

# Effectiveness of midurethral slings in mixed urinary incontinence: a systematic review and meta-analysis

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## Abstract

**Introduction and hypothesis** Mixed urinary incontinence (MUI) is a coexistence of stress (SUI) and urgency urinary incontinence (UUI). There is conflicting evidence on the effectiveness of midurethral slings (MUS) in this condition. The objective of this study is to evaluate the effectiveness of MUS in women with MUI by systematic review of the literature.

**Methods** Systematic literature search was carried (June 2010) using relevant search terms in Medline, EMBASE, CENTRAL and Google Scholar. Relevant randomised controlled trials (RCT) and prospective studies were selected and then analysed by two independent reviewers. Meta-analysis was performed with random effects model using STATA 8.

**Results** There were six randomised trials and seven prospective studies with average to good quality included in this systematic review. There was heterogeneity in outcomes reported. The overall subjective cure from seven prospective nonrandomised studies that included patients with symptomatic±urodynamically proven MUI was found to be 56.4% (95% confidence interval 45.7–69.6%) at 34.9±22.9 months follow-up. The overall cure of urgency and UUI component

was 30–85% at a follow-up of few months up to 5 years. Most of the studies described that this cure does not persist over the time. The cure rate of SUI following MUS varies from 85% to 97%. On meta-analysis of five RCTs which included women with MUI symptoms, the odds of overall subjective cure with TVT versus transobturator tapes are similar at 6–33 months follow-up (OR, 0.9; 95% CI, 0.63–1.27). This was true when a subgroup analysis was performed on women with MUI who were negative for DO on UDS (OR, 1.21; 95% CI, 0.7–2.08). **Conclusions** There is evidence of persistent and good cure of stress component following MUS in women with MUI. The cure of the urge component is variable but less than stress component. Methodologically sound RCTs of retro-pubic and transobturator tapes with long-term follow-up are needed specifically for women with urodynamically proven and symptomatic mixed incontinence.

**Keywords** Midurethral slings · Mixed urinary incontinence · Tension-free tape · Transobturator tape · Urge urinary incontinence

## Abbreviations

SUI	Stress urinary incontinence
MUI	Mixed urinary incontinence
UUI	Urge urinary incontinence
MUS	Midurethral sling
TOT	Transobturator tape
TVT	Tension-free vaginal tape
TVT-O	Transobturator tension-free vaginal tape
SPARC	Suprapubic arch sling
DO	Detrusor overactivity
UI	Urinary incontinence
UDS	Urodynamics
UDI	Urogenital distress inventory
KHQ	King's health questionnaire

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## Introduction

Mixed urinary incontinence (MUI) is the coexistence of stress and urgency urinary incontinence and is defined as involuntary loss of urine associated with the sensation of urgency and also associated with exertion, effort, sneezing or coughing [1]. MUI is estimated to affect 33% of women presenting with urinary incontinence (UI) [2]. A large number of patients are treated with conservative measures, including bladder training, anticholinergics, and pelvic floor muscle training. The management of patients with MUI refractory to initial measures presents a challenge.

There are variable data available regarding cure rate of MUI following midurethral sling surgery of both the stress and urge components. Furthermore, the postoperative course of urge incontinence after surgery is unpredictable because it may resolve, persist or worsen. There are no consistent predictors of persistent or worsening of urgency symptoms after sling surgery. We aimed to evaluate the effectiveness of midurethral slings (MUS) in women with MUI and also to find out the factors predicting outcome of surgery.

## Methods

### Sources

All prospective studies describing effectiveness of MUS in women with mixed incontinence were included in this review. They were identified by searching the MEDLINE, EMBASE, CINAHL, CENTRAL (The Cochrane Library, Issue 2, 2009), National Library for health, MetaRegister of controlled trials, Google scholar (up to June 2010) using subject headline from each database. The following keywords were used for the search as text word or subject headings without language restriction: ‘mixed urinary incontinence, midurethral sling, tension-free tape, urge urinary incontinence, stress urinary incontinence’. Hand searches of the bibliographies and citation list of all relevant articles was also carried out. In most cases, the first or corresponding authors of included trials were contacted for additional information. No ethical approval was sought for this study, as it was a systematic review and meta-analysis of published manuscripts.

### Study selection

Randomised controlled trials (RCTs), prospective studies of women with symptomatic or urodynamically proven MUI, who underwent retropubic and transobturator vaginal tapes (TVT), outside-in transobturator tape (TOT), inside-out transobturator tape (TVT-O) and suprapubic arch sling

(SPARC), were included. The studies describing cure of stress component only, without mentioning about effect on urge component or total cure following surgery were excluded. Two reviewers (PJ and KJ) independently selected the articles for inclusion by assessing their eligibility of full papers against the review inclusion criteria, with disagreements resolved by discussion, if necessary, a third reviewer (PL). In cases of duplication, the study that reported most recent data was to be included.

**Participants:** Women with symptomatic or urodynamically proven MUI

**Intervention:** synthetic midurethral slings TVT/TOT/TVT-O/SPARC

**Outcome measures:** cure/improvement in the stress and urge components of MUI

### Data extraction and quality assessment

Two independent reviewers (PJ and KJ) extracted data for quality and results. Data include characteristics of participants, intervention, comparisons if any, outcome assessment tools and results of the studies. The Jadad score was used to assess quality of RCT and Newcastle Ottawa Scale was used for the prospective cohort studies.

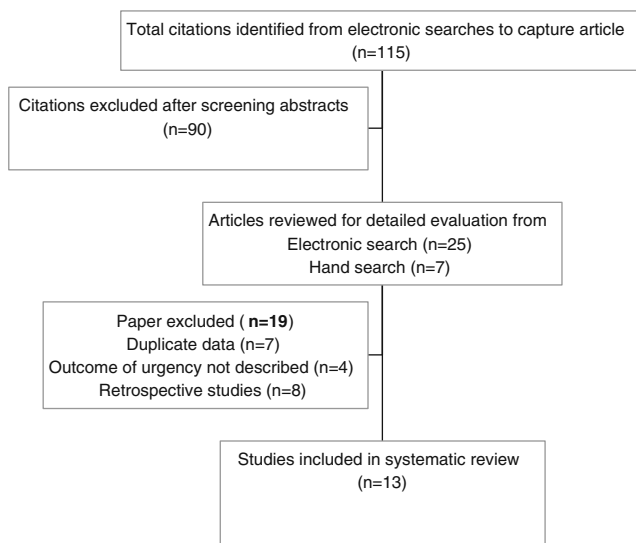
### Statistical analysis

Regression rates from individual studies were meta-analysed using random effects model [3]. Heterogeneity of the exposure effects was statistically analysed using the chi-square test [4]. Statistical analyses were performed using Stata 8.0 (Stata Corp, TX, USA). Statistical analyses of RCTs were performed according to the statistical guidelines of the Cochrane Collaboration [20] using the RevMan 5 software. Data from intention-to-treat analyses was used where available. For the dichotomous data, results of each study were expressed as an odds ratio (OR) with 95% confidence intervals (CI) and combined for meta-analysis using the Mantel–Haenszel method (random effects model)

## Results

We included 13 studies in total; Fig. 1 summarises the flow for study selection in this systematic review.

There were six RCTs [5–10], seven prospective studies [11–17] with a total of 2,693 participants between 29 and 84 years of age (see Tables 1, 2, 3 and 4 for details of included studies). There were six noncomparative studies that described effectiveness of TVT. Seven comparative studies that described comparison between different sling procedures in the management of MUI included TVT vs



**Fig. 1** Selection process for the systematic review of midurethral sling surgeries in the management of mixed urinary incontinence

TOT vs TVT-O in six [5–10] and TVT/TOT/SPARC in other study [17]. Eight of the 13 studies were based on symptomatic diagnosis of MUI [5–7, 10–13, 17] and two of 13 studies included patients with urodynamically proven MUI [14, 15], and three studies included patient with symptomatic as well as urodynamically confirmed MUI [8, 9, 16]. Metanalysis was performed on the five of six studies that reported dichotomous outcomes.

#### Methodological quality

For the RCTs, description of randomisation and follow-up was adequate for all 6 studies. Power calculation was done in five RCTs [6–10] and blinding was described in two studies [8, 9] (see Fig. 2). Jadad score was 4 in two RCTs [8, 9], 3 in three RCTs [5–7] and 2 in one RCT [10]

Three of seven prospective studies had patients who had MUI along with patients with pure stress incontinence. The recruitment was consecutive in three studies (see Table 2, 3 and 4). The ascertainment of diagnosis was done clinically in four studies, urodynamically in one and combined clinically and urodynamically in two studies. The instruments used to assess outcomes were satisfactorily described in all studies. The outcome was assessed subjectively and objectively in all the studies. The follow-up was described in all of them and it was adequate (>80%).

#### Outcomes

The studies used different parameters for subjective/objective cure and improvement. Subjective parameters used were discontinuation of antimuscarinics, warning time, voiding diaries, Kings quality of life questionnaire,

Likert's scale, incontinence impact questionnaire, urogenital distress inventory (UDI), visual analogue scale, stress and urge indices, absence of complaint of leakage and ICIQ-OAB questionnaire, medical, epidemiological and social aspects of ageing questionnaires, detrusor instability score, urinary incontinence severity score and Women irritative prostate symptoms score.

The objective outcomes measured in these studies were: urodynamics (UDS), video UDS, cough stress test, pad test (which included 1-h pad test <2 g or less than 1 g, pad test with provocation for stress and urge, 24-h pad test <10 g and 48-h pad test <8 g/24 h).

Criteria used for improvement were decrease in dosage of anticholinergics, urge incontinence episode reported as less frequent than pre-operatively, 1-h pad test <5 g and quality of life improvement >75% but less than <90%.

Using the random effects model, the overall subjective cure from seven prospective nonrandomised studies that included patients with symptomatic±urodynamically proven MUI was found to be 56.4% (95% confidence interval, 45.7%–69.6%) at 34.9±22.9 months follow-up. Test for heterogeneity was statistically significant ( $p=0.000$ ) (Fig. 3)

#### Overall subjective cure

On meta-analysis, the odds of overall subjective cure (OR, 0.9; 95% CI, 0.63–1.27) were similar whether TVT or transobturator tape was used as were the odds of urge incontinence cure (OR, 0.83; 95% CI, 0.52–1.31). On subgroup analysis of studies [6, 10] that included women with MUI but no detrusor overactivity (DO) on UDS, there was no difference found in the effectiveness of the retropubic versus transobturator route (OR, 1.21; 95% CI, 0.7–2.08) (see Figs. 4 and 5)

#### Outcome of stress component of MUI

One RCT reported a significant improvement in UDI score for SUI (from 81.3 to 9.4) at 15.7 weeks [5]. One study observed an SUI cure rate of 87% at 7 months and only slightly reduced to 83% at 38-month follow-up after TVT [11]. These authors also identified a lower cure of the stress component in women with urgency predominant or equal MUI than those who had stress predominant MUI [11]. Some comparative studies observed equally good results with TVT, TOT and TVT-O [6, 10, 17].

#### Outcome of urge incontinence of MUI

There was a wide variation in the cure rate of urgency and UUI. MUI without evidence of DO may have different outcomes than MUI with DO [16]. One RCT showed significant improvement in urge scores with retropubic as well as with

**Table 1** Randomised controlled trials (six studies) of effectiveness of tapes in mixed urinary incontinence (MUI)

No.	Author, pub date, location	Participants	Methods and duration of follow-up	Intervention± comparison	Outcome measures	Effectiveness
1	But, I 2008, Slovenia	<i>n</i> =89 Stress predominant MUI symptoms  Mean age: 52.6 years (32–82)	Randomization: computer generated Concealment: not stated Blinding: not used  Power calculation: no ITT analysis: not done  Follow-up: 15.7 weeks Pre-operative: pad test with provocations for stress, flowmetry and PVR, 3-day voiding diary, IIQ and UDI	Group 1 Monarc outside-in transobturator tape Group 2 TVT-O inside-out transobturator tape	Subjective assessment: VAS, 3-day voiding diaries and IIQ and UDI questionnaire  Objective assessment: pad test with provocations for stress and urge UI, flowmetry and PVR	Significant postoperative improvement in UDI scores for stress (81.3 vs 9.4) and irritative (49.8 vs 11.0) symptoms  No differences between procedures regarding mean postoperative UDI scores  QOL improved significantly after both procedures using IIQ  Success of treatment (VAS SCORE) 88.7% vs 90.7% ( <i>p</i> =0.96)  Lower mean satisfaction score in women with MUI 87.3% than those with SUI 96.6% ( <i>p</i> =0.00012)  Subjective overall cure: TVT, 43 (58.9%) and TOT, 35 (53%)  Cure of SUI: TVT, 71 (93%) and TOT: 59 (89.3%)
2	Barber, M 2008, Ohio	<i>n</i> =142 MUI symptoms: with negative DO on urodynamics  Mean age: 54±10	Randomization Computer generated  Concealment: stated Blinding: not done Power calculation: yes F/U 18.2±6 months Pre-operative: 3-day bladder diary, urodynamic evaluation and validated questionnaires (ISI, PFIQ-7 and SF-12)	TVT: <i>n</i> =76 TOT: <i>n</i> =66	Subjective assessment: bladder diary and validated questionnaires  Objective assessment: cough stress test and post-void residual volume determination	Subjective overall cure: TVT, 43 (58.9%) and TOT, 35 (53%)  Cure of SUI: TVT, 71 (93%) and TOT: 59 (89.3%)
3	Rinne, K 2007, Finland	<i>n</i> =50 symptoms of MUI  Mean age: 53±10 years	Randomization Computer generated Blinding: not done Concealment: not stated Power calculation: stated Follow-up: 12 months Pre-operative: 24-h pad test, cough stress test, 3-day bladder diary and validated questionnaires (UDI-6, VAS, UISS, IIQ-7 and DIS)	TVT: <i>n</i> =27 TVT-O: <i>n</i> =23	Subjective assessment: validated questionnaires (UISS, DIS, VAS 0-100, IIQ-short form and UDI-short form)  Objective assessment: cough stress test 24-h pad test	Subjective cure of UUI: TVT, 25/27 (93%) and TVT-O, 23/23 (100%)
4	Richter, H 2010, USA	<i>n</i> =395 women with MUI symptoms with DO+USI on UDS in 70 cases	Randomization: permuted block schedule	Retropubic sling: <i>n</i> =191	Subjective assessment: 3-day voiding diary, MESA questionnaire and self-reported absence of symptoms	Subjective cure of UUI: TVT, 155 (81%) and transobturators 174 (85%)

5	Porena, M 2007, Italy	<p>Age group: <math>53 \pm 10</math> years</p> <p><math>n=61</math> women with MUI symptoms with DO+USI in 21 cases.</p> <p>Mean age: <math>61 \pm 10</math> years</p>	<p>Blinding: done</p> <p>Power analysis Stated</p> <p>Follow-up: 12 months</p> <p>Pre-operative: cough stress test, UDS, validated questionnaires (UDI-6 and IIQ-7), UISS, stress score and urge score</p> <p>Randomization</p> <p>Computer generated</p> <p>Concealment: not stated</p> <p>Blinding: follow-up visit assessment by a blinded assessor</p> <p>Power calculation Stated</p> <p>Follow-up: mean 31 months</p> <p>Pre-operative: 1-h pad test, 3-day bladder diary, UDS, validated questionnaires (UDI-6 and IIQ-7), anticholinergic therapy prior to surgery to women with DO and surgery only if failed pharmacotherapy</p> <p>Randomization computer generated</p> <p>Concealment: not stated</p> <p>Blinding: not done.</p>	<p>Transobturator sling: <math>n=204</math></p> <p>Objective assessment stress test 24-h pad test</p> <p>Subjective assessment: validated questionnaires (UDI-6, IIQ-7 and VAS scale)</p> <p>Objective assessment: free flowmetry, post-void residuals and cough stress test</p>	<p>MESA urge score: pre-op—TVT (5.94), TOT (6.57) and TVT-O and postop—TVT (1.83) and TOT (1.78)</p> <p>Subjective overall cure: TVT—dry (14 (52%)), improved (8 (30%)) and unchanged (5 (18%)) and TOT—dry (24 (70%)), improved (8 (24%)) and unchanged (2 (6%))</p>
6	Meschia M 2007, Italy	<p>Mean age: <math>56 \pm 10</math> years</p> <p><math>n=69</math> women with MUI symptoms and negative DO on UDS</p>	<p>Power calculation stated</p> <p>Follow-up: median, 6 months</p> <p>Pre-operative: cough stress test, UDS, VAS, and validated questionnaires (ICIQ-SF,W-IPSS and PGI-S)</p>	<p>Subjective assessment: validated questionnaires (PGI-I, VAS, W-IPSS and ICIQ-SF)</p> <p>Objective assessment: cough stress test and UDS</p>	<p>Cure rate of SUI: TVT—subjective, 30 (88%) and objective, 31(91%) and TVT-O—subjective, 35 (86%) and objective, 31 (89%)</p> <p>Cure rate of UUI: TVT, 16 (47%) and TVT-O, 14 (40%)</p>

**Table 2** Nonrandomised studies which included women with symptomatic mixed urinary incontinence

No.	Primary author, publication date, location	Participants	Methods, quality and duration of follow-up	Rx	Outcome measures	Effectiveness
1	Kulseng Haussens S 2007, Norway	<i>n</i> = 1,113 symptoms of MUI, 66.4% PSI, predominant stress, 6.8% PUI; predominant urge, 26.8% SUIE stress and urge equally	Prospective design Follow-up: 7 and 38 months— included only those women who had both a 7- and 38-month follow-up	TVT	Subjective assessment: stress and urge indices 2 or less (leaking 1–4 times a month = 2) and very satisfied on satisfaction scale	Overall cure: subjective cure (months)—623 (60%) at 7 months and 547 (53.8%) at 38 months and objective cure—727 (68.5%) at 7 months and 612 (59.4%) at 38 months SUI cure: 952 (87%) at 7 months and 851 (83%) at 38 months UUI cure: 461 (43%) at 7 months and 366 (34.6%) at 38 months Reduction in urge episodes: 40% at 7 months and 42.5% at 38 months Worsening in 7.8% and 11% at 7 and 38 months, respectively Results at 7/12: subjective—PSI, 66.5 and PUI, 45.2 and objective—PSI, 73.6 and PUI, 49.3 Results at 38/12: subjective—PSI (60), PUI (38.4) and SUIE (51.3) and objective—PSI (64.2), PUI (45.2) and SUIE (42.3) Overall cure: cure (16 (67%)), improvement (2 (8.3%)), no change (3 (12.5%)) and worsening (3 (12.5%)) Cure rate was 84.5% for the SUI cases and de novo urgency 6%
2	Chene G 2006, France	<i>n</i> = 30 symptoms of MUI  Median age: 56 years (48–65 years)	Bladder training and anticholinergics was given as initial treatment for PUI group Prospective study	TVT	Objective assessment: stress test dry (no leakage) and 24 h pad test dry (<10 g during 24 h)	Subjective assessment: QOL questionnaires
3	Ankardal M 2006, Sweden	<i>n</i> = 311 symptoms of MUI  Mean age: 54.6	Follow-up: 80% (5 years) Pre-op: UDS pad test	TVT	Objective assessment: clinical and UDS evaluation at 1 year, UDS only at 30 months 24-h pad test, PVR and flow rate Definition of cure: estimated QOL score above 90%, negative cough test, 24 h pad test lower than 10 g/24 h	Overall cure: at 3/12 (264 (85.2%)), at 12/12 (147 (74.6%)), at 2 years (140 (71.1%)) and at 5 years (45 (54.9%)) In patients with MUI the subjective cure rate was lower than in patients with SUI at 5 years (54.9% versus 81%, respectively).
4	Paick JS 2007, Korea	<i>n</i> = 144 symptoms of MUI  Mean age: 57.3 years (29–77)	Follow-up: 5 years Pre-op: F/V chart, 48-h pad test, cough provocation Prospective collection of data Follow-up mean 10.9 months (6–52 months)	TVT: <i>n</i> = 72 TOT: <i>n</i> = 50 SPARC: <i>n</i> = 22	Objective assessment: after 5 years (4% of cases) F/V chart, 48-h pad test (less than 8 g/24 h) and cough provocation stress test (no leakage) Subjective assessment: absence of subjective complaint of leakage and non-validated questionnaire	Overall cure: TVT (59 (81.9%)) and TOT (39 (78%)) and SPARC (17 (77.3%)) Cure of SUI and UUI: SUI cure—TVT (69 (95.8)) and TOT (47 (94%)) and UUI cure—TVT (59 (81.9%)) and TOT (41 (82%)) No significant difference in the three groups in terms of the cure rate for SUI and UUI

**Table 3** Nonrandomised studies which included Urodynamic proven mixed incontinence

Primary author, publication date, location	Participants	Methods and duration of follow-up	Rx	Outcome measures	Effectiveness
1 Rezapour M 2001, Sweden	<i>n</i> =80 UDS proven MUI Mean age: 59±11 years	Prospective study Follow-up: 4 years (3–5 years)  Pre-op: cough stress test, 24-h pad test UDS and urethral profile measurement	TVT	Subjective assessment: QOL improvement  Objective assessment: cough stress test, 24-h pad test Definition of cure: no leakage at cough stress test, urine leakage <10 g/24-h pad test, QOL improvement of >90%  Improvement: no leakage at stress test, QoL improvement of >75% but less than 90%	Overall cure: cure (68 (85%)), improvement (3 (4%)) and failure (9 (11%))  Negative impact on QoL from 67% before surgery to 14% post surgery. Urine leakage from 104±16 to 27±18 g 25% of improved/cured women reported urgency without incontinence
2 Duckett J 2007, UK	<i>n</i> =77 UDS proven MUI Age: 54 years (34–82)	Prospective study Follow-up: 24 months (6–38)  Pre-op: UDS, anticholinergic bladder drill, physiotherapy was offered before surgery	TVT	Subjective assessment: KHQ and postop OAB if women experience urgency/urge incontinence more than once per month  Objective assessment: assessment of tape position by trans-perineal USS	Cure of SUI: 75 (97%) Cure of UUI: 23 (30%)  Relation between position of tape and persistent of OAB symptoms: 76% with mid position as compared with 66% with distal position of tape  No significant correlation between postoperative resolution of irritative symptoms and the position of the TVT ( <i>p</i> >0.05)

transobturator tapes at the follow-up of 12 months [8], on the other hand there was only 40%–45% cure of urge component at 6 months follow-up in other RCT [10]

At 4-year follow-up, one prospective study with 80 women reported persistence of cure rate of 85% of stress and urge components. This study excluded those with significant symptoms and signs of DO and minor SUI pre-

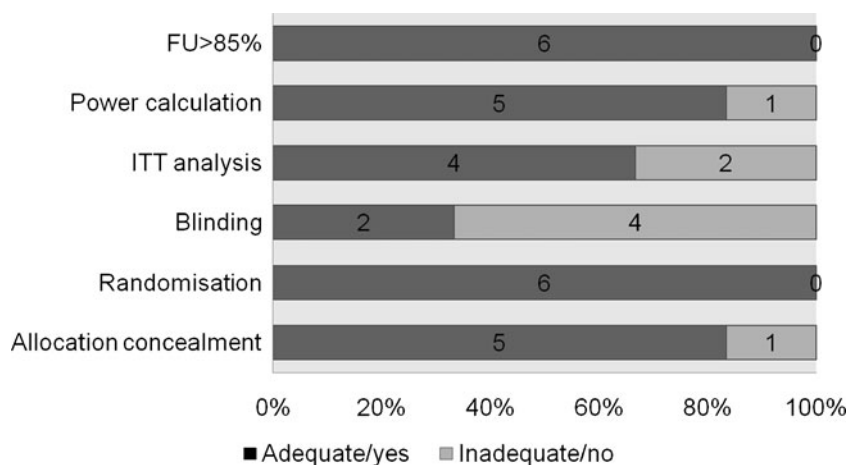
operatively [14]. One study reported that the overall cure rate was lower in women with MUI (55%) as compared with women with SUI only (81%) at 5-year follow-up after surgery. They found type of incontinence was the only independent variable found to influence surgical outcome [13]. In another study, when cure rate was defined as stress and urge indices of two or less (episode of incontinence one

**Table 4** Nonrandomised studies that included women with symptomatic and urodynamic proven MUI

Primary author, publication date, location	Participants	Methods and duration of follow-up	Intervention	Outcome measures	Effectiveness
1 Choe JH 2008, Korea	<i>n</i> =132 symptoms of MUI DO present: 28.8% DO absent: 71.2%  Age: 53.2 years (34–84)	Prospective Follow-up: 3 month  Pre-op: pad test and UDS and BFLUTS questionnaires	TVT	Subjective assessment: no urgency/UI, frequency of <8 per 24 h, and validated questionnaires  Objective assessment: FV chart	Overall OAB cure: 31(23.5%) Cure in DO-present group: 36.8% Cure in DO-absent group: 18.1% ( <i>p</i> =0.021)  The patients with DO had a higher cure rate than those without DO for urgency (52.6% vs 38.3%) and urge incontinence (68.9% vs 53.7%), respectively.  Subjective cure of USI (126 (95.5%)) Objective cure of SUI (123 (93.2%))

SUI stress urinary incontinence, MUI mixed urinary incontinence, UUI urge urinary incontinence, VAS visual analogue score, QOL quality of life, UDI urogenital distress inventory, IIQ incontinence inventory questionnaire, POP-Q pelvic organ prolapse quantification, MUS midurethral sling, MUCP maximal urethral closing pressure, VLPP valsalva leak point pressure, DM diabetes mellitus, ISD intrinsic sphincter deficiency, DO detrusor overactivity, USI urinary stress incontinence, ICIQ-OAB international consultation on incontinence-overactive bladder, OAB overactive bladder, V<sub>e</sub>AS verbal analogue satisfaction, UTI urinary tract infection, TVT tension-free vaginal tape, TOT transobturator tape,TVT-O transobturator tension-free vaginal tape, IS Ingelman-Sundberg procedure, IC interstitial cystitis, ODP opening detrusor pressure, MMK Marshall–Marchetti–Krantz, RR relative risk, CI confidence interval, OR odds ratio, UDS urodynamics, PSI predominant stress incontinence, PUI predominant urge incontinence, SUIE stress and urge incontinence equally, MESA questionnaire, Medical, Epidemiological and Social Aspects of Ageing questionnaires, DIS detrusor instability score, UISS urinary incontinence severity score, W-IPSS women irritative prostate symptoms score

**Fig. 2** Quality of RCTs in the meta-analysis of MUS in MUI



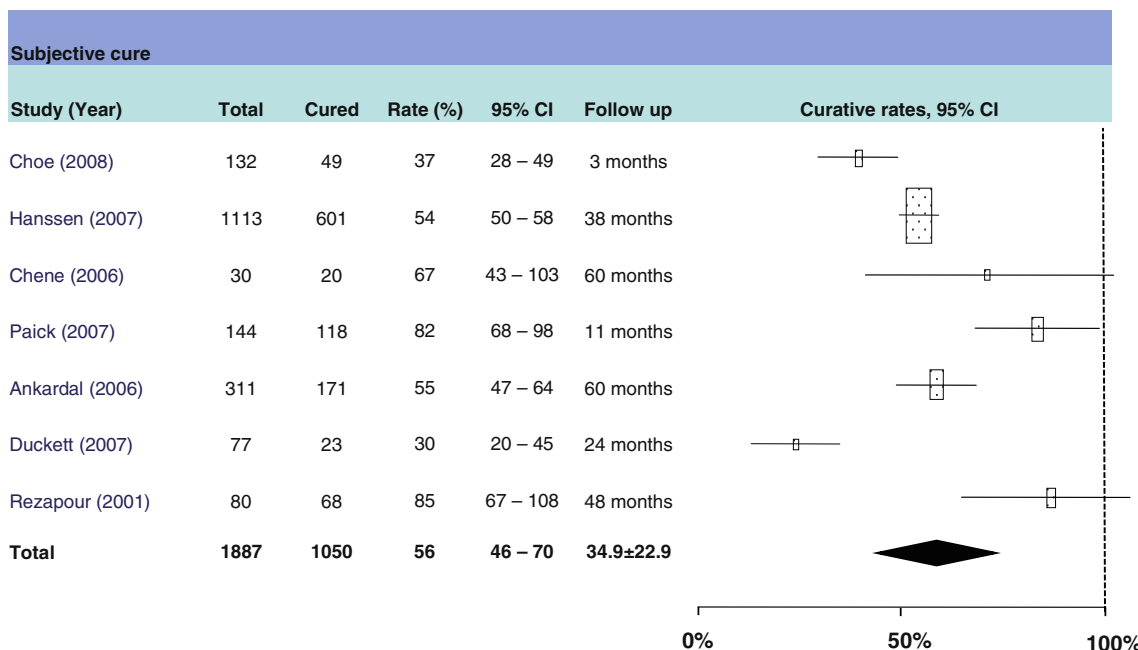
to four times a month or less), the observed subjective cure was 60% at 7 months and 53.8% at 38 months. But on the other hand, when cure was defined as complete dryness, the subjective cure rate dropped to 35.9% at 7 months and 28.4% after 38 months [11].

**Discussion**

The studies report good cure rates of stress component (85–97%) and lower (30–85%) and declining cure rates of urge incontinence over time following MUS in MUI. From the meta-analysis, there seems to be no significant difference in the overall subjective and UUI cure between tapes used by retropubic (TVT) or transobturator routes.

To our knowledge, this is the first systematic review and meta-analysis looking at overall subjective cure after insertion of MUS in MUI. The search was thorough and not restricted by language. We included studies with symptoms-based±urodynamically proven MUI. The manuscript adheres to the 27-item PRISMA checklist [18]. We could be criticised for not searching the conference proceedings/abstracts of previous years. Definition of cure varied between studies and this can also account for the variable success rates described. If criteria for cure are strict and include only women who are completely dry, it will significantly affect success rate. Some of the studies reported a higher cure rate of UUI following surgery, but they didn't include those with DO on urodynamics [14].

There are several theories of DO in MUI. There is a possibility that mixed symptoms may be due to a more



**Fig. 3** Meta-analysis of (prospective observational studies) subjective cure after midurethral retropubic sling surgery in mixed urinary incontinence



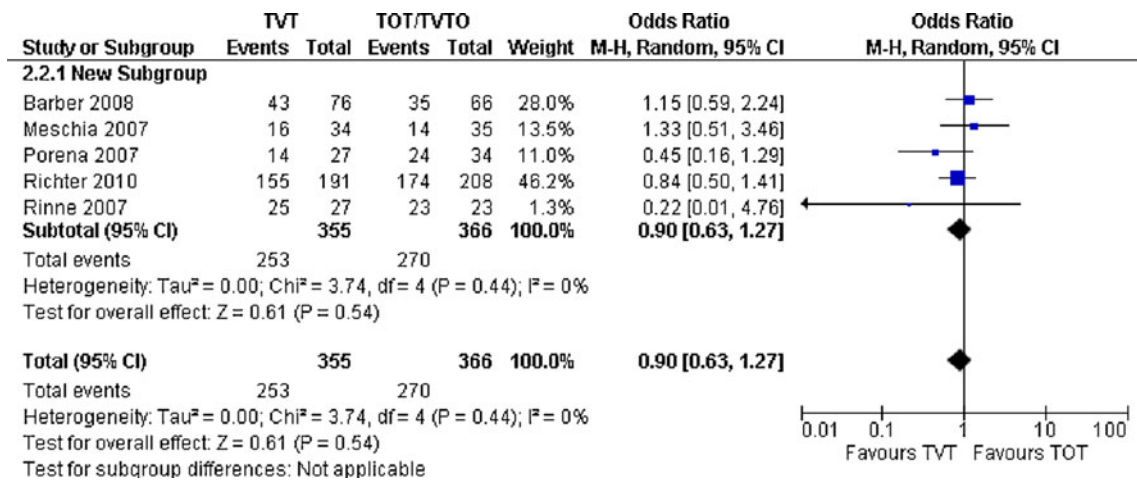


Fig. 4 Overall subjective cure in women with MUI symptoms with or without UDS confirmation (RCTs)

severe form of stress component rather than two separate mechanisms for urge and stress incontinence [19]; or that DO is caused by a weak urethral sphincter mechanism, resulting in funnelling of the proximal urethra. When intra-abdominal pressure is increased, urine enters the proximal urethra, producing sensory stimulation and resulting in a reflex bladder contraction [19]. Another proposed mechanism is that increases in intra-abdominal pressure result in stretching of the pelvic nerves, which trigger an involuntary bladder contraction [20]. There also exists a possibility of a urethral element that induces a bladder contraction rather than primary bladder abnormality [21]. There are several explanations that have been suggested to explain why UUI may improve after MUS surgery. One particular explanation is that MUS prevents urine from entering into the upper posterior urethra with increases in intra-abdominal pressure thereby avoiding reflex urgency [22, 23].

Appropriate case selection is of utmost importance in order to get good results after surgery. Cure rate of MUI is better in a group of women with predominant SUI symptoms in comparison to a group with predominant UUI symptoms [11]. The effect of detrusor overactivity on urodynamics associated with MUI on outcomes is not as clear as the majority of studies did not include urodynamically proven MUI. Potential pharmacologic approaches to the treatment of mixed incontinence include antimuscarinic agents, estrogen

replacement therapy (for postmenopausal women), and dopamine, serotonin, and norepinephrine reuptake inhibitors [24]. Electrical stimulation is another conservative measure that could potentially be used for the treatment of MUI [25]. Surgery should be considered after failed medical management, proper work up, and careful counselling about the lower overall success rates of around 55%.

Though there are various factors described in the literature to predict who will be more likely to benefit, these have not been clearly defined. There is some evidence that surgery may relieve symptoms of DO, especially if stress symptoms predate urge symptoms [16]. Presence of specific urodynamic criteria pre-operatively is more likely to be associated with persistence of UUI/DO. These include low maximum urethral closure pressure (MUCP) [26, 27], low maximum urinary flow rate [28], higher opening detrusor pressure [29], low maximum cystometric capacity [30, 31] presence of uninhibited detrusor contraction during cystometry [15], lower volume at DO [29] and higher detrusor pressure [29]. Treatment should be individualized based on clinical scenario along with urodynamic findings. There is insufficient evidence at present, to suggest the best type of sling for these patients. Currently, relative symptom components are most frequently reported as predominant and nonpredominant (assuming a rough estimate of percentage contribution). This method can be inaccurate

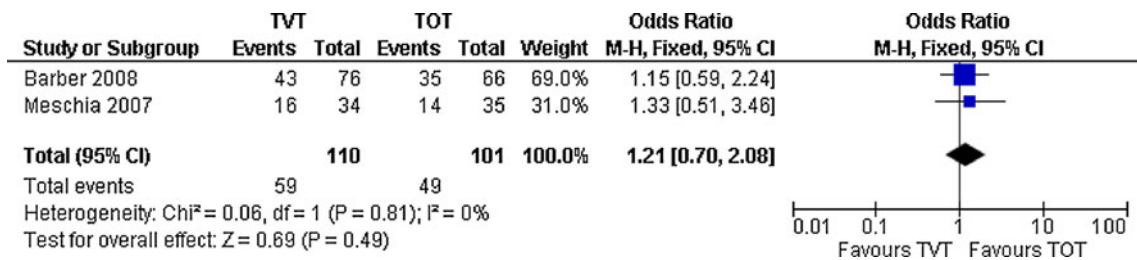


Fig. 5 Overall cure of MUI in women with no DO on UDS (RCTs)

and begs the need for better methods of symptom quantification. Ideally, during reporting of MUI, the relative contributions of the stress and urge components should be explicitly stated [23]. A reproducible symptom assessment tool that is robust enough to reflect subtle changes in contributing symptoms is desirable in future studies. There is a need for methodologically robust RCT to evaluate the effectiveness of MUS versus conservative treatment in women with MUI. Further studies are also needed describing the effects of urodynamically proven DO in MUI on surgical outcomes. The studies should be powered enough to enable us to identify any patient and/or surgical variables responsible for higher overall cure/improvement rates in MUI.

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