Review Article



# Surgical treatments (especially middle urethral suspension) for female stress urinary incontinence: a literature review

**Can Luo[1,2], Kaiyin Pang[1,2], Dongmei Wei[1,2], Xiaoyu Niu[1,2]**

[1]Department of Obstetrics and Gynecology, West China Second University Hospital of Sichuan University, Chengdu, China; [2]Laboratory of Birth Defects and Related Diseases of Women and Children (Sichuan University), Ministry of Education, Chengdu, China

*Contributions:* (I) Conception and design: C Luo, X Niu; (II) Administrative support: C Luo, K Pang; (III) Provision of study material or patients: D Wei, X Niu; (IV) Collection and assembly of data: C Luo; (V) Data analysis and interpretation: C Luo; (VI) Manuscript writing: All authors; (VII) Final approval of manuscript: All authors.

*Correspondence to:* Xiaoyu Niu, PhD. Department of Obstetrics and Gynecology, West China Second University Hospital of Sichuan University, No. 20 Renmin South Road, Chengdu 610041, China; Laboratory of Birth Defects and Related Diseases of Women and Children (Sichuan University), Ministry of Education, Chengdu, China. Email: Niuxy@scu.edu.cn.

**Background and Objective:** Pelvic floor dysfunctions (PFDs) are increasingly prevalent worldwide. Among PFDs, stress urinary incontinence (SUI) stands out due to its complex pathogenesis, making it the most common form of urinary incontinence (UI), affecting at least 50% of adult women globally, particularly elderly and postpartum women. This condition leads to significant physical and psychological impairments. Surgical interventions have shown greater efficacy compared to conservative treatments, particularly in cases of severe SUI. Recent advancements in minimally invasive surgery have significantly improved surgical treatments, addressed associated side effects and achieved better therapeutic outcomes than in the past.

**Methods:** A comprehensive literature search was conducted on PubMed, focusing on studies published from 2015 to 2022.

**Key Content and Findings:** Mid-urethral slings (MUSs) have long been considered the preferred procedure for treating severe SUI. However, recent trials have suggested that single-incision slings (SISs) exhibit fewer side effects than traditional slings. Unfortunately, the efficacy and safety of SISs remain a subject of controversy due to limitations stemming from small sample sizes and short follow-up periods. To enhance postoperative outcomes, preoperative urodynamic reports have emerged as a valuable tool in identifying potential voiding dysfunctions (VDs).

**Conclusions:** The paradigm of surgical treatment for SUI has evolved from anatomical restoration to providing support for defective structures. To optimize surgical outcomes, clinicians are advised to proactively identify high-risk factors associated with VD before the procedure. Furthermore, it is crucial to adequately inform patients about the potential need for postoperative indwelling catheters, thereby mitigating the risk of doctor-patient disputes.

**Keywords:** Stress urinary incontinence (SUI); middle urethral suspension; mesh; voiding dysfunctions (VDs)

Received: 05 August 2022; Accepted: 11 August 2023; Published online: 17 August 2023.
doi: 10.21037/gpm-22-26
**View this article at:** https://dx.doi.org/10.21037/gpm-22-26

## Introduction

According to the International Society for Urinary Control and the International Urogynecological Association (IUGA), stress urinary incontinence (SUI) is characterized by the involuntary leakage of urine during activities that raise intra-abdominal pressure, such as coughing, sneezing, or laughing. It has been reported that approximately 49% of women are affected by SUI (1). Several risk factors have been associated with SUI in the literature, including pregnancy (2), childbirth, advanced

age, high body mass index (BMI), menopause, pelvic organ prolapses (POPs) (3), previous history of pelvic surgery, and respiratory system diseases and others (4). Currently, SUI is believed to arise from two primary mechanisms. The first mechanism involves urethral hypermobility, which occurs when the supporting tissues around the urethra weaken. As a consequence, when intra-abdominal pressure increases, the bladder neck and urethra are unable to adequately close, leading to urine leakage. The second mechanism is known as intrinsic sphincter deficiency (ISD), characterized by more bothersome symptoms (4,5). When addressing female SUI, the initial step involves the exclusion of other types of urinary incontinence (UI) and the identification of any reversible underlying causes. Subsequently, personalized therapeutic approaches can be formulated to suit the individual patient. In instances where the diagnosis and classification of UI present challenges, seeking consultation from a urogynecology specialist for further evaluations is considered the optimal course of action.

Customizing treatment strategies to align with the specific goals and preferences of individual patients is of paramount importance. The concerns expressed by many individuals pertaining to treatment costs and potential adverse effects necessitate thorough consideration and discussion during the treatment decision-making process. The management of SUI has been categorized into three steps, encompassing lifestyle adjustments, physical rehabilitation, and surgical interventions (6). For patients who present with mild leakage symptoms, non-invasive treatment methods, such as lifestyle modifications, pelvic floor muscle training (PFMT), vaginal inserts, electrical/magnetic stimulations, and fractional $CO_2$ lattice laser, are often preferred. Ultimately, patients' goals and preferences play a crucial role in determining the most suitable treatment approach. When conservative treatments prove ineffective, or if severe SUI symptoms persist, many patients turn to surgical interventions.

The management of SUI through surgical interventions is continually evolving, leading to varying outcomes in terms of surgical efficacy and postoperative complication rates. In this paper, we aim to provide a comprehensive review of recent surgical treatments for female SUI. While previous literature has already addressed the surgical management of SUI, our focus lies in delivering a detailed overview of the advancements in mid-urethral slings (MUSs) and the latest clinical studies on novel surgical approaches, with particular emphasis on single-incision slings (SISs). The present article adheres to the narrative review reporting checklist to ensure a comprehensive and methodical presentation of the subject matter. We present this article in accordance with the Narrative Review reporting checklist (available at https://gpm.amegroups.com/article/view/10.21037/gpm-22-26/rc).

## Methods

A systematic search of relevant studies was conducted on PubMed, with a focus on publications from 2015 to 2022. The search did not impose any restrictions based on geographical or ethnic factors. A comprehensive summary of the search strategy is presented in *Table 1*.

## Results and discussions

Preoperative evaluations and consultations hold paramount importance as they are integral to the surgical decision-making process (7). The retropubic Burch colposuspension was initially introduced by Burch (8). However, recent randomized controlled trials (RCTs) have demonstrated that the outcomes of Burch colposuspension are less effective compared to MUSs (9). Notably, the MUSs groups reported superior patient-centered subjective outcomes (10). For the purpose of this review, our focus will primarily be on MUS, and we will not delve into discussions about Burch procedures (11). MUS, first reported by Ulmsten in 1995 based on the integral theory, has gained widespread recognition as a preferred surgical approach for SUI due to its simplicity, minimal complications, and lower recurrence rates (12,13). However, the Food and Drug Administration (FDA) has recently cautioned gynecologists and urologists about the elevated rates of mesh-related infection and exposure in POP surgery, prompting a need for vigilance regarding the use of slings in anti-SUI procedures as well. It is worth noting that the efficacy and postoperative complication rates may vary among different MUS procedures (14,15). Furthermore, various types of SISs are gaining popularity worldwide; however, it is important to acknowledge that these procedures often lack sufficient sample sizes and long-term follow-up data.

## MUSs

MUSs are seen as the preferred standard for the treatment of severe SUI (16-18). Over time, surgical techniques and sling materials have undergone multiple modifications. Notable surgical paths include tension-free vaginal

**Table 1** The search strategy summary

| Items | Specification |
|---|---|
| Data of search | 2021.10–2022.8 |
| Databases and other sources searched | PubMed |
| Search terms used | "Urinary Stress Incontinence" [MeSH] |
| | "Incontinence, Urinary Stress" [MeSH] |
| | "Stress Incontinence, Urinary" [MeSH] |
| | "Sling, Suburethral" [MeSH] |
| | "Transobturator Tape/Tapes" [MeSH] |
| | "Transobturator Suburethral Tape" [MeSH] |
| | "Urethral Slings" [MeSH] |
| | "Midurethral Slings" [MeSH] |
| | "Tensionless Vaginal Tape" [MeSH] |
| | "Tension-Free Vaginal Tape" [MeSH] |
| | "Slings, Mid-Urethral" [MeSH] |
| | "Trans-Obturator Tape" [MeSH] |
| Timeframe | 2015–2022 |
| Inclusion and exclusion criteria | Concentrated on original papers and reviews in English about the surgical treatments about SUI. If the articles do not fit the topic, which will be excluded |
| Selection process | Luo C and Pang K independently conducted the search process |

SUI, stress urinary incontinence.

tape (TVT), tension-free vaginal tape-exact (TVT-E), trans-obturator tape (TOT), tension-free vaginal tape-obturator (TVT-O) and tension-free vaginal tape-Abbrevo (TVT-A). These slings are typically composed of synthetic materials, which may potentially induce rejection and elicit inflammatory reactions.

### *TVT and TVT-E*

TVT was first introduced in the 1990s in Sweden by Olmsten. This technique involves introducing the mesh through a vaginal incision, directly inserting it into the Retzius space, and then passing it out from the abdominal wall into the suprapubic area. A substantial body of literature has reported that TVT is an effective treatment for SUI (19-21). Moreover, TVT has been considered a suitable surgical approach for patients with combined POP (22). However, some side effects associated with TVT have been reported in the literature. These side effects include damage to the urinary system (bladder and urethra), bleeding, abnormalities in urination function, exposure and corrosion of slings, difficulties in sexual life, and chronic pelvic pain, among others (23,24).

TVT-E represents a reformative version of TVT, sharing similarities with the latter. However, TVT-E boasts several advantages over TVT, such as requiring only a single puncture and one cystoscopy, thus simplifying surgical procedures, reducing operation time, and inflicting fewer harms to neighboring structures due to its easier, smaller (3 mm), and lighter puncture. In an RCT conducted by Feng *et al.* (25), TVT-E demonstrated better subjective cure rates and less postoperative discomfort than TVT-A in the 3-month follow-up. However, no significant differences were observed in the 12-month follow-up. Importantly, no peri-operative complications or discomfort were reported in this trial. Additionally, Sun *et al.* (26) reported that TVT-E might be a more favorable choice for overweight patients, significantly improving I-QOL, PFIQ-7, and UDI-6 scores compared to TVT-A in overweight women group. Consequently, TVT-E can serve as a valuable reference for doctors when selecting minimally invasive surgery for their patients. It is worth noting that both studies (25,26) (*Table 2*) originated from the same sample and clinical trial center, which raises questions about the credibility of the conclusions. Thus, further investigations are needed to corroborate the findings. Unfortunately, clinical studies on TVT-E have been scarce in recent years. We strongly advocate and anticipate more high-quality studies with larger sample sizes to thoroughly assess the efficacy of TVT-E for SUI and to inform clinical decision-making processes.

### *TVT and TVT-O/TOT*

A new surgical approach was introduced called TVT-O and TOT (27). Transobturator tapes have demonstrated advantages over TVT, including the avoidance of certain complications associated with the retropubic path (such as bladder perforation and voiding difficulties) and a reduction in operation time (24). However, in some trials involving females SUI, pain in the groin and thighs domain was reported after TVT-O/TOT. This phenomenon may occur due to the passage of slings through the thigh muscles and tendons or their proximity to the filiations of the obturator

**Table 2** Literature review of TVT-E in SUI

| Author/year | Study type | Number of subjects | Outcomes evaluated | Results |
|---|---|---|---|---|
| Feng 2018 | Single center randomized control trials | N=125 patients | 1. Questionnaires on quality of life | 1. TVT-E took more time but caused less postoperative pain than TVT-A |
| | | TVT-E =63 | 2. Symptom severity | 2. The rate of urine leakage in TVT-A group was higher than that in TVT-E ($P<0.05$) |
| | | TVT-A =62 | 3. Patient satisfaction | 3. TVT-E group showed the higher score in I-QOL and the lower scores in both ICIQ-SF and PFIQ-7 scales |
| | | | | 4. Two groups showed comparable objective cure rates by cough stress test |
| | | | | 5. The subjective cure rate of TVT-E was better than that of TVT-A in 3 months, but was similar between two groups in 12 months |
| Sun 2017 | Single center retrospective data analysis | N=426 patients | 1. Subjective efficiency | 1. In the normal weight patients, the subjectively and objectively cured rates were all high in both TVT-A and TVE-E |
| | | TVT-E =220 (119 normal weight and 101 overweight) | 2. Questionnaires: | 2. The score of I-QOL, PFIQ-7, and UDI-6 have significantly changed |
| | | TVT-A =206 (114 normal weight and 92 overweight) | ICIQ-SF | 3. In the overweight patients, the subjective and objective efficiency were better in TVT-E than TVT-A |
| | | | I-QOL | 4. The score of I-QOL, PFIQ-7, and UDI-6 of overweight women have significantly changed only in the TVT-E |
| | | | PFIQ-7 | 5. Both procedures have no effect on the score of PISQ-12 |
| | | | UDI-6 | |
| | | | PISQ-12 | |

TVT-E, tension-free vaginal tape-exact; SUI, stress urinary incontinence; TVT-A, tension-free vaginal tape-Abbrevo.

nerve (4). Two surgical methods, TVT and TVT-O, are widely used in clinical practice, and the superiority of their curative effects has not been consistently concluded. Elers *et al.* (28) noted that TVT and TVT-O showed equal efficacy in terms of decreasing the number of incontinence episodes, but leg and groin pain were more common in TVT-O. They recommended TVT as the preferred option for SUI rather than TVT-O. A prospective observational trial conducted by Offiah *et al.* (29) observed that 41.8% of women who underwent TVT had no SUI symptoms compared to 21.8% for TOT. They found no significant differences in the occurrence of severe vaginal or groin pain and concluded that TVT is superior to TOT for treating SUI. Wang *et al.* (30) showed that the objective cure rate was higher and the incidence of postoperative thigh/groin pain was lower in TVT compared to TVT-O/TOT, but TVT had higher incidences of dysuria and lower urinary tract infections. They recommended TVT as a better option than TVT-O/TOT. Kim *et al.* (31) also demonstrated that TVT was more effective than TVT-O/TOT for women with high risks, such as obesity, ISD, POP, and recurrent SUI after MUSs. However, Song *et al.* (32) recommended TOT as a first-line treatment compared to TVT, TVT-O, and TVT-S, for its higher efficacy and

safety. Lier *et al.* (33) confirmed that TVT-O is cost-effective compared to TVT. Nevertheless, larger samples and high-quality clinical trial centers are critically needed to establish clinical guidelines and advanced diagnostic methods. To mitigate the discomfort and avoid damage to the obturator nerve associated with TVT-O, the TVT-O procedure was modified into TVT-A (34).

### *TVT-A*

Indeed, the surgical procedures for TVT-A are almost identical to those of TVT-O. Compared with TVT-O, the slings are shortened to 12 cm (34). The most notable characteristic of TVT-A lies in its inability to pierce the obturator membrane, which contributes to reduced pain around the puncture sites. In a randomized trial conducted by Zullo *et al.* (35), women who underwent TVT-O were compared to those who underwent TVT-A. The study observed that TVT-A demonstrated similar efficacy and safety over a 36-month follow-up period when compared to TVT-O. However, TVT-A did not exhibit advantages in terms of intraoperative surgical time, blood loss, or length of hospital stay. Another study by Braga *et al.* (34) reported that 90% of patients subjectively reported cure, and 92.5% of patients were objectively cured with no serious postoperative complications or reports of groin/thigh pain. The authors recommended TVT-A as a highly effective choice for the treatment of women with pure SUI. Similarly, a retrospective study (36) indicated that TVT-A surgery is comparable to TVT-O in terms of a high success rate and low incidence of complications, including bladder injury and groin pain. However, it is essential to acknowledge that the current evidence on TVT-A is limited by small sample sizes and a lack of robust trials in recent years, which renders the efficacy of TVT-A somewhat controversial.

### *SISs*

To mitigate the significant complications associated with traditional MUSs, such as damage to the viscera and vascellums, and groin/thigh pain, the third-generation MUS, also known as SISs, were introduced in 2005 (37). This innovative procedure involves placing a sub-urethral sling in the mid-urethra and anchoring it to the internal obturator muscle/membrane, thus reducing related complications by shortening the surgical path for insertion and the volume of polypropylene mesh implanted (38). Despite these advancements, the efficacy and safety of SISs for SUI continue to be a subject of controversy in the medical community.

Osse *et al.* (39) conducted an observational study and reported that 75% of women who underwent SISs procedures, using Ajust® and the Altis®, experienced improved conditions, with a subjective cure rate of 61% over an average follow-up of 54 months. Ruffolo *et al.* (40) compared SIS (SIMS-Altis®) with TVT-A during a 5-year follow-up and found no significant difference in subjective and objective cure rates, as well as the postoperative complications rate between the two groups. Gromicho *et al.* (41) observed an overall treatment success rate of 73.3% at a median follow-up of 8 years after using Altis® SIS. However, they reported two cases of vaginal extrusion, three cases of intravesical obstructions, and 20 patients with *de novo* urgency. Hwang *et al.* (42) compared the use of SISs [MiniArc® (American Medical Systems, Minnetonka, MN, USA), Solyx™ (Boston Scientific Corporation, Marlborough, MA, USA), and I-STOP® (CL, Medical, Lyon, France)] versus transobturator slings (TOSs) in patients with ISD SUI over a median follow-up of 21 months. They found that the objective and subjective cure rates were comparable between the two groups (objective: 76% *vs.* 76%; subjective: 78% *vs.* 83%). TOS procedures had shorter surgical times and lower postoperative visual analog scale scores. However, other aspects, including UDI-6, IIQ-7, 1-hour pad test, and adverse events, did not show significant statistical differences. The authors concluded that while TOS cannot be replaced by SISs, it remains the best surgical approach for female SUI.

Careful consideration of the findings presented in this context is vital, taking into account the respective study designs and limitations. However, it is evident that further research is imperative to comprehensively investigate the efficacy and safety of SISs in comparison to other surgical procedures for treating female SUI. Notably, the commercial availability of diverse designs of SIS from different companies has led to emerging controversies about their overall efficacy, which may be influenced by these variations. For instance, in a study conducted by Chiang *et al.* (43) they compared the clinical efficacy and urodynamic parameter changes in patients who received two types of SISs, namely MiniArc® and Solyx™. After a 3-month follow-up, they observed that 91.1% of MiniArc patients versus 100% of Solyx users achieved objective cure with statistical differences. However, no significant difference was found in subjective cure rates (93.7% *vs.* 90.2% at 3 months; 89.9% *vs.* 80.4% at 1 year). The

authors concluded that SISs are safe and effective for female SUI, with the Solyx™ SIS demonstrating superiority over the MiniArc®. Nonetheless, it is essential to acknowledge the low credibility of the study's conclusions due to limited sample sizes and follow-up time. Therefore, more high-quality multicentric prospective RCTs are required to draw definitive conclusions about the efficacy and safety of these SISs designs.

The unique T-shaped structure of the Needleless sling allows for firm fixation to the obturator, providing sufficiently large support with ample contact areas. In a study conducted by Dogan *et al.* (44) the objective and subjective cure rates were reported as 85.4% and 87.6%, respectively, after using the Contasure-needleless® (Neomedic International) mini-sling (SIMS) during a 12-month follow-up. The overall failure rates were 3.4% in the TOT group and 2.2% in the SIMS group. The study further indicated that SIMS resulted in significantly less postoperative pain compared to TOT. However, another study by Dogan *et al.* (45) revealed that, when compared to hammock-shape placement, the U-shape placement of the needleless single-incision mini-sling was inferior in achieving the patient's goals over an 18-month follow-up period. Fernandez-Gonzalez *et al.* (46) incorporated 187 patients and concluded that Contasure-Needleless® (C-NDL) was not inferior to Monarch® (an outside-in TOS) in terms of efficacy. Nevertheless, it was found to be inferior when comparing a negative stress test and patient satisfaction.

While the needleless sling has increasingly become novel option for surgeons due to its expected effects and high safety, it is imperative to emphasize the necessity for further trials to provide more comprehensive support for its efficacy and safety profile. Continued research and larger-scale trials are essential to establish a more definitive understanding of the advantages and limitations of the Needleless sling in the management of female SUI.

Moreover, efforts have been made to reduce the number of remaining slings in the patient's body while maintaining the efficacy and safety of TVT-O procedures. In 2006, TVT-Secur (TVT-S) was introduced, aiming to decrease complications such as postoperative pain. Unlike TVT/TVT-O, TVT-S procedures do not involve going through the groin and femoral adductor muscles, and they can be performed under local anesthesia. TVT-S requires only a small incision in the anterior vaginal wall without any incision on the groin skin (47). However, it is important to note that the slings in TVT-S need to be given light tension. A meta-analysis (48) suggested that TVT-O is superior to TVT-S, even though it may have a higher risk of postoperative thigh pain. The efficacy of TVT-S has remained a subject of controversy. Sun *et al.* (49) also reported that TVT-O demonstrated superior objective cure and subjective satisfaction rates and a lesser decline in success over a 10-year period compared with TVT-S. Serdinsek *et al.* (50) pointed out that the lower efficacy of TVT-S might be due to inadequate fixation and increasing tape descent. Currently, TVT-S is not widely used in hospitals because the slings in TVT-S are shorter than those used in TVT/TVT-O, resulting in a relatively lower success rate. Therefore, more high-quality multicentered trials are necessary to draw conclusive findings regarding the efficacy and safety of TVT-S in the treatment of female SUI.

## Injection of urethral bulking agents (UBAs)

UBAs present a distinct approach from the aforementioned surgical treatments, as they produce a therapeutic effect by increasing the ability to block the urethra rather than altering the angle and position of the bladder urethra (51). However, it is essential to note that UBAs are far less effective than MUSs (14). A meta-analysis (51) has shown that UBAs should not be offered as a first-line therapy for women seeking a "one-time" durable solution for primary or recurrent SUI. In a study conducted by Itkonen Freitas *et al.* (21), TVT surgery was compared to polyacrylamide hydrogel (PAHG) injection. Both TVT and PAHG treatments showed improvements in quality of life (QoL) scores and sexual functions at 1 year. However, incontinence and health-related QoL scores were better in the TVT group. Nevertheless, for women aged over 60 years old with fewer than 2.5 daily SUI episodes, UBAs demonstrated a 90% success rate (52). The utilization rates of UBAs vary in different countries and hospitals, reflecting the importance of considering patient-specific factors and preferences when determining the most appropriate treatment approach for SUI. While UBAs may have a role in specific patient populations, further research is needed to fully understand their efficacy, limitations, and overall effectiveness in comparison to other treatment options. Therefore, clinicians should carefully assess individual patient characteristics and consider the available evidence when making treatment decisions related to UBAs for SUI.

## Autologous rectus fascia pubovaginal sling (AF-PVS)

Despite MUSs being considered the gold standard for

treating female SUI, the FDA has recently emphasized mesh-related adverse effects, particularly exposure and erosion. Following the FDA warnings in 2011 (53), the utilization of MUS procedures decreased from 135 (in 2011) to 75 (in 2016) per 100,000 women, indicating a significant decline of 44%. In contrast, there was a 13% increase in the usage of autologous slings, which have been employed to treat SUI since the beginning of the last century. The two types of autologous slings used are fascia lata (FL) and rectus fascia (RF). However, it was not until the 1970s and 1980s, through the work of McGuire and Blavias, that autologous slings found a role in treating ISD. Prior to this, the Burch procedure was the most commonly performed treatment for SUI. The AF-PVS is particularly suitable for patients with ISD, a history of prior pelvic irradiation, failed and/or complicated synthetic MUSs procedures, or compromised urethral lumen. An RCT (54) compared synthetic transobturator tapes with AF-PVS, both showing similar success rates, but AF-PVS demonstrated higher complication rates, including postoperative urinary retention (POUR) and wound infections. One patient in the AF-PVS group developed a vesicovaginal fistula, while another required cutting of the tape. However, the incidence of groin pain was lower in the AF-PVS group. A cohort study (55) with a median follow-up of 14.5 years reported a success rate of nearly 53%. Haudebert *et al.* (56) retrospectively analyzed 16 female SUI patients, all with high risk factors for mesh-related complications, and found an effective rate of 56.3% after 3 months of follow-up. Similarly, Sharifiaghdas *et al.* (57) reported a 65% success rate for AF-PVS in female patients who had previously failed anti-SUI surgery, with 25% of patients developing new urgency.

AF-PVS emerges as a promising primary option for patients with multiple surgical failures, such as failed MUSs or the Burch procedure. However, it is imperative for clinicians to engage in thorough communication with patients, ensuring they are well-informed about the potential postoperative complications associated with AF-PVS. This step is particularly crucial for patients with contraindications to mesh or those who have experienced SUI recurrence after MUSs procedures. Furthermore, additional research is warranted to establish the efficacy and safety of AF-PVS as a viable treatment option for managing female SUI. Considering the possibility of lower urinary tract dysfunction, particularly urinary retention (UR), following AVF surgery, AF-PVS stands as a noteworthy alternative treatment, especially for patients with contraindications to mesh or those who have experienced SUI recurrence after MUS procedures. Clinicians should prioritize comprehensive communication with patients, ensuring they understand the potential postoperative complications when considering AF-PVS as the primary choice for treatment.

## Postoperative voiding dysfunctions (VDs)

Currently, anti-SUI surgery continues to face a significant challenge: postoperative VDs, with UR being particularly prevalent. The incidence of UR after MUSs procedures has been reported to range widely, from 7.8% to 84% (58). To address this issue, indwelling catheters such as Foley catheters or clean intermittent catheterization (CIC) are often employed as a solution. However, the use of catheters can lead to hospital-acquired urinary tract infections and may cause discomfort and embarrassment for patients (59). In order to enhance patient satisfaction and prevent potential medical disputes, it is crucial to identify risk factors associated with POUR. By doing so, healthcare providers can better inform patients about the possibility of requiring a catheter before discharge and devise appropriate strategies to minimize the occurrence of POUR. Such efforts are essential to optimize patient outcomes and ensure the success of anti-SUI surgical procedures.

Mutone *et al.* (60) conducted a study and identified that previous anti-SUI surgery, previous anti-pop surgery, and increasing age were associated with an increased risk of delayed POUR. On the other hand, Turner *et al.* (61) reported no correlation between POUR and concomitant anti-SUI surgery in sacrocolpopexy. Norton *et al.* (62) conducted a study and reported that certain adaptive procedures, such as straining to void, pressing on the bladder to void, and bending forward to void, increased the risk of postoperative incomplete bladder emptying by nearly two-fold. They also compared the risk factors between retropubic slings and TOSs and found that using retropubic slings posed a higher risk of incomplete bladder emptying, while age or prior surgery were not identified as risk factors. To accurately attribute postoperative VDs to the surgical procedure itself, it is crucial to consider the patients' preoperative voiding symptoms. Norton *et al.* (62) observed that preoperative VDs were common, even in patients with no previous POP or anti-SUI surgery. Interestingly, only a small number of patients reported a steady stream, while almost three-quarters of women described experiencing dribbling.

The existing literature on VDs after anti-SUI surgery is currently limited, and the identified risk factors show variation across different studies. In order to establish a more robust prediction model and gain a comprehensive understanding of postoperative VDs, further high-quality RCTs are essential. These future studies will play a critical role in enhancing patient care and optimizing surgical outcomes. By elucidating the factors contributing to postoperative VDs, clinicians can implement more targeted and effective interventions to improve patients' post-surgery experiences and overall QoL. Additionally, a better understanding of the risk factors will aid in refining surgical techniques and decision-making, leading to improved outcomes for women undergoing anti-SUI surgery.

## Conclusions

This paper presents a systematic review of the development of MUSs and recent clinical studies. However, it is worth noting that further exploration and in-depth analysis of each surgical procedure would enhance the comprehensiveness of this review. Pelvic floor dysfunctions (PFDs), particularly SUI, are prevalent worldwide and significantly impact the well-being of females. Thus, the management, diagnosis, and prevention of PFDs represent crucial tasks for gynecologists.

A crucial step in the management of PFDs is accurately distinguishing between different types of UI and assessing the severity of symptoms. Conservative treatments should be attempted first, and if they prove ineffective, various surgical options must be discussed with patients. While MUSs are widely regarded as the best choices for sever SUI, it is important to consider the rates of mesh-related side-effects, patient expectations, preferences, and overall suitability for surgery. Recent clinical trials on SISs have shown promising results, including higher cure rates, fewer complications, and lower costs. However, the current applications of SISs remain limited compared to traditional slings due to sample size limitations and relatively short follow-up periods.

In preparation for surgery, clinicians must identify high-risk factors associated with postoperative VDs and inform patients about the possibility of postoperative indwelling catheters to minimize doctor-patient disputes. As research in surgical techniques continues to advance, we believe that a new chapter is unfolding for the surgical treatment of female SUI. Emphasizing evidence-based practice and conducting further rigorous research will undoubtedly contribute to improving surgical outcomes and the overall quality of care for patients with PFDs.

## Acknowledgments

*Funding:* This study was supported by the National Key Research and Development Program of China (No. 2021YFC2009100).

## Footnote

*Reporting Checklist:* The authors have completed the Narrative Review reporting checklist. Available at https://gpm.amegroups.com/article/view/10.21037/gpm-22-26/rc

*Peer Review File:* Available at https://gpm.amegroups.com/article/view/10.21037/gpm-22-26/prf

*Conflicts of Interest:* All authors have completed the ICMJE uniform disclosure form (available at https://gpm.amegroups.com/article/view/10.21037/gpm-22-26/coif). XN serves as the unpaid Executive Editor-in-Chief of *Gynecology and Pelvic Medicine*. The other authors have no conflicts of interest to declare.

*Ethical Statement:* The authors are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.



## References

1. McKenzie S, Watson T, Thompson J, et al. Stress urinary incontinence is highly prevalent in recreationally active women attending gyms or exercise classes. Int Urogynecol J 2016;27:1175-84.
2. Ptak M, Ciećwież S, Brodowska A, et al. The Effect of Pelvic Floor Muscles Exercise on Quality of Life

in Women with Stress Urinary Incontinence and Its Relationship with Vaginal Deliveries: A Randomized Trial. Biomed Res Int 2019;2019:5321864.
3. Wang K, Xu X, Jia G, et al. Risk Factors for Postpartum Stress Urinary Incontinence: a Systematic Review and Meta-analysis. Reprod Sci 2020;27:2129-45.
4. Tran LN, Puckett Y. Urinary Incontinence. StatPearls. Treasure Island (FL): StatPearls Publishing Copyright © 2022, StatPearls Publishing LLC.; 2022.
5. Lugo T, Riggs J. Stress Incontinence. StatPearls. Treasure Island (FL): StatPearls Publishing Copyright © 2022, StatPearls Publishing LLC.; 2022.
6. Nambiar AK, Arlandis S, Bø K, et al. European Association of Urology Guidelines on the Diagnosis and Management of Female Non-neurogenic Lower Urinary Tract Symptoms. Part 1: Diagnostics, Overactive Bladder, Stress Urinary Incontinence, and Mixed Urinary Incontinence. Eur Urol 2022;82:49-59.
7. Geary RS, Gurol-Urganci I, Mamza JB, et al. Variation in availability and use of surgical care for female urinary incontinence: a mixed-methods study. Southampton (UK): NIHR Journals Library; March 2021.
8. Burch JC. Urethrovaginal fixation to Cooper's ligament for correction of stress incontinence, cystocele, and prolapse. Am J Obstet Gynecol 1961;81:281-90.
9. Trabuco EC, Linder BJ, Klingele CJ, et al. Two-Year Results of Burch Compared With Midurethral Sling With Sacrocolpopexy: A Randomized Controlled Trial. Obstet Gynecol 2018;131:31-8.
10. Trabuco EC, Klingele CJ, Blandon RE, et al. Burch Retropubic Urethropexy Compared With Midurethral Sling With Concurrent Sacrocolpopexy: A Randomized Controlled Trial. Obstet Gynecol 2016;128:828-35.
11. Ciećwież S, Chełstowski K, Brodowska A, et al. Association between the Urinary Bladder Volume and the Incidence of "De Novo" Overactive Bladder in Patients with Stress Urinary Incontinence Subjected to Sling Surgeries or Burch Procedure. Biomed Res Int 2019;2019:9515242.
12. Sung VW, Borello-France D, Newman DK, et al. Effect of Behavioral and Pelvic Floor Muscle Therapy Combined With Surgery vs Surgery Alone on Incontinence Symptoms Among Women With Mixed Urinary Incontinence: The ESTEEM Randomized Clinical Trial. JAMA 2019;322:1066-76.
13. Sarrazin C, Baron M, Thuillier C, et al. Synthetic mid-urethral slings for the treatment of stress urinary incontinence in women with neurogenic lower urinary tract dysfunction: a systematic review. Int Urogynecol J 2022;33:767-76.
14. Pivazyan L, Kasyan G, Grigoryan B, et al. Effectiveness and safety of bulking agents versus surgical methods in women with stress urinary incontinence: a systematic review and meta-analysis. Int Urogynecol J 2022;33:777-87.
15. Liu J, Li L, Bv S, et al. Systematic review and meta-analysis of therapeutic effects of pelvic restoration combined with anti-stress urinary incontinence surgery on pelvic floor dysfunction. Ann Palliat Med 2021;10:11678-87.
16. Harvie HS, Sung VW, Neuwahl SJ, et al. Cost-effectiveness of behavioral and pelvic floor muscle therapy combined with midurethral sling surgery vs surgery alone among women with mixed urinary incontinence: results of the Effects of Surgical Treatment Enhanced With Exercise for Mixed Urinary Incontinence randomized trial. Am J Obstet Gynecol 2021;225:651.e1-651.e26.
17. Yu S, Sun L, Jiang J, et al. Sonographic assessment of compression effect on urethra following transobturator MUS. Int Urogynecol J 2022;33:2849-57.
18. Braga A, Caccia G, Regusci L, et al. Mid-urethral sling in a day surgery setting: is it possible? Int Urogynecol J 2020;31:817-21.
19. Kranz J, Schmidt S. Open retropubic colposuspension for urinary incontinence in women. Urologe A 2017;56:505-8.
20. Marschke J, Reisenauer C, Mikkola TS, et al. Comparison of two retropubic tension-free vaginal tape procedures in women with stress urinary incontinence: a randomized controlled multicenter trial. Arch Gynecol Obstet 2019;299:1015-22.
21. Itkonen Freitas AM, Mikkola TS, Rahkola-Soisalo P, et al. Quality of life and sexual function after TVT surgery versus Bulkamid injection for primary stress urinary incontinence: 1 year results from a randomized clinical trial. Int Urogynecol J 2021;32:595-601.
22. He P, Zou J, Gong B, et al. Systematic review and meta-analysis of the efficacy of tension-free vaginal tape on pelvic organ prolapse complicated by stress urinary incontinence. Ann Palliat Med 2021;10:12589-97.
23. MacCraith E, Cunnane EM, Joyce M, et al. Comparison of synthetic mesh erosion and chronic pain rates after surgery for pelvic organ prolapse and stress urinary incontinence: a systematic review. Int Urogynecol J 2021;32:573-80.
24. Doyle PJ, Grimes CL, Balk EM, et al. Surgical Removal of Midurethral Sling in Women Undergoing Surgery for Presumed Mesh-Related Complications: A Systematic Review. Obstet Gynecol 2022;139:277-86.
25. Feng S, Luo D, Liu Q, et al. Three- and twelve-month follow-up outcomes of TVT-EXACT and TVT-

 

ABBREVO for treatment of female stress urinary incontinence: a randomized clinical trial. World J Urol 2018;36:459-65.
26. Sun Y, Luo D, Yang L, et al. The Efficiency and Safety of Tension-Free Vaginal Tape (TVT) Abbrevo Procedure Versus TVT Exact in the Normal Weight and Overweight Patients Affected by Stress Urinary Incontinence. Urology 2017;110:63-9.
27. Shebl SE. Two-year outcomes of surgeon-tailored trans obturator tape for female stress urinary incontinence: a randomized, comparative, trial with traditional trans obturator tape. BMC Urol 2021;21:155.
28. Elers J, Hornum Bing M, Birkefoss K, et al. TVT or TVT-O? - A systematic review and meta-analysis comparing efficacy, complications and re-operations. Eur J Obstet Gynecol Reprod Biol 2021;258:146-51.
29. Offiah I, Freeman R; . Long-term efficacy and complications of a multicentre randomised controlled trial comparing retropubic and transobturator mid-urethral slings: a prospective observational study. BJOG 2021;128:2191-9.
30. Wang H, Liu J, Fang K, et al. Transobturator tape, tension-free vaginal tape, and transvaginal tension-free vaginal tape-obturator for the treatment of female stress urinary incontinence: A systematic review and network meta-analysis. Int J Gynaecol Obstet 2022;157:527-35.
31. Kim A, Kim MS, Park YJ, et al. Retropubic versus Transobturator Mid Urethral Slings in Patients at High Risk for Recurrent Stress Incontinence: A Systematic Review and Meta-Analysis. J Urol 2019;202:132-42.
32. Song P, Wen Y, Huang C, et al. The efficacy and safety comparison of surgical treatments for stress urinary incontinence: A network meta-analysis. Neurourol Urodyn 2018;37:1199-211.
33. Lier D, Robert M, Tang S, et al. Surgical treatment of stress urinary incontinence-trans-obturator tape compared with tension-free vaginal tape-5-year follow up: an economic evaluation. BJOG 2017;124:1431-9.
34. Braga A, Caccia G, Ruggeri G, et al. 3-Year follow-up of tension-free vaginal tape-ABBREVO procedure for the treatment of pure urodynamic stress urinary incontinence: efficacy and adverse effects. Int Urogynecol J 2020;31:739-44.
35. Zullo MA, Schiavi MC, Luffarelli P, et al. TVT-O vs. TVT-Abbrevo for stress urinary incontinence treatment in women: a randomized trial. Int Urogynecol J 2020;31:703-10.
36. Kim MK, Kim JH, Chae HD, et al. Surgical outcomes of tension-free vaginal tape (TVT)- abbrevo® and TVT-obturator® for the treatment of stress urinary incontinence: a retrospective study. Obstet Gynecol Sci 2021;64:540-6.
37. Khandwala S, Cruff J. Single-incision Midurethral Sling by the Dynamic Intraoperative Standing Sling Technique as an Office-based Procedure: A Pilot Study. Urology 2021;149:34-9.
38. Gon LM, Andrade DL, Palma P, et al. Preliminary report of post-Ophira mini sling implantation voiding pattern: What to learn from pressure-flow studies? Curr Urol 2021;15:181-4.
39. Osse NJE, Engberts MK, Koopman LS, et al. Evaluation of the long-term effect and complication rate of single-incision slings for female stress urinary incontinence. Eur J Obstet Gynecol Reprod Biol 2021;267:1-5.
40. Ruffolo AF, Bonavina G, Serati M, et al. Single-incision mini-sling and trans-obturator sling for stress urinary incontinence: A 5-year comparison. Eur J Obstet Gynecol Reprod Biol 2022;270:90-4.
41. Gromicho A, Dias J, Araújo D, et al. Long-term outcomes of Altis® single-incision sling procedure for stress urinary incontinence. Int Urogynecol J 2022;33:717-22.
42. Hwang JC, Huang WC, Su TH, et al. Evaluation of efficacy and safety of single-incision sling versus transobturator sling in women with stress incontinence and intrinsic sphincter deficiency. Int Urogynecol J 2022;33:985-90.
43. Chiang FC, Sun R, Chang YJ, et al. Comparison of Clinical Efficacy and Urodynamic Changes Using Single-incision Slings (MiniArc® vs. Solyx™) for the Treatment of Female Stress Urinary Incontinence. Gynecol Minim Invasive Ther 2021;10:235-42.
44. Dogan O, Kaya AE, Pulatoglu C, et al. A randomized comparison of a single-incision needleless (Contasure-needleless®) mini-sling versus an inside-out transobturator (Contasure-KIM®) mid-urethral sling in women with stress urinary incontinence: 24-month follow-up results. Int Urogynecol J 2018;29:1387-95.
45. Dogan O, Basbug A, Kaya AE, et al. A randomized prospective comparison of the needleless mini-sling "hammock" and "U-shape" configurations for management of stress urinary incontinence: 18 month follow-up results. Arch Gynecol Obstet 2018;297:1483-93.
46. Fernandez-Gonzalez S, Martinez Franco E, Lin Miao X, et al. Contasure-needleless® compared with Monarc® for the treatment of stress urinary incontinence. Int Urogynecol J 2017;28:1077-84.
47. Rodrigues CA, Bianchi-Ferraro AMHM, Zucchi EVM, et al. Pelvic Floor 3D Ultrasound of Women with a TVT,

 

TVT-O, or TVT-S for Stress Urinary Incontinence at the Three-year Follow-up. Rev Bras Ginecol Obstet 2017;39:471-9.
48. Song B, He Y, Shen R, et al. TVT-O vs TVT-S for female stress urinary incontinence: A systematic review and meta-analysis. Int J Clin Pract 2020;74:e13506.
49. Sun Z, Wang X, Lang J, et al. Comparison of outcomes between single-incision sling and transobturator sling for treating stress urinary incontinence: A 10-year prospective study. Neurourol Urodyn 2019;38:1852-8.
50. Serdinsek T, Martan A, Svabik K, et al. Is the fixation of single incision TVT-S tape as good as that of transobturator tape? An ultrasound study of randomized trial results. Int Urogynecol J 2021;32:141-8.
51. Li H, Westney OL. Injection of Urethral Bulking Agents. Urol Clin North Am 2019;46:1-15.
52. Elmelund M, Sokol ER, Karram MM, et al. Patient Characteristics that May Influence the Effect of Urethral Injection Therapy for Female Stress Urinary Incontinence. J Urol 2019;202:125-31.
53. Berger AA, Tan-Kim J, Menefee SA. The impact of the 2011 US Food and Drug Administration transvaginal mesh communication on utilization of synthetic mid-urethral sling procedures. Int Urogynecol J 2021;32:2227-31.
54. Sharma JB, Deoghare MK, Bhatla N, et al. A comparative study of autologous rectus fascia pubovaginal sling surgery and synthetic transobturator vaginal tape procedure in treatment of women with urodynamic stress urinary incontinence. Eur J Obstet Gynecol Reprod Biol 2020;252:349-54.
55. Kim S, Wong DG, Lee D, et al. Very long-term follow-up of autologous pubovaginal fascia slings in women with stress urinary incontinence. Int Urogynecol J 2022;33:821-8.
56. Haudebert C, Richard C, Common H, et al. Autologous fascia pubovaginal slings in women with stress urinary incontinence at high risk of mesh/device-related complications. Prog Urol 2022;32:500-8.
57. Sharifiaghdas F, Mahmoudnejad N, Honarkar Ramezani M, et al. Salvage autologous fascial sling after failed anti-incontinence surgeries: Long term follow up. Urol J 2019;16:193-7.
58. Ripperda CM, Kowalski JT, Chaudhry ZQ, et al. Predictors of early postoperative voiding dysfunction and other complications following a midurethral sling. Am J Obstet Gynecol 2016;215:656.e1-6.
59. Tunitsky-Bitton E, Murphy A, Barber MD, et al. Assessment of voiding after sling: a randomized trial of 2 methods of postoperative catheter management after midurethral sling surgery for stress urinary incontinence in women. Am J Obstet Gynecol 2015;212:597.e1-9.
60. Mutone N, Brizendine E, Hale D. Factors that influence voiding function after the tension-free vaginal tape procedure for stress urinary incontinence. Am J Obstet Gynecol 2003;188:1477-81; discussion 1481-3.
61. Turner LC, Kantartzis K, Shepherd JP. Predictors of postoperative acute urinary retention in women undergoing minimally invasive sacral colpopexy. Female Pelvic Med Reconstr Surg 2015;21:39-42.
62. Norton PA, Nager CW, Chai TC, et al. Risk factors for incomplete bladder emptying after midurethral sling. Urology 2013;82:1038-41.

doi: 10.21037/gpm-22-26
**Cite this article as:** Luo C, Pang K, Wei D, Niu X. Surgical treatments (especially middle urethral suspension) for female stress urinary incontinence: a literature review. Gynecol Pelvic Med 2023;6:14.