independent.

The impact of dU or dUUI on outcomes of surgery for SUI has several important implications. Given the results of our analysis, it seems prudent to conduct careful evaluation for significant pelvic organ prolapse, urodynamic investigations and appropriate prolapse surgery to optimise global patient outcomes in women presenting for MUS, in addition to reiterating the importance of detailed preoperative counselling.

Conclusions

Previous stress incontinence or prolapse surgery, presence of urodynamic ISD or coexistent DO (with USI) significantly increased, whereas concomitant apical prolapse surgery

significantly decreased the risk of women developing dU/dUUI following MUS. Urodynamic parameters and concomitant apical prolapse operation for concurrent large prolapse are important predictors in the development of dU/dUUI following MUS procedures. Overall satisfaction with the operation was significantly less in women who developed OAB symptoms following MUS procedures.

Conflicts of interest There was no outside funding or technical assistance with the production of this article. This study was presented at the Joint Annual Meeting of the International Continence Society/International Urogynecological Association in Toronto 2010. JL, PD, AR and YL are investigators in an ongoing RCT of midurethral slings and had received an external research grant from American Medical Systems.

Appendix

Follow-up questionnaire

Question	Questionnaires
1 Do you experience any urine leakage? No, yes	UDI
2 Do you experience urine leakage related to physical activity, coughing or sneezing? No, yes	UDI
3 Do you experience a strong feeling of urgency to empty your bladder? No, yes	UDI
4 Do you experience urine leakage related to the feelings of urgency? No, yes	UDI
5 Do you usually experience difficulty emptying your bladder? No, yes	PFDI–20
6 Did you have another surgery for incontinence since your last one at our medical centre? No, yes (if yes, when and what type?)	Nonspecific
7 Would you recommend this operation to someone else with incontinence? No, yes	Nonspecific

UDI Urogenital Distress Inventory [12], *PFDI* Pelvic Floor Distress Inventory [13]

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