Analysis of urinary tract infections as a predictor of obstruction in women with a history of urethral sling surgery

Arushi Wadhwa[1], Ailsa May Li Gan[2], James Ross[3], Duane Hickling[2]

[1]Faculty of Medicine, University of Ottawa, Ottawa, ON, Canada; [2]Division of Urology, Department of Surgery, The Ottawa Hospital, Ottawa, ON, Canada; [3]Division of Urology, Department of Surgery, Scarborough Health Network, Scarborough, ON, Canada

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ABSTRACT

INTRODUCTION: Midurethral sling (MUS) remains a widely used and effective treatment for stress urinary incontinence, although complications such as voiding dysfunction and urinary tract infections (UTIs) may occur. Prior research has shown that up to 60% of women with chronic lower urinary tract symptoms (LUTS) after MUS surgery meet objective criteria for bladder outlet obstruction (BOO). This exploratory study aimed to assess whether UTI burden is associated with the presence of BOO in women with chronic LUTS following MUS. Secondarily, UTI patterns before and after urethral sling excision were descriptively evaluated.

METHODS: A retrospective chart review was conducted examining women with a history of MUS and persistent LUTS for at least six months at a single tertiary care center. Obstruction was assessed using urodynamic studies according to Blaivas criteria or fluoroscopic evidence. UTIs were defined using a combination of culture-positive results and documented symptomatic episodes. Associations between UTI burden and obstruction were evaluated using exploratory regression analyses, and symptom outcomes were assessed before and after sling lysis.

RESULTS: Among 95 patients, 58 (61%) demonstrated urodynamic evidence of obstruction. Across the entire cohort, the median number of UTIs over a two-year period was zero. The proportion of patients with at least one UTI did not differ significantly between obstructed and non-obstructed groups (Fisher's exact test, p=0.80). On exploratory multivariable logistic regression adjusting for age, menopausal status, and diabetes, the association between pre-lysis UTI burden and obstruction was not statistically significant (odds ratio [OR] 1.08, 95% confidence interval [CI] 0.90–1.29, p=0.42). Fifty-seven patients underwent sling lysis. In obstructed patients undergoing lysis, UTI frequency did not change significantly postoperatively (p=0.29), although many patients reported subjective improvement in storage and voiding symptoms.

CONCLUSIONS: In this exploratory cohort of women with chronic LUTS following MUS, UTI burden was not observed to be associated with the presence of BOO. While sling excision was associated with subjective symptom improvement, changes in UTI frequency were not statistically significant. These findings suggest that UTI history alone may have limited utility as a clinical marker of obstruction and highlight the need for larger, prospective studies with standardized outcome measures.

INTRODUCTION

Urinary incontinence is a common condition with a substantial impact on quality of life. Synthetic midurethral slings (MUS) are widely acknowledged as an effective surgical intervention for stress urinary incontinence following unsuccessful conservative treatments. Although these procedures demonstrate success rates ranging from 62–98%, postoperative complications can occur, including urinary tract infections (UTIs) in up to 16% of patients within six weeks of their surgery.[1] Other, less common, complications include mesh erosion, mesh extrusion, and voiding dysfunction.[2]

Bladder outlet obstruction (BOO) has been associated with an increased risk of UTIs, as impaired bladder emptying promotes urinary stasis and bacterial growth. In patients with MUS, BOO may develop due to oversuspension of the urethra or scarring around the sling. While BOO can contribute to infection risk, UTIs themselves do not cause obstruction. Clinically, patients with BOO after MUS often present with persistent or recurrent lower urinary tract symptoms (LUTS) that can overlap with, or be initially attributed to, infection, making it challenging to differentiate obstruction-driven symptoms from infection-related symptoms.

Few studies have examined whether UTI patterns in patients with chronic LUTS following MUS are associated with the presence of obstruction. As such, UTIs may function not as a causal factor, but as a potential clinical marker of increased risk in symptomatic

KEY MESSAGES

- In this exploratory cohort, UTI burden was not observed to be associated with BOO in women with persistent LUTS following midurethral sling surgery.
- Exploratory multivariate analysis indicated that pre-lysis UTI count did not suggest an association with obstruction after adjusting for age, menopausal status, and diabetes.
- ing lysis was associated with subjective improvement in storage and voiding symptoms, but not with changes in UTI frequency.
- UTI history alone may have limited utility as a marker for obstruction, underscoring the need for larger, prospective studies with standardized outcome measures to further investigate this relationship.

patients. Additionally, it remains unclear whether relieving obstruction through sling excision is associated with changes in UTI frequency, information that may help contextualize postoperative expectations.

Accordingly, the primary objective of this study was to explore whether UTI burden is associated with the presence BOO in patients with chronic LUTS following MUS. A secondary objective was to descriptively assess UTI patterns before and after MUS excision. Given the retrospective design and heterogeneous definitions of UTIs, this analysis is intended to be exploratory and hypothesis-generating, with the goal of improving understanding of MUS-related complications and informing future prospective research.

METHODS

A retrospective chart review was performed and included patients referred to a single tertiary center between January 1, 2014, and June 30, 2021, with chronic urinary tract symptoms and a history of urethral sling surgery, including either synthetic midurethral or autologous fascia pubovaginal sling. Chronic urinary tract symptoms were defined as new-onset or continuing symptoms following sling surgery of at least six months in duration. Exclusion criteria included 1) <18 years old; 2) male; 3) <6 months of urinary symptoms; 4) baseline neurogenic voiding dysfunction; 5) incomplete records; 6) a documented history of chronic urinary symptoms (excluding stress urinary incontinence) predating sling placement; or 7) underwent other incontinence procedure (i.e., retropubic urethropexy/colpopexy, urethral bulking).

All patients underwent a history, physical exam, cystoscopy, and urodynamic testing. Demographic information, such as age, date and type of surgery, and comorbidities were collected. Urinary symptoms were categorized as storage (frequency, urgency, urge incontinence, nocturia), voiding (weak stream, intermittency, straining incomplete emptying), or mixed symptoms.

Patients underwent either video urodynamics testing with fluoroscopy or traditional urodynamics testing without fluoroscopy. BOO was defined using the Blaivis criteria (sustained detrusor pressure >20 cm H_2O with maximum urinary flow rate [Qmax] <12 mL/s) or through fluoroscopic evidence of obstruction (acute urethral narrowing with proximal urethral dilatation).[3] Patients were categorized into three groups: obstructive, non-obstructive, or equivocal. The equivocal group included patients whose urodynamic results did not clearly meet criteria for obstruction or non-obstruction, reflecting intermediate findings during testing.

UTIs were recorded in two ways: 1) culture-positive UTI, defined as any positive urine culture; and 2) symptomatic UTI, defined as patient-reported or clinician-documented urinary symptoms for which a UTI was suspected when culture results were not available. For analysis, either a culture-positive result or a symptomatic episode was considered a UTI. For UTI number, patient data were collected for the two years preceding sling lysis in those who underwent the procedure, or the two years before the urodynamics study in those who did not. UTI characteristics were also collected for two years after sling lysis. Specific findings of UTI symptoms included dysuria, incontinence, urgency, suprapubic pain, hematuria, retention, frequency, and fever. Additionally, data were gathered on whether the UTI was confirmed by urine culture and which bacteria grew, and when available, the specific antibiotic treatment prescribed.

Findings between patients who underwent sling lysis and those who did not were compared.

All statistical analyses were conducted using Python and Microsoft Excel. Continuous variables, such as the number of UTIs, were summarized using medians and interquartile ranges (IQR) and compared between groups using the Mann-Whitney U test. Paired comparisons of UTI frequency before and after sling lysis were assessed by Wilcoxon signed rank test, where applicable. Categorical variables were compared using

Fisher's exact test, and a two-tailed p-value of <0.05 was considered statistically significant.

To evaluate whether the number pre-lysis UTIs was a predictor of BOO, a multivariate logistic regression was performed, including age, menopausal status, and diabetes as covariates. Odds ratios (OR), 95% confidence intervals (CI), and p-values were reported. Patients with incomplete data for the outcome or predictors were excluded from regression analyses.

RESULTS

A total of 95 patients met the inclusion criteria and were included in analysis (Figure 1). The average age was 62 years (95% CI 59–64), and the average time from original sling surgery to urodynamic study was seven years (95% CI 6–8). years. Common comorbidities included diabetes (20%), hypertension (45%), asthma (9%), and depression/anxiety (37%). Most (71%) patients were postmenopausal. Most patients presented with storage-predominant mixed urinary symptoms (28/95), followed by true mixed symptoms (26/95) and isolated storage symptoms (24/95). Only a small number of patients had isolated voiding symptoms (9/95) or voiding-predominant mixed symptoms (8/95) (Table 1).

Among the 95 patients who met the inclusion criteria, 58 patients were in the obstructed group (61%), 22 patients in the non-obstructed group (23%), and 15 patients in the equivocal group (16%).

Among the cohort of 95 patients, 36 patients had at least one documented UTI during the study period.

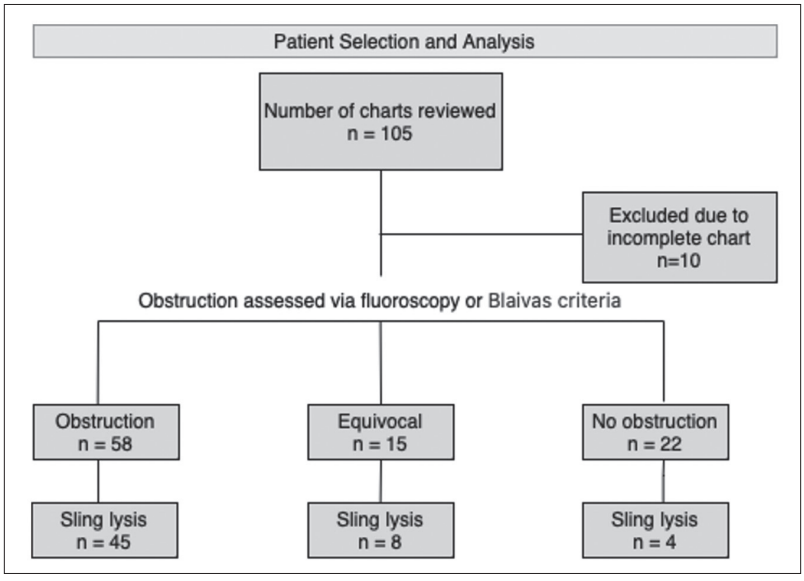

Figure 1. Flowchart illustrating patient inclusion and categorization.

Of the patients with obstruction, 21 (21/58, 36%) had a history of one or more UTIs in the two years prior to urodynamic studies or sling lysis, compared to 9 (9/22, 41%) in the non-obstructed group. The number of UTIs per patient in the entire cohort ranged from 0–25, with a median of zero UTIs in a two-year period (IQR 0–1). The median number of UTIs in both the obstructed and non-obstructed group was zero (Table 2). The difference in UTI burden between the two groups was not significant (p=0.69), and there was no significant association between UTI status and obstruction (Fisher's Exact test, p=0.80) (Figure 2)

To further evaluate whether pre-lysis UTIs were an independent predictor of obstruction, a multivariate logistic regression was performed, which included age, menopausal status, and diabetes as covariates. The regression analysis demonstrated that the number of pre-sling lysis UTIs was not significantly associated with obstruction (OR 1.08, 95% CI 0.86–1.36, p=0.52). Similarly, age, menopause, and diabetes were not significant predictors in the model (Table 3).

The most common presenting symptoms included dysuria, increased urinary frequency, urinary retention, and increased urinary urgency. Seventy-five percent of infections were confirmed with positive urine cultures. The most frequently isolated organisms were

Table 1. Baseline demographics and presenting symptoms

Characteristic	Value
Total number of patients	95
Average age (IQR)	62 (59–64)
Average time from MUS to UDS	7 years (6–8)
Postmenopausal	67 (71%)
Diabetes	19 (20%)
Hypertension	43 (45%)
Asthma	9 (9%)
Depression/anxiety	35 (37%)
Storage-predominant mixed urinary symptoms	28 (29%)
True mixed symptoms	26 (27%)
Isolated storage symptoms	24 (25%)
Isolated voiding symptoms	9 (9%)
Voiding-predominant mixed symptoms	8 (8%)

IQR: interquartile range; MUS: mid-urethral sling; UDS: urodynamic studies.

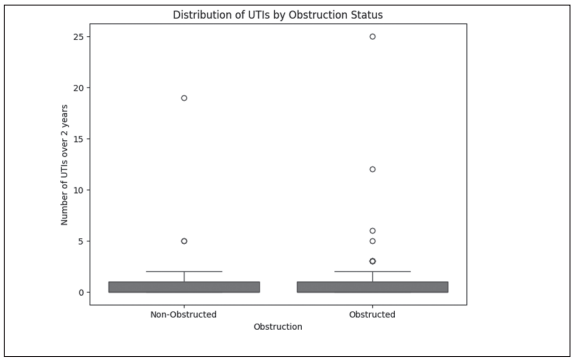

Figure 2. Box plot of distribution of urinary tract infections (UTIs) by obstruction status.

Escherichia coli (25%), followed by *Klebsiella pneumonia* (20%). Antibiotic treatment was documented in 29% of patients, with nitrofurantoin as the most common prescription.

A total of 57 patients underwent sling lysis, which accounts for 60% of our study population. This included 45 patients who were obstructed (45/58, 78%), four patients who were non-obstructed (4/22, 18%), and eight patients who had equivocal results (8/15, 53%). The non-obstructed patients who underwent sling lysis had a tight band on palpation and bothersome voiding symptoms. Notably, all non-obstructed patients who underwent sling lysis had negative urodynamic studies but reported bothersome LUTS. Among the 45 patients with obstruction who underwent sling lysis, 24 had no UTIs before or after the procedure, five developed new UTIs post-lysis, six experienced resolution of UTIs following lysis, and 10 had persistent UTIs both before and after the intervention. The median number of UTIs was unchanged from the two years pre-sling lysis (0) to the two years post-sling lysis (0). Statistical analysis using a Wilcoxon signed-rank test showed that the change in UTI frequency after sling lysis in obstructed patients (n=45) was not significant (p=0.29).

The most common UTI symptoms reported post-sling lysis were dysuria and incontinence; 43% of patients reported improvement in their storage symptoms following sling lysis, with 7% experiencing complete resolution. Additionally, 39% of patients noted improvement in voiding symptoms, and 32% reported complete resolution of these symptoms. Most (63%) UTIs were culture-proven, with *Escherichia coli* as the most common organism (42%). Only 25% had documented antibiotic use, with nitrofurantoin being the most prescribed.

Overall, obstruction was present in over half of the patients undergoing urodynamic study after sling surgery. While there was no statistically significant difference in UTI burden between obstructed and non-obstructed patients, sling lysis was associated with subjective symptom improvement in a majority of patients, and a modest reduction in UTI frequency.

Table 2. UTI burden by obstruction status

Group	Number of patients (n)	Median UTIs (2-year period)	IQR
Overall	95	0	0–1
Obstructed	58	0	0–1

IQR: interquartile range; UTI: urinary tract infection.

Table 3. Multivariate logistic regression assessing predictors of post-sling obstruction

Variable	OR	95% CI	p
Number of UTIs pre-sling lysis	1.08	0.86–1.36	0.52
Age	0.96	0.90–1.01	0.12
Menopause status	1.67	0.30–9.35	0.56
Diabates	0.59	0.17–2.04	0.40

CI: confidence interval; OR: odds ratio; UTI: urinary tract infection.

DISCUSSION

LUTS following MUS surgery represent a complex clinical challenge. In this exploratory cohort, BOO was observed in 61% of patients with prior MUS and persistent LUTS. UTI burden did not appear to differ meaningfully between obstructed and non-obstructed patients (p=0.80) and was not clearly associated with obstruction in multivariable analysis (OR 1.08, p=0.52). While overall UTI frequency did not show a consistent decrease following sling lysis, many patients reported subjective improvement in both storage and voiding symptoms. These findings highlight the multifactorial nature of post-MUS urinary symptoms and suggest that UTIs alone may have limited utility as a marker of obstruction.

BOO following incontinence surgery is known to occur in 2–25% of patients.[4] Our study had a much higher rate of obstruction, which likely reflects a referral bias, as all patients included in this study were symptomatic, underscoring the importance of careful assessment in patients with persistent LUTS after sling surgery.

The central aim of this study was to explore whether UTI burden was associated with the presence of BOO.

While previous studies have reported an association between BOO and UTIs, citing rates as high as 77% in obstructed patients, our findings did not support this relationship.[5,6] In our cohort, we did not observe a difference between the median number of UTIs in the obstructed and non-obstructed group, as both reported a median of zero UTIs, and the presence of at least one UTI was not predictive of BOO (p=0.80).

To further examine whether pre-lysis UTIs were an independent predictor of obstruction, we performed an exploratory multivariable logistic regression adjusting for age, menopausal status, and diabetes. Within this model, the number of pre-lysis UTIs was not significantly associated with obstruction (OR 1.08, 95% CI 0.86–1.36, p=0.52). Similarly, age, menopausal status, and diabetes were not associated with obstruction in this analysis.

A key distinction of our study is its focus on women with BOO following MUS surgery, a population that has not been well-studied. Previous research has primarily examined BOO related to other causes, including benign prostatic hyperplasia, urethral strictures, and urolithiasis, often in male or mixed-gender populations. Many of these studies also included patients with complicating factors, such as indwelling catheters.[6] These differences in patient characteristics and referral patterns may contribute to the absence of a clear association between UTI burden and obstruction in our cohort.

Similarly, the lack of a statistically significant relationship suggests that UTI history alone may have limited utility as a surrogate marker for BOO. This likely reflects the multifactorial nature of UTIs, which are influenced by factors beyond mechanical obstruction, including host defense mechanisms and microbial virulence. Risk scores and nomograms developed to predict BOO, such as those by Liu et al and Lee et al, do not include UTI history as a predictive variable.[7,8]

Our results suggest a lower rate of LUTS improvement compared to previously published studies. For example, a 2008 study by South et al examined outcomes in patients undergoing early vs. late midline sling lysis due to bothersome LUTS. They reported that 84% of patients experienced overall improvement in symptoms, with greater benefit observed in those who underwent earlier intervention;[9] however, their study had a shorter median time from sling placement to lysis. In contrast, our cohort included patients with more chronic symptoms and longer intervals between initial surgery and intervention, which may have contributed to more persistent or irreversible bladder dysfunction.

The absence of a clear association between UTI burden and obstruction in this cohort suggests other mechanisms contributing to infections in this population. UTIs following sling excision may reflect factors beyond mechanical obstruction, such as detrusor underactivity or shifts in the urinary microbiome. Furthermore, the median number of UTIs prior to sling excision was zero, indicating that most patients experienced no UTIs during this interval. This low baseline infection frequency may have limited our ability to detect a significant postoperative change. Taken together, these findings are consistent with the possibility that, for many patients, UTIs represented isolated events rather than a manifestation of a persistent or clinically significant voiding dysfunction.

Limitations

One consideration in interpreting this data is the retrospective nature of the study. We relied on the information provided by the subjects to determine overall improvement in LUTS.

Additionally, we were limited to the medical records provided by our institution and did not have access to records by primary care providers or pharmacists. This is particularly relevant for patients without recurrent symptoms, who may not have been referred to the tertiary center for evaluation, and excludes data from those who may have sought care for UTI symptoms from other practitioners. As a result, the true incidence of UTIs may have been underestimated. Furthermore, the retrospective design meant that documentation was sometimes incomplete, with some cases showing a urine culture without an accompanying clinical note, and others describing symptoms without a corresponding culture. This variability in documentation may have influenced the accuracy of UTI identification.

Additionally, the inclusion of both culture-proven and presumed UTIs introduces the potential for misclassification bias, which may have attenuated observed associations between UTI burden and obstruction.

Finally, analyses examining UTI patterns before and after sling lysis were descriptive in nature and should be interpreted cautiously. These findings are susceptible to residual confounding, including variation in followup duration, differences in healthcare-seeking behavior, and the low overall event rate. The limited number of UTI events also constrained statistical power, underscoring that these observations are exploratory and hypothesis-generating rather than definitive.

To address these limitations, future studies could consider prospective designs with standardized symp-

tom assessment tools to improve consistency in outcome measurement. Studies with larger cohorts may provide greater statistical power to detect more subtle associations between UTI burden and obstruction. More comprehensive data capture, including information from primary care physicians and pharmacists, may help provide a fuller estimate of UTI burden. Additionally, further exploration of factors that may contribute to UTIs following MUS excision, such as alterations in detrusor activity or patterns of antibiotic exposure and resistance, could help refine understanding of infection risk in this population.

CONCLUSIONS

Within this exploratory cohort of women presenting with chronic LUTS following MUS, UTI burden was not observed to be associated with the presence of BOO. Although many patients reported subjective improvement in storage and voiding symptoms following sling lysis, changes in UTI frequency were variable, and no clear reduction was demonstrated. Taken together, these findings suggest that UTI history alone may have limited utility as a surrogate marker for obstruction in this population and underscore the multifactorial nature of post-sling urinary symptoms. Larger, prospective studies with standardized outcome measures are needed to further clarify the relationships between obstruction, infection, and symptom progression following MUS surgery.

COMPETING INTERESTS: Dr. Hickling has been an advisory board moderator for Abbvie and a speaker for Boston Scientific. The remaining authors have no relevant conflicts of interest to report.

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CORRESPONDENCE: Arushi Wadhwa, Faculty of Medicine, University of Ottawa, Ottawa, ON, Canada; arushi.wadhwa@uottawa.ca