Curr Bladder Dysfunct Rep (2016) 11:45–52
DOI 10.1007/s11884-016-0352-9

Bladder Outlet Obstruction After Incontinence Surgery

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Published online: 19 February 2016

Abstract Stress urinary incontinence (SUI) is said to effect up to 80 % of all women who complain of some type of urinary leakage. As education about the diagnosis and treatment of SUI becomes more widespread, there is a need for understanding the efficacy and potential complications of the therapies used to treat this condition. It is widely accepted that the gold standard for treatment of SUI is mid-urethral sling (MUS). One significant complication of the MUS procedure is subsequent bladder outlet obstruction (BOO). We review the incidence and etiology of BOO following MUS and hope this document can be used as a guide for identifying patients who may be affected by postsurgical BOO. Additionally, we discuss modalities for achieving a timely and accurate diagnosis and highlight recent evidence regarding the various applications of urodynamic studies, when concerned for BOO. Lastly, various managements of this complication are discussed. This chapter serves as a comprehensive overview of BOO after incontinence procedures, highlighting the recent research contributions, which have enhanced our understanding of this potential complication when treating SUI.

This article is part of the Topical Collection on *Stress Incontinence and Prolapse*

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Keywords Bladder outlet obstruction · Anti-incontinence procedure · Mid-urethral sling · Stress urinary incontinence · Sling complications

Introduction

Urinary incontinence continues to remain common among adult women, and overall incidence is on the rise as awareness and education of this disorder increases. The literature reveals that approximately 50 % of women will be affected by urinary incontinence (UI) in their lifetime and of those, approximately 30–80 % will report symptoms of stress urinary incontinence (SUI), specifically, as a predominant source of incontinence [1••, 2]. In the most recent comprehensive report from the International Consultation on Incontinence, which exhibited an exhaustive collection of data concerning epidemiology of pelvic floor, a yearly incidence of SUI was estimated to be approximately 4–10 % [3]. With the increase in the diagnosis of SUI comes an impetus to evaluate treatment modalities in order to uncover potential evidence for superiority of one treatment method over another. This has led to various robust comparative trials looking at the efficacy and complication rates and patient satisfaction rates associated with transvaginal suspension and sling procedures used to treat SUI. As a result, there is now moderate- and/or high-quality evidence to support the use of mid-urethral slings (MUS) as the "gold standard" for treatment of SUI [4]. In a recent position statement published by the American Urogynecologic Society (AUGS) and Society of Urodynamics, Female Pelvic Medicine and Urogenital Reconstruction (SUFU), it was stated that both retropubic and transobturator mid-urethral slings should be recognized as the worldwide standard of care for the surgical treatment of SUI and acknowledged polypropylene mesh slings in particular as a great advancement in the treatment

of this condition. To date, it has been extrapolated that over three million synthetic MUS procedures have been performed worldwide (80 % of those occurring in the USA), and it is estimated that 99 % of AUGS members now utilize this modality as a first-line surgical treatment [5•, 6].

In spite of this widespread acceptance, there is some cautiousness regarding MUS as the optimal treatment for SUI. Several experts claim that it is paramount to continue to pursue various mechanisms by which to address SUI, so as not to become complacent with the negative factors associated with this procedure. This is propelled by recent data, which illustrates the adverse events associated with MUS [7, 8]. Although of relatively low incidence, it is imperative to recognize these complications and understand how to remedy undesirable events potentially resulting from this treatment method. One of the common complications of anti-incontinence procedures in general is iatrogenic obstruction. The true incidence of post-procedure bladder outlet obstruction (BOO) is not known; however, it is estimated to occur in up to 20 % of patients after incontinence surgery. In particular, synthetic MUS procedures have been associated with some of the lower rates of this complication; however, BOO is still a current risk associated with MUS. In a 2004 review of the literature, Dunn and colleagues estimated an incidence of 4 % of bladder outlet obstruction after MUS versus that of approximately up to 20 % incidence with transvaginal suspension procedures such as pubovaginal slings, Marshall-Marchetti-Krantz procedures, and Burch colposuspensions [9].

This current review aims to discuss the etiology, clinical evaluation, diagnosis, and treatment of BOO after incontinence surgery. Given the widely accepted standard of mid-urethral sling surgery to treat stress incontinence, this discussion will be tailored toward obstructive bladder complications from sling surgeries specifically; however, the information can be broadly applied. BOO is a generic term for obstruction during voiding usually characterized by increased detrusor pressure during void (or attempt at voiding) and reduced (or absent) urine flow rate. It is usually diagnosed by studying the synchronous values of flow rate and detrusor pressure [10].

Incidence and Etiology

Although the exact incidence of BOO after incontinence surgery is not known, it has been estimated to range from 2 to 25 % [9, 11]. Sling procedures tend to be associated with an overall lower incidence of BOO although a recent extensive meta-analysis looking at all anti-incontinence procedures revealed similar incidences of voiding lower urinary tract symptoms (LUTS), including obstructive voiding symptoms, with both sling and culposuspension techniques [12]. In 2009, the American Urological Association published an estimated long-term urinary retention rate of 1–10 % after sling surgery. This was defined as catheter dependency for >28 days following surgery [13]. It is important to recognize that BOO after incontinence surgery may be underestimated. One theory for this is that patients who undergo anti-incontinence procedures are less likely to report minor voiding dysfunction, as they are simply content with being dry after long periods of incontinence. Furthermore, most studies in the literature conclude that 50–75 % of patients undergoing sling revisions experience revision surgery with a surgeon other than the implanting surgeon [14•]. This lack of continuity could also lead to a decrease in accurate reporting of BOO following sling procedures.

At times, obstructive voiding symptoms improve or resolve with time. Surgical intervention is not always necessary; however, when clinically significant and occurring in close temporal relation to the anti-incontinence surgery, sling revision, sling incision, excision, or urethrolysis are common and oftentimes needed to restore normal voiding phase of micturition. Overall, the incidence of requiring any intervention for obstruction after an anti-incontinence procedure hovers around 6 % [8, 15]. Voiding dysfunction managed with only catheter intervention is approximately 2 and 1.3 % for retropubic and transobturator procedures, respectively [16]. Surgical intervention for voiding dysfunction after sling procedures varies in the literature. Historically, it has been documented that rates of voiding dysfunction and urinary retention requiring intervention are higher with pubovaginal versus mid-urethral slings and higher with retropubic slings when comparing various types of synthetic slings, as they are thought to be more compressive around the urethra [13, 17, 18]. Recently, a comprehensive review by Blaivis et al. quoted the incidences of urethral obstruction requiring surgical interventions with both retropubic (RP) and transobturator (TOT) slings. For patients fitted with RP slings, obstruction requiring intervention ranged from 0 to 8.9 %, while the range was 0–21.3 % for the TOT group [14•].

More recent studies reveal the incidence of outlet obstruction requiring surgery is decreasing, possibly due to improvement in surgical proficiency, appropriate training, etc. In a study aimed to estimate perioperative complications and reoperations after the use of prosthetic implants, reoperation for sling loosening or sling incisions was 1.2 % for retropubic procedures and 1.9 % for transobturator slings in a cohort of 3747 women who had sling surgery and who were subsequently followed over a 21-month period. Sixty-three percent of slings in this cohort was performed retropubically, and the average time to reoperation was 80 days [19]. In the largest study to date with the longest follow-up analysis described,

over 188,000 women who had MUS procedures were evaluated over a 9-year study period. Authors set out to assess long-term risks of sling revision/removal and also to identify predictors of this outcome. The 9-year cumulative risk of revision/removal was 1.3 % for urethral obstruction, where more than 25,000 women were followed for 4 or more years from index sling. More of these reoperations were performed in women who were 18–29 years old and those who had concomitant anterior or apical prolapse repairs, and the majority of reoperations were performed within 4 years of index surgery [20••]. This data was based on the reference of only a single CPT code, and there was no discussion of patients lost to follow-up, begging the question of a possible underestimation of BOO after incontinence procedures. Still, this is the most comprehensive prevalence study in the literature, and the results cause us to contemplate the various reasons for this adverse event and the populations in which it is more likely to occur. Younger patients may be more bothered by irritative urinary symptoms and more willing to undergo revision surgery. Additionally, when performing concomitant procedures, it is important to understand how they can possibly alter the healing process or distort anatomy in such a way that may exacerbate obstructive symptoms. While the overall rate of obstruction and subsequent revision surgeries is low, it is still a noteworthy complication and understanding potential causes of BOO is vital when caring for patients who encounter this issue.

Many etiologies for postoperative BOO have been described in the literature. Pre-operative findings such as valsalva voiding, elevated pre-operative detrusor pressures, and lower pre-operative peak flow rates have all been associated in some studies with post-sling obstruction [21, 22]. Other measures like post-void residual (PVR) may indicate baseline bladder or bladder outlet dysfunction and may suggest further evaluation of voiding mechanics needing to be obtained. These surrogates of pre-operative-altered detrusor contractility should be assessed when considering any sling procedure, especially in an older population. Additionally, potential contributory intraoperative factors have also been discussed. Variation in technique of placement and "tensioning" of slings can play a role in the causation of postoperative obstruction of the bladder neck. Sonographic findings of more proximal sling positioning and voiding cystourethrogram findings of urethral distortion have both been associated with higher postoperative detrusor pressures, higher post-void residual volumes, and decreased maximum flow rates, all components proven to contribute to BOO [23, 24]. Regarding BOO after sling procedures, postoperative factors such as mesh erosion and significant pelvic organ prolapse may also have a role in urethral obstruction postoperatively. Given all of these contributing factors, it is paramount to revisit pre-operative, intraoperative, and postoperative circumstances for patients undergoing anti-incontinence surgery in order to understand the possible causes of BOO in this specific population.

Clinical Evaluation and Diagnosis

The temporal relationship between a patient's anti-incontinence procedure and emergence of obstructive urinary symptoms is paramount to understand in order to properly diagnose postsurgical BOO. Initially, knowledge of pre-operative data points such as post-void residual, flowmetry, bladder and urethral contour, and detrusor contractility can be vital when evaluating these patients and should be referenced when comparing a patient's postoperative urinary function to that prior to surgical intervention. The symptoms most easily attributed to an obstructing sling are a complete inability to void, suprapubic fullness, weak urinary stream, and needing to strain or change position to void. Symptoms that also suggest an obstructive sling include urinary urgency and/or frequency and the feeling of incomplete emptying but may also exist without obstruction. Other signs or symptoms may be present but take an increasingly high level of suspicion to identify and may very well require additional testing to confirm. When performing a comprehensive exam for a potentially obstructed patient, it is crucial to obtain a urinalysis, post-void residual, assessment of urethral mobility and angulation, and assessment of anterior vaginal wall to assess for prolapse and exclude mesh erosion/extrusion. Non-invasive uroflow can also be a valuable tool. Cystoscopy has been historically utilized. In some cases, this may prove useful and can help rule out concomitant intraurethral or intravesicle sling complications. Invasive pressure flow urodynamics has traditionally been used to define BOO in many urologic conditions including iatrogenic obstruction. The addition of simultaneous fluoroscopy (e.g., video urodynamics) has also been used to define obstruction and can confirm the location of obstruction in the case on women who have previously had anti-incontinence procedures [25]. In some cases, there is debate regarding the utility of these tools to adequately predict and/or diagnose BOO [26, 27].

In the last few years, many authors have set out to understand the urodynamic parameters used to diagnose iatrogenic bladder outlet obstruction following SUI procedures. Rodrigues and colleagues analyzed over 300 women who developed clinical signs of obstruction up to 120 days after SUI surgery and found five distinct different pressure-flow voiding patterns among them, most commonly that of normal pressure and poor flow (41.5 %). There were no correlations among any groups when comparing Urinary Distress Inventory questionnaires, and authors concluded that there is no single pressure-flow relationship that distinctly defines BOO in this postoperative population [28]. Critics have argued that the actual diagnosis of intravesical obstruction

requires low flow that is generated by high pressures; however, actual cutoffs for pressure and flow rates in this setting have been debated [27]. When comparing urodynamic results in patients with functional bladder outlet obstruction (FO) to those with anatomical bladder outlet obstruction (AO), we found that there was no difference in symptom profiles between the two groups, and we also found no difference in mean detrusor pressure at maximum flow rate when comparing the two groups. The only statistically significant difference noted was in maximum flow rate achieved between the two groups (FO average 10.6 ml/s versus AO average 7.4 ml/s, $p = 0.0044$) [29]. Further investigation comparing these two groups is necessary to better understand the significance of these findings; however, both studies referenced above reiterate the point that current definitions of BOO are in need of modification in order to avoid misdiagnosis in patients with iatrogenic BOO. Many studies have shown that urodynamics does not always correlate with clinical picture [26, 27]. More recently, Aponte and colleagues set out to determine the usefulness of video urodynamics (VUDS) to predict outcomes of intervention in patients with suspected BOO as a result of anti-incontinence surgery, specifically. Seventy-one women underwent either urethrolysis or sling incision/removal for suspected iatrogenic BOO, and 68 % of these patients had VUDS prior to their procedure. Both subjective (resolution or development of storage, voiding, or SUI symptoms) and objective (PVR and physical exam) follow-up data were obtained. Bladder outlet obstruction was diagnosed by VUDS when there was radiographic evidence of obstruction between the bladder neck and distal urethra in the presence of a sustained detrusor contraction during voiding. VUDS was proven to be predictive of symptom improvement only in patients with storage symptoms who had no evidence of detrusor overactivity (DO). These patients had significantly greater symptom improvement that those who exhibited DO (85.7 % vs 53.8 %, $p = 0.02$). When voiding symptoms or urinary retention were the primary indications for intervention urodynamic, findings were not predictive of outcomes following intervention to relieve obstruction. Regardless of VUDS confirmation of obstruction, this data revealed that in women whom obstruction was clinically suspected (either by symptom profile, elevated PVR, or both), similar postoperative outcomes were found in terms of symptom improvement [30]. This study further emphasizes the importance of clinical suspicion for BOO. It can be argued that in cases of new onset urinary retention and incomplete emptying, other parameters may not necessarily be needed for the diagnosis of BOO. Furthermore, the temporal relationship to SUI surgery and impact on quality of life should be an impetus in many cases to propel intervention. Many nomograms based on urodynamics (UDS) have been proposed as guidelines for diagnosing BOO in women; however, none have been universally adopted due to the inconsistencies in the literature, as partly illustrated above. One nomogram proposed by Solomon et al. used the VUDS definition to define BOO in 186 women and from this, developed and tested a nomogram that predicts obstruction if Pdet.Qmax > 2Qmax. This was validated to capture BOO in women with sensitivity of 0.94, specificity of 0.93, and accuracy of 0.94. As only an abstract is available, it is difficult to extract materials and methods used for this study; however, the specificity reported is higher than others previously identified [31]. This study used VUDS to validate sensitivity and specificity, which can be seen as questionable given that studies like those previously described have revealed inconsistencies in using UDS diagnosis of BOO to predict outcomes after intervention. Given these variations in the literature, it is imperative to consider these individual tools as guides for diagnosis and not confirmatory tests. For each clinical scenario, surgeon's comfort and experience as well as the patient's desires will factor into the appropriate testing needed.

In addition to VUDS, other tools such as ultrasound and cystoscopy have been described as useful modalities when making a diagnosis of BOO after incontinence surgery. Translabial ultrasound is used to assess sling location relative to the urethra, and oftentimes, voiding dysfunction has been found to be associated with kinking of migration of the sling to a more proximal position, which could cause further elevation of the urethra toward the symphysis, resulting in anatomic obstruction [22, 23, 32]. Lastly, cystoscopy and/or voiding cystourethrogram may be used, in addition, to assess for any angulation or kinking of the urethra. Cystoscopy may, identify any suture or mesh erosion that could cause obstructive or irratative urinary symptoms [33].

Management

After the diagnosis of iatrogenic BOO has been made, appropriate treatment options should be identified and agreed upon based on patient factors and preference, temporal relationship of symptoms to index surgery, and in many instances, sling type. In certain cases, conservative therapies may be used as first-line interventions, although some would argue that earlier intervention may decrease risk of detrusor damage and optimize sling identification prior to onset of scarring [34]. Many centers resort to short-term clean intermittent catheterization (CIC) if retention is noted. Although many would not consider this a long-term option, CIC can be offered as a reasonable treatment modality in patients who are not bothered by catheterizing and prefer to avoid additional surgery and possibly recurrent SUI. Anticholinergic medications may also be used in patients with storage symptoms after sling surgery. In our opinion, these are most useful to alleviate patient discomfort while awaiting surgical correction of iatrogenic obstruction. Pharmacotherapy can be considered in the short term to

achieve a better quality-of-life prior to definitive treatment rather than as a treatment option itself when obstruction exists. Pelvic floor physiotherapy and biofeedback therapy have also been used in some cases, although it seems these measures would be most appropriate in patients with equivocal or minimal obstruction such as those patients with delayed or prolonged urine stream, slightly elevated PVR, or mild urgency/frequency symptoms. Certainly, if obstruction is occurring because of concomitant pelvic floor muscle tightness, PT maybe more appropriate. PT should not be thought of as a way of loosening a clearly obstructing sling. There have been conflicting reports in the literature as to whether urethral dilatation significantly improves voiding dysfunction in patients diagnosed with BOO after anti-incontinence surgery, but some have experienced greater than 80 % improvement or cure rate with this technique [34, 35]. Oftentimes, sounding the urethra and placing downward traction in attempts at sling loosening is not well tolerated. There is also potential for considerable damage to the urethra and surrounding tissue. It is essentially a blind, difficult to control procedure and may not afford any benefit compared to a more formal incision. For these reasons, we do not routinely utilize this option in patients with iatrogenic obstruction.

When conservative measures fail, surgical intervention is the mainstay for treatment of iatrogenic BOO. It has been stated that surgery may be reserved for patients with significant retention, such as PVR > 200 ml or 50 % of bladder capacity; however, in our practice, there is no parameter by which to resort to surgery, and the optimal goal should be improvement of obstructive symptoms and restoration of normal bladder function. When discussing surgical options, sling loosening, incision, and urethrolysis have all been described.

In patients who exhibit symptoms of BOO immediately after anti-incontinence surgery, sling loosening or takedown may be the most appropriate intervention. This technique requires the use of local anesthesia and subsequent opening of vaginal incision. A right angle clamp is then used to hook the sling after it has been identified and downward traction is applied (approximately 1–2 cm). This technique has been well described and is fairly successful. In the literature, this technique is usually performed within the first 2 weeks of index surgery to avoid tissue ingrowth. Recently, published articles similarly illustrate restoration of normal voiding in up to 96 % of individuals without vast compromise in most patients' continence [36–38]. In anticipation of sling loosening, Chang et al. has described a technique of placing 3-0 vicryl suture loop along the midpoint of the tape, leaving at least 3 cm of suture for later use in further manipulation of the sling [39].

Sling incision or excision (partial and complete) has also been described in detail and also has proven to be effective. Moore and Goldman have recently described a simple sling incision technique using video aide, which captures the simplicity and effectiveness of this treatment modality [40]. Recurrence of SUI and persistence of lower urinary tract symptoms have both been associated with this treatment, however, and should be discussed in patients desiring this type of intervention. In the literature, the incidence of recurrent SUI hovers around 14–19 % [34, 41]. Various methods of incision have been described, including midline versus lateral incisions and bilateral incisions as well. In our experience, this technique works best with an inverted-U or midline excision. The sling is isolated (as seen in Fig. 1) and then lysed in the midline (as seen in Fig. 2). A small portion of the sling on the left and right sides of the midline incision are removed to ensure that the suburethral portion has been removed and the vaginal incision can be closed with less potential for extrusion. We recommend sending this small amount of material to pathology to document the complete excision. If a plane cannot be easily developed in the midline, the sling can be isolated laterally, and the edges of the sling can be mobilized off the edges of peri-urethral fascia. In some cases, a complete excision of synthetic materials is carried out. This may be needed for women with concomitant pain, large exposures, failed relief of BOO with sling incision, etc. For patients with BOO as the sole indication for sling surgery, complete excision with aggressive resection and counter incisions is generally not needed. If a sling is not clearly delineated, a formal transvaginal urethrolysis may be needed to identify the obstructing band. Also, careful attention should be paid to the bladder neck if the sling is not identified in the appropriate mid-urethral location. In these scenarios, it is extremely helpful to obtain the operative report and know the sling type that was initially used prior to intervening on a sling placed by another provider.

Urethrolysis has been described extensively in the literature and is usually performed transvaginally, although it can be

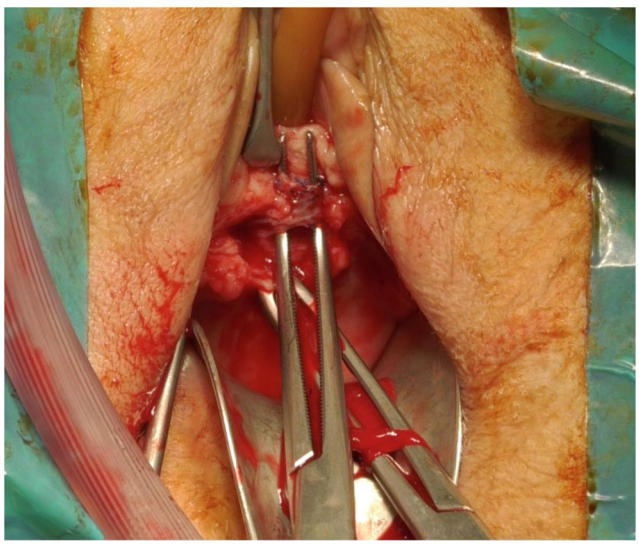

Fig. 1 Mesh sling is identified and elevated off of the periurethra fascia with a right angle clamp

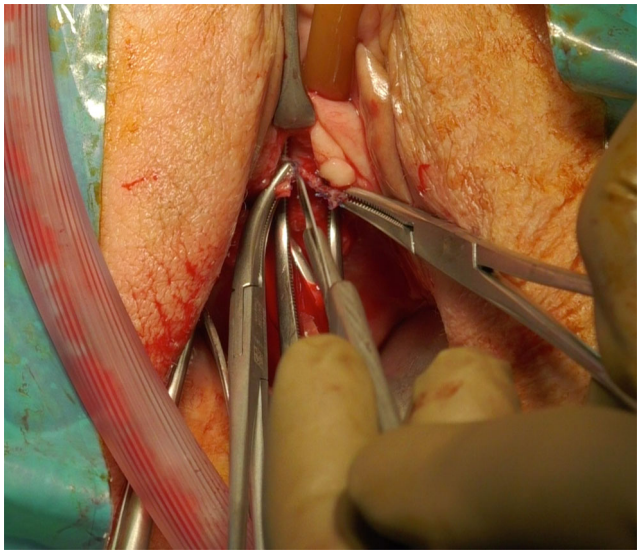

Fig. 2 The sling is grasped to the right and left of midline using hemostat clamps, and incision is made in the middle using the scalpel

performed retropubically. Suprameatal urethrolysis has also been described [33]. Cure rates range from 63 to 93 % with urethrolysis, and recurrent SUI rates are similar to those found with sling incision [13, 22]. Due to the increased morbidity of this technique, it is usually reserved for patients with more severe obstruction or those who have undergone multiple anti-incontinence procedures. Certainly, this can be needed if prior, less morbid attempts at correcting obstruction are unsuccessful. These procedures are also needed in the event that BOO is caused by more traditional retropubic suspensions. The most commonly used technique is that using a midline or inverted-"U" incision approximately 3 cm long along the anterior vaginal wall. The retropubic space is entered and the urethra should be completely freed proximally to the bladder neck so that full urethral mobility is achieved [33]. There has been debate regarding whether Martius flap graft is required as part of this procedure for reducing risk of fibrosis, increasing urethral support, and protecting urethra from injury if future sling procedures are required. In our practice, we reserve this technique for particular circumstances (i.e., prior failed urethrolysis).

Recently, a retrospective chart review was performed looking at satisfaction rates after surgical release of obstructive anti-incontinence procedures in 87 women who had undergone unilateral sling transection, sling excision/removal, or formal urethrolysis. Satisfaction rates reached at least 74 % in the last follow-up visit, revealing high success regardless of sling release procedure. Interestingly, when surgical release was performed more than 180 days after index anti-incontinence procedure, less SUI was reported. Conversely, in patients without pre-operative overactive bladder (OAB) symptoms, those who had surgical release within 70 days had fewer postoperative OAB symptoms [42]. These results complement those illustrated by Leng and colleagues, which revealed that delay in corrective surgery was associated with the persistence of bladder storage symptoms [43]. This data calls us to be mindful of timely diagnosis and treatment to avoid future bladder dysfunction.

Conclusion

BOO after incontinence surgery, although not of high incidence, can be very anxiety-provoking and debilitating for patients. Given this reality, it is of paramount importance to understand the reasons for BOO and the ways in which we diagnose and treat this known complication. With the number of sling procedures rising, now the primary surgical treatment for SUI, it is imperative to further identify which complications are more likely to be associated with the various sling types and of principal significance to continue to investigate the true prevalence of this complication in this treatment setting. There is a need to develope and utilize standardize terminology, means of diagnosing, and methods for intervention for iatrogenic obstruction. More data on the influence of ancillary tests like urodynamics and ultrasound is needed to assist in readily identifying obstruction, and the results of these interventions should be investigated to measure correlation with treatment outcomes. After diagnosis of BOO has been made, treatment options should be discussed in detail. More data on the timing and technique of the intervention will allow for better counseling and establishment of care pathways. When considering treatment, patients should be made aware of the potential need for future anti-incontinence procedures and the potential persistence of storage symptoms.

Compliance with Ethics Standards

Conflict of Interest Drs, Brucker and Malacarne declare that they have no conflict of interest.

Human and Animal Rights and Informed Consent This article does not contain any studies with human or animal subjects performed by any of the authors.

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