

Review

Storage symptoms after surgical treatment of stress urinary incontinence in women: a clinical review

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Abstract

Objectives: Minimally invasive sling procedures for the treatment of stress urinary incontinence has gained a topic of great interest for the last decades. However, postoperative storage symptoms after sling implantation or conventional surgical techniques are one of the most distressing complications which can significantly impair quality of life. The current review aims to focus on the development of storage symptoms after surgical treatment in comparison of different surgical techniques. **Mechanism:** A narrative review has been performed to identify literature reporting the incidence of storage symptoms after female stress urinary incontinence surgery. The results of systematic reviews and meta-analysis have been included in this review. **Findings in brief:** Pubovaginal slings have a higher risk for developing storage symptoms. In contrast, standard midurethral slings (SMUS) and colposuspensions demonstrate comparable rates of postoperative storage symptoms. Regarding SMUS, the surgical route did not demonstrate significant differences in storage symptoms. In comparison between SIMS and SMUS, no significant difference of postoperative storage symptoms could be identified. **Conclusions:** Pubovaginal slings have the highest risk for postoperative storage symptoms in comparison to colposuspension and SMUS and SIMS. Furthermore, surgical technique and misplacement of sling may contribute significantly in the development of postoperative storage symptoms.

Keywords: Synthetic midurethral sling; Single-incision mini-sling; Storage symptom; Stress urinary incontinence; Lower urinary tract symptoms

1. Introduction

Stress urinary incontinence (SUI) is a bothersome symptom that can have a serious impact on social and psychological well-being [1]. When conservative management with pelvic floor training fails, surgical treatment can be considered. Several surgical procedures have been proposed for the treatment of SUI. Although these procedures are often effective for the resolution of stress incontinence, storage symptoms including urgency and urgency urinary incontinence (UUI) occur frequently after surgery [2]. Patients with mixed urinary incontinence (MUI) can experience persistence or even aggravation of overactive bladder (OAB) symptoms, whereas patient with pure SUI can develop de novo urgency. Potentially reversible causes such as infection, bladder outlet obstruction (BOO), and foreign bodies (mesh or suture material) are common complications after sling surgery causing OAB symptoms. Nevertheless, the cause remain unclear in many cases [3].

Complicating, the mesh ban for transvaginal meshes by the Food and Drug Administration (FDA) [4] also questioned the use of slings for the treatment of stress urinary incontinence. Although there is a consensus statement of the European association of urology and European urogynecology association indicating that the use of slings for the treatment of SUI is still safe [5], more critical recommendations have been given by NICE guidelines [6]. Nevertheless, although alternative surgical procedures are gaining interest in particular countries where mesh has been banned, most European recommendations still recommend slings for the treatment of SUI [7].

However, most studies on the surgical treatment of SUI focus on the success rate with little focus on storage symptoms. Furthermore, definitions and measurements for OAB symptoms vary between the studies, incidences are incongruent and consequently, direct comparison between studies are difficult to perform. Moreover, it is often un-



clear how symptoms were exactly recorded. In this paper, we reviewed the current literature on storage symptoms after SUI surgery. We compared the results of different surgical techniques and identified possible risk factors for the occurrence of de novo or persistent OAB symptoms and furthermore reviewed the pathophysiology for these symptoms.

2. Materials and methods

We conducted a narrative review in order to assess the incidence and management of OAB symptoms after SUI surgery. By extracting the relevant data from existing reviews and meta-analyses, we give an overview of the current evidence. Included for this review were the surgical techniques Burch colposuspension, pubovaginal sling and synthetic sling procedures.

The review of the relevant literature addressing OAB symptoms after SUI surgery was performed in February 2018 using the PubMed database. Search terms included Medical subject heading (MeSH) as well as free text. The terms “urgency”, “overactive bladder”, “detrusor overactivity” or “storage” in combination with the “urinary stress incontinence”, “midurethral sling”, “transobturator tape”, “transvaginal tape” or “colposuspension”. Reviews and meta-analyses between 2010 and 2018 evaluating the efficacy and safety of SUI surgery were analysed. Studies, which reported the number of storage symptoms after SUI surgery were included in this review.

3. Results

3.1 De novo storage symptoms

Newly diagnosed storage symptoms are a known complications after surgical treatment of SUI [8]. These include both urgency/frequency symptoms and UUI. However, no widely accepted definition of de novo storage symptoms following surgery for SUI exists. A prerequisite is that the patient has no bother from these symptoms pre-operatively which usually rely on the subjective report of the patient. The origin of these symptoms is poorly understood. They may be the result of partial BOO or irritation of the urethra [3]. Bladder outlet obstruction is often regarded as the most important mechanism of developing storage symptoms due to changes in the innervation of the bladder or changes in the detrusor muscle [9]. It has been previously reported that women whose maximum flow rate decreases significantly after sling surgery are more likely to develop storage symptoms [10]. However, BOO is not well defined in women and no universally accepted nomograms exist.

Antunes-Lopes *et al.* [11] found an increase in urinary neurotrophin levels (nerve growth factor and brain-derived neurotrophic factor) after the placement of a midurethral sling. There was a significantly higher percentage increase of these neurotrophins in women with de novo urgency than in those without these symptoms. These findings suggest

that increased bladder outlet resistance after midurethral sling surgery may play a key role in the rise of urinary neurotrophins, promoting sensitization of bladder primary afferents. Furthermore, damage to the bladder autonomic nerve innervation resulting in detrusor overactivity has also been suggested to be a cause of de novo urgency [12]. This could be caused by bladder denervation in abdominal surgery or extensive dissection, for example with an autologous fascial sling.

3.2 Persistent storage symptoms

Persistent storage symptoms refer to symptoms which were present preoperatively and do not resolve after surgery. Despite the absence of an established definition of persistent storage symptoms, these include persistence of urgency or UUI. In an updated guideline of the American Urological Association, the incidence of persistent storage symptoms after SUI surgery was reported between 14–52% for all procedures [2]. Approximately 30% of all women with urinary incontinence suffer from an overlap of SUI and UUI [13]. Although the success rate of surgical treatment for mixed incontinence is lower than for SUI, many studies have reported improvement of urgency symptoms in patients with MUI after a sling procedure [14–16]. It has been suggested that the mechanism through which OAB symptoms occur in MUI is stimulation by urine leakage into the proximal urethra by increasing abdominal pressure [17]. Therefore, by counteracting the leakage of urine with a sling procedure or suspension, urgency symptoms may resolve.

3.3 Surgical technique

A variety of surgical procedures have been reported for the treatment of women with SUI. At large, three categories exist: colposuspensions, pubovaginal slings, and synthetic midurethral slings. Other techniques, such as artificial sphincters, injectables or laparoscopic procedures are not discussed in this review. Burch colposuspensions and pubovaginal slings are both well-established procedures with long-term data on efficacy and complications [18,19]. However, since the introduction of the minimally invasive synthetic midurethral sling in the 1990s, this has become the most commonly performed procedure today in the treatment of female SUI. In the last two decades, a large number of clinical trials have been published comparing the efficacy and complication rates between these surgical treatments. The comparative data have been pooled and reviewed in various meta-analyses, which are demonstrated in Table 1 (Ref. [20–32]) and discussed in the following sections.

3.4 Colposuspension vs pubovaginal sling

In a Cochrane review by Lapitan *et al.* [33], 6 trials were identified comparing open retropubic colposuspensions with traditional pubovaginal slings. Only one trial evaluated the OAB symptoms after surgery [34]. Seventy-

Table 1. Overview of systematic reviews and meta-analysis included in this review.

Publication	Year of publication	Operative techniques	Number of trials	Number of patients
Ford [23]	2017	Standard midurethral slings (SMUS)	81	12113
Fusco [22]	2017	Colposuspensions, pubovaginal slings, Standard midurethral slings (SMUS)	28	15885
Jain [26]	2011	Standard midurethral slings (SMUS)	13	2693
Jiao [32]	2018	Mini-sling (MiniArc) vs Standard midurethral slings (SMUS)	12	1794
Kim [30]	2018	Single-incision mini-sling (SIMS) vs Standard midurethral slings (SMUS)	29	Not specified
Lapitan [33]	2016	Colposuspensions vs Standard midurethral slings (SMUS) vs open vaginal surgery	55	5417
Latthe [24]	2010	Standard midurethral slings (SMUS, transobturator route)	31	4769
Madhuvrata [25]	2012	Standard midurethral slings (SMUS, transobturator route)	5	771
Mostafa [28]	2014	Single-incision mini-sling (SIMS) vs Standard midurethral slings (SMUS)	26	3308
Nambiar [29]	2017	Single-incision mini-sling (SIMS)	31	3290
Novara [20]	2010	Colposuspensions, pubovaginal slings, standard synthetic midurethral slings (SMUS)	39	not specified
Ogah [21]	2011	Single-incision mini-sling (SIMS)	62	7101
Pergialiotis [26]	2017	Single-incision mini-sling (SIMS) vs standard synthetic midurethral slings	32	3139
Schimpf [27]	2014	Colposuspensions, pubovaginal slings, standard synthetic midurethral slings (SMUS)	8	465
Zhang [31]	2015	Single-incision mini-sling (SIMS) vs Standard midurethral slings (SMUS)	5	678

two patients were randomised to undergo colposuspension or traditional fascial sling. Two of 36 patients (5.6%) in the colposuspension group developed de novo OAB symptoms versus 5 of 36 patients (13.9%) in the sling group. Two studies reported on the incidence of DO after surgery. Both found a higher incidence of DO in the colposuspension group.

3.5 Colposuspensions vs standard midurethral slings (SMUS)

Three meta-analyses compared the results of colposuspensions with SMUS [20,21,33]. Novara *et al.* [20] evaluated 10 randomized controlled trials (RCTs) between 2002 and 2008, comparing 580 patients in the SMUS group with 548 patients in the colposuspension group. No significant difference between the groups was identified for the incidence of post-operative storage lower urinary tract symptoms (LUTS) (98/580 (16.9%) vs 89/548 (16.2%) respectively). Although an updated review was published by the same working group in 2017 by Fusco *et al.* [22], the comparison between of colposuspension and SMUS did not include the complication rates. Ogah *et al.* [21] evaluated 4 RCTs comparing the efficacy and complications of open colposuspensions with SMUS. They found no significant difference in de novo urgency or urgency incontinence rates reporting a comparative risk of 129/1000 vs 89/1000 for open colposuspension and SMUS respectively. Also, no significant difference was identified in the occurrence of post-operative detrusor overactivity. Lapitan *et al.* [33] compared the results of 6 RCTs, with a total of 521 patients. Again, no significant difference was found in the rate of storage symptoms and detrusor overactivity.

3.6 Pubovaginal slings vs standard midurethral slings (SMUS)

In a meta-analysis by Novara *et al.* [20], 3 RCTs were evaluated comparing the incidence of storage symptoms between pubovaginal and SMUS. A significant better outcome in favour of the synthetic slings was identified (38/188 (20.2%) vs 80/193 (41.5%)). All three studies demonstrated a lower incidence of storage LUTS in the synthetic sling group. Ogah *et al.* [21] also evaluated 3 RCTs (of which one was equal to the study by Novara) comparing pubovaginal with SMUS. Meta-analysis demonstrated a significant better outcome for the SMUS group regarding de novo urgency and UUI (7/123 (5.7%) vs 19/113 (16.8%)). However, no significant difference in detrusor overactivity could be identified.

3.7 SMUS technique

Two surgical implantation techniques (retropubic vs transobturator) are available for Standard midurethral slings (SMUS).

Fusco *et al.* [22] compared in a recent meta-analysis a total of 5231 patients with a retropubic or transobturator sling regarding storage symptoms. Similarly, no significant differences between the groups could be identified (299/2664 (11.2%) vs 282/2567 (11.0%)). Ford *et al.* [23] identified a comparative risk for storage symptoms of 82/1000 for retropubic and 80/1000 for transobturator slings which demonstrated no significant difference.

In one review, the transobturator technique was associated with a lower rate of storage symptoms compared to the retropubic technique [2]. However, Ogah *et al.* [21] did not identify a significant difference in their meta-analysis of 14 studies. Latthe *et al.* [24] compared two routes of transobturator tape (inside-out and outside-in) with the

retropubic procedure. De novo urgency was seen more frequently in transobturator procedures, although no difference was observed between the inside-out and outside-in technique [24]. Madhuvrata *et al.* [25] also found no difference in de novo urgency rates in their meta-analysis of 5 randomised trials. Jain *et al.* [26] reviewed the effectiveness of SMUS in patients with mixed urinary incontinence. A meta-analysis demonstrated no significant difference in the urgency incontinence cure rate between tapes used by retropubic or transobturator routes.

3.8 Sling route

Both, retropubic and transobturator slings, can be inserted either by an outside-in or inside-out technique. Regarding retropubic slings, the outside-in technique tend to inferior cure rates despite increased complications in comparison to the inside-out technique [21,35]. However, cure rates have been proven comparable in both sling routes of transobturator slings [21,35]. Focusing on storage symptoms, only three trials reported storage symptoms in the meta-analysis of Ogah *et al.* [21] including a total of 260 patients which demonstrated no significant difference between the groups. Fusco *et al.* [22] identified two trials with a total of 194 patients comparing both sling routes. No significant differences could be identified between the groups (11/101 (10.9%) inside-out vs 7/93 (7.5%) outside in).

3.9 Single-incision mini-sling (SIMS) vs Standard midurethral slings (SMUS)

Currently, the implantation of SIMS is gaining interest as an alternative method of treating SUI. In a meta-analysis by Schimpf *et al.* [27] 8 studies were evaluated comparing the minisling technique with either retropubic or transobturator synthetic sling. They found an estimated incidence of 5.4% urgency symptoms which was comparable to the full-length sling group (5.3% in obturator and 6.9% in retropubic techniques).

Mostafa *et al.* [28] conducted a meta-analysis including 26 RCTs and quasi-RCTs comparing SIMS with SMUS. They found no significant differences in de novo urgency and/or worsening of pre-existing symptoms, although there was a trend towards more de novo urgency with the TVT-Secur. Nambiar *et al.* [29] included 8 RTC comparing postoperative storage symptoms between SMUS with SIMS. They demonstrated as well no significant difference between the groups.

In a recent meta-analysis by Kim *et al.* [30], SIMS were compared to SMUS in which TVT-Secur was excluded. Furthermore, this meta-analysis provides the so far longest follow-up period. In conclusion, there were no significant differences between the groups regarding urgency or de novo urgency. However, voiding dysfunction was less observed in patients with a mini sling ($p < 0.002$) but definition of voiding dysfunction was not explained in this meta-analysis.

Pergialiotis *et al.* [36] investigated the incidence of de novo overactive bladder (OAB) following SIMS and SMUS. Including a total of 3139 patients in this meta-analysis, he could not identify a significant difference between the groups regarding the incidence of de novo OAB (mini slings 9.7%, Tension-free vaginal tape-obturator (TVT-O) 11.2%, Transobturator tape (TOT) 8.7%, TVT 9.8%).

In comparison of Ajust with SMUS surgery, no significant differences regarding urgency, de novo urgency or voiding dysfunction could be identified [31]. Jiao *et al.* [32] compared MiniArc with SMUS regarding de novo urgency. Equally, he could not identify a significant difference between the groups.

3.10 Tape position and storage symptoms

Placement of the sling under the mid-urethra was first described by Ulmsten *et al.* [37]. Earlier, it was believed that the surgical support should be mainly provided to the proximal urethra or bladder neck. Since there is extensive high-quality evidence on the efficacy and safety of synthetic slings, the midurethral position has become generally accepted as the preferred position. It has been postulated that a suboptimal position of the tape can be associated with urgency symptoms. Flock *et al.* [38] reported on a prospective study of 206 women who underwent transvaginal ultrasound 10 weeks after surgery. The development of urgency incontinence or voiding dysfunction was compared with the position of the tape in relation to the length of the urethra. There was no apparent difference in the tape position in the women who developed de novo urgency incontinence when compared to the women without these symptoms. Jiang *et al.* [39] also found no correlation between de novo urgency and tape position on transrectal ultrasound in 153 women after TVT procedure.

Yang *et al.* [40] used 4-D transvaginal ultrasound to determine tape position and tension in 56 women who underwent TVT procedure (Monarc). They demonstrated that women with postoperative OAB symptoms had a more caudoventral resting tape position relative to the symphysis pubis compared with women without OAB symptoms. The authors speculated that a distally placed tape along with some tension on the urethra, but not sufficient to cause the development of urethral encroachment during resting, may be factors associated with postoperative OAB symptoms.

Kociszewski *et al.* [41] evaluated the proximity of the tape to the urethral lumen. They found that in most patients who experienced urgency symptoms, the tape was located less than 3 mm from the longitudinal smooth muscle complex. The authors concluded that storage symptoms are probably more attributable to the proximity of the tape to the urethral lumen than the exact tape position along the urethra.

4. Discussion

Different surgical techniques are available in the treatment of SUI. Of these, SMUS and colposuspensions demonstrate comparable rates of postoperative storage symptoms. Pubovaginal slings are associated with an increased risk of developing storage symptoms, possibly due to a higher degree of obstruction or autonomic bladder denervation. Regarding SMUS, the surgical technique (retropubic vs transobturator) did not demonstrate significant differences in de novo or persistence of storage symptoms. The utilised route in transobturator slings (inside-out vs outside-in) does not affect the rate of storage symptoms. In comparison of SIMS with SMUS, no significant difference of postoperative storage symptoms could be identified. Nevertheless, in a recent meta-analysis voiding dysfunction was less existent in SIMS. Considering, that SMIS are inferior to SMUS in regard to long-term efficacy, the lower rates of storage symptoms could be correlating to less correctives of the surgery [42]. Furthermore, the correct positioning of the sling may not only contribute the efficacy of sling surgery but also the prevention of storage symptoms. Illiano *et al.* [43] evaluated the sling position in women by ultrasound in women after MUS surgery. The sling position beneath the proximal urethra was significantly associated with the development or persistence of storage symptoms. Thus, the surgical technique may have significant impact for the overall outcome of SUI surgery.

Other factors such as tape tension and proximity to the urethral lumen could also be involved in the development of storage symptoms. Further research is needed in order to clarify the pathophysiology of postoperative storage symptoms.

Author contributions

TM, TH, TAL, MR, BG, JNC and MSR designed the review, collected data, analysed the data, wrote and edited the manuscript. All authors contributed to editorial changes in the manuscript, read and approved the final version.

Ethics approval and consent to participate

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Conflict of interest

The authors declare no conflict of interest.

References

- [1] Schimpf MO, Patel M, O'Sullivan DM, Tulikangas PK. Difference in quality of life in women with urge urinary incontinence

compared to women with stress urinary incontinence. *International Urogynecology Journal*. 2009; 20: 781–786.

- [2] Dmochowski RR, Blaivas JM, Gormley EA, Juma S, Karram MM, Lightner DJ, *et al.* Update of AUA guideline on the surgical management of female stress urinary incontinence. *The Journal of Urology*. 2010; 183: 1906–1914.
- [3] Sajadi KP, Vasavada SP. Overactive Bladder after Sling Surgery. *Current Urology Reports*. 2010; 11: 366–371.
- [4] Dyer O. Transvaginal mesh: FDA orders remaining products off US market. *British Medical Journal*. 2019; 365: 11839.
- [5] Chapple CR, Cruz F, Deffieux X, Milani AL, Arlandis S, Artibani W, *et al.* Consensus Statement of the European Urology Association and the European Urogynaecological Association on the Use of Implanted Materials for Treating Pelvic Organ Prolapse and Stress Urinary Incontinence. *European Urology*. 2017; 72: 424–431.
- [6] NICE Guidance - Urinary incontinence and pelvic organ prolapse in women: management: © NICE (2019) Urinary incontinence and pelvic organ prolapse in women: management. *BJU International*. 2019; 123: 777–803.
- [7] Harding CK, Lapitan MC, Arlandis S, Bø K, Cobussen-Boekhorst H, Costantini E, *et al.* Management of Non-Neurogenic Female Lower Urinary Tract Symptoms (LUTS). In: *Guidelines of the European Association of Urology*. 2021. Available at: <https://uroweb.org/guideline/non-neurogenic-female-luts/> (Accessed: 8 November 2021).
- [8] Holmgren C, Nilsson S, Lanner L, Hellberg D. Frequency of de novo urgency in 463 women who had undergone the tension-free vaginal tape (TVT) procedure for genuine stress urinary incontinence—a long-term follow-up. *European Journal of Obstetrics & Gynecology and Reproductive Biology*. 2007; 132: 121–125.
- [9] Goldman HB, Zimmern PE. The treatment of female bladder outlet obstruction. *BJU International*. 2006; 98.
- [10] Duckett JRA, Basu M. The predictive value of preoperative pressure-flow studies in the resolution of detrusor overactivity and overactive bladder after tension-free vaginal tape insertion. *BJU International*. 2007; 99: 1439–1442.
- [11] Antunes-Lopes T, Coelho A, Pinto R, Barros SC, Cruz CD, Cruz F, *et al.* Urinary Neurotrophin Levels Increase in Women with Stress Urinary Incontinence after a Midurethral Sling Procedure. *Urology*. 2017; 99: 49–56.
- [12] Kershen RT, Appell RA. De novo urge syndrome and detrusor instability after anti-incontinence surgery: current concepts, evaluation, and treatment. *Current Urology Reports*. 2002; 3: 345–353.
- [13] Katsumi HK, Rutman MP. Can we predict if overactive bladder symptoms will resolve after sling surgery in women with mixed urinary incontinence? *Current Urology Reports*. 2010; 11: 328–337.
- [14] Bergman A, Koonings PP, Ballard CA. Predicting postoperative urinary incontinence development in women undergoing operation for genitourinary prolapse. *American Journal of Obstetrics and Gynecology*. 1988; 158: 1171–1175.
- [15] Partoll LM. Efficacy of tension-free vaginal tape with other pelvic reconstructive surgery. *American Journal of Obstetrics and Gynecology*. 2002; 186: 1292–1295.
- [16] Rezapour M, Ulmsten U. Tension-Free vaginal tape (TVT) in women with mixed urinary incontinence—a long-term follow-up. *International Urogynecology Journal and Pelvic Floor Dysfunction*. 2001; 12.
- [17] Grimshaw R, Jain P, Latthe P. Management of mixed urinary incontinence. *Women's Health*. 2012; 8: 567–577.
- [18] Kulseng-Hanssen S, Berild GH. Subjective and objective incontinence 5 to 10 years after Burch colposuspension. *Neurourology and Urodynamics*. 2002; 21: 100–105.

- [19] Thiel DD, Pettit PD, McClellan WT, Petrou SP. Long-term urinary continence rates after simple sling incision for relief of urinary retention following fascia lata pubovaginal slings. *Journal of Urology*. 2005; 174: 1878–1881.
- [20] Novara G, Artibani W, Barber MD, Chapple CR, Costantini E, Ficarra V, *et al*. Updated systematic review and meta-analysis of the comparative data on colposuspensions, pubovaginal slings, and midurethral tapes in the surgical treatment of female stress urinary incontinence. *European Urology*. 2010; 58: 218–238.
- [21] Ogah J, Cody JD, Rogerson L. Minimally invasive synthetic suburethral sling operations for stress urinary incontinence in women. *Cochrane Database of Systematic Reviews*. 2009; 4: CD006375.
- [22] Fusco F, Abdel-Fattah M, Chapple CR, Creta M, La Falce S, Waltregny D, *et al*. Updated Systematic Review and Meta-analysis of the Comparative Data on Colposuspensions, Pubovaginal Slings, and Midurethral Tapes in the Surgical Treatment of Female Stress Urinary Incontinence. *European Urology*. 2017; 72: 567–591.
- [23] Ford AA, Rogerson L, Cody JD, Aluko P, Ogah JA. Midurethral sling operations for stress urinary incontinence in women. *The Cochrane Database of Systematic Reviews*. 2017; 7: CD006375.
- [24] Latthe PM, Singh P, Foon R, Toozs-Hobson P. Two routes of transobturator tape procedures in stress urinary incontinence: a meta-analysis with direct and indirect comparison of randomized trials. *BJU International*. 2010; 106: 68–76.
- [25] Madhuvrata P, Riad M, Ammembal MK, Agur W, Abdel-Fattah M. Systematic review and meta-analysis of “inside-out” versus “outside-in” transobturator tapes in management of stress urinary incontinence in women. *European Journal of Obstetrics & Gynecology and Reproductive Biology*. 2012; 162: 1–10.
- [26] Jain P, Jirschele K, Botros SM, Latthe PM. Effectiveness of midurethral slings in mixed urinary incontinence: a systematic review and meta-analysis. *International Urogynecology Journal*. 2011; 22: 923–932.
- [27] Schimpf MO, Rahn DD, Wheeler TL, Patel M, White AB, Orejuola FJ, *et al*. Sling surgery for stress urinary incontinence in women: a systematic review and metaanalysis. *American Journal of Obstetrics and Gynecology*. 2014; 211: 71.e1–71.e27.
- [28] Mostafa A, Lim CP, Hopper L, Madhuvrata P, Abdel-Fattah M. Single-incision mini-slings versus standard midurethral slings in surgical management of female stress urinary incontinence: an updated systematic review and meta-analysis of effectiveness and complications. *European Urology*. 2014; 65: 402–427.
- [29] Nambiar A, Cody JD, Jeffery ST, Aluko P. Single-incision sling operations for urinary incontinence in women. *The Cochrane Database of Systematic Reviews*. 2017; 7: CD008709.
- [30] Kim A, Kim MS, Park YJ, Choi WS, Park HK, Pacik SH, *et al*. An Updated Systematic Review and Meta-analysis: Clinical Outcome of Single-Incision Slings Excluding TVT-Secur versus Standard Slings in Surgical Management of Stress Incontinence. *British Journal of Urology*. 2018.
- [31] Zhang P, Fan B, Zhang P, Han H, Xu Y, Wang B, *et al*. Meta-analysis of female stress urinary incontinence treatments with adjustable single-incision mini-slings and transobturator tension-free vaginal tape surgeries. *BMC Urology*. 2015; 15: 64.
- [32] Jiao B, Lai S, Xu X, Zhang M, Diao T, Zhang G. A systematic review and meta-analysis of single-incision mini-slings (MiniArc) versus transobturator mid-urethral slings in surgical management of female stress urinary incontinence. *Medicine*. 2018; 97: e0283.
- [33] Lapitan MCM, Cody JD. Open retropubic colposuspension for urinary incontinence in women. *The Cochrane Database of Systematic Reviews*. 2016; 4: CD002912.
- [34] Enzelsberger H, Helmer H, Schatten C. Comparison of burch and lyodura sling procedures for repair of unsuccessful incontinence surgery. *Obstetrics and Gynecology*. 1996; 88: 251–256.
- [35] Kobashi KC, Albo ME, Dmochowski RR, Ginsberg DA, Goldman HB, Gomelsky A, *et al*. Surgical Treatment of Female Stress Urinary Incontinence: AUA/SUFU Guideline. *The Journal of Urology*. 2019; 198: 875–883.
- [36] Pergialiotis V, Mudiaga Z, Perrea DN, Doumouchtsis SK. De novo overactive bladder following midurethral sling procedures: a systematic review of the literature and meta-analysis. *International Urogynecology Journal*. 2017; 28: 1631–1638.
- [37] Ulmsten U, Falconer C, Johnson P, Jomaa M, Lannér L, Nilsson CG, *et al*. A multicenter study of tension-free vaginal tape (TVT) for surgical treatment of stress urinary incontinence. *International Urogynecology Journal and Pelvic Floor Dysfunction*. 1998; 9: 210–213.
- [38] Flock F, Kohorst F, Kreienberg R, Reich A. Ultrasound assessment of tension-free vaginal tape (TVT). *Ultraschall in Der Medizin*. 2011; 32.
- [39] Jiang Y, Wang C, Chuang F, Ke Q, Kuo H. Positioning of a suburethral sling at the bladder neck is associated with a higher recurrence rate of stress urinary incontinence. *Journal of Ultrasound in Medicine*. 2013; 32: 239–245.
- [40] Yang J, Huang W. Sonographic findings in a case of voiding dysfunction secondary to the tension-free vaginal tape (TVT) procedure. *Ultrasound in Obstetrics and Gynecology*. 2004; 23: 302–304.
- [41] Kociszewski J, Rautenberg O, Kuszka A, Eberhard J, Hilgers R, Viereck V. Can we place tension-free vaginal tape where it should be? The one-third rule. *Ultrasound in Obstetrics and Gynecology*. 2012; 39: 210–214.
- [42] Kim A, Kim MS, Park Y, Choi WS, Park HK, Paick SH, *et al*. Clinical outcome of single-incision slings, excluding TVT-Secur, vs standard slings in the surgical management of stress incontinence: an updated systematic review and meta-analysis. *BJU International*. 2019; 123: 566–584.
- [43] Illiano E, Trama F, Li Marzi V, Mancini V, Carrieri G, Ruvoletto CC, *et al*. Translabial ultrasound: a non-invasive technique for assessing “technical errors” after TOT failure. *International Urogynecology Journal and Pelvic Floor Dysfunction*. 2021. (in press)