Infectious complications associated with the use of temporary prostatic urethral stents in patients with benign prostatic hyperplasia

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Introduction: *To examine the infectious outcomes after the insertion of the temporary prostatic urethral stent (TPUS) in benign prostatic hyperplasia (BPH) patients.*

Material and methods: *Between November 2007 and September 2012, ninety TPUS were used in 33 patients with BPH at our institution. All patients had negative urine cultures prior to the first stent insertion. TPUS were sent for cultures at time of removal or exchange. Stents were removed at the time of definite surgical intervention, at 4-6 weeks, or when patients elected another course of treatment. Colonization was defined as asymptomatic positive stent culture. Infection was defined as symptomatic positive stent culture requiring treatment. Infection and colonization rates are reported. Logistic regression was used to examine the predictors of infection at any point. Predictors examined were age, body mass index, history of prostate cancer, diabetes mellitus, hyperlipidemia, coronary artery disease, neurologic disorder, erectile dysfunction and the sequence of stent placement.*

Results: *The majority of the subjects, 72% (24/33) had 1-2 stents, 9.0% (3/33) had 3-4 stents, 6.0% (2/33) had 5-6 stents, and 12% (4/33) of patients had more than 6 stents. From the 69 available culture results, the symptomatic infection rate was 16% (11/69) (95% CI: 8.2%-26.7%). The colonization rate was 58% (40/69) (95% CI: 45.5%-69.7%). None of the predictors examined were identified as a predictor of infection. There was no colonization detected when stents were removed in the first 20 days.*

Conclusion: *Infection rates with TPUS in BPH patients are acceptable and early removal may prevent colonization.*

Key Words: temporary prostatic stent, prostatic stent, urethral stent, benign prostatic hyperplasia, colonization

Introduction

The quest to relieve bladder outlet obstruction with a device that is functionally acceptable while minimizing patient discomfort and providing independence and freedom from maintaining external appliances has been an interest since the Foley catheter was first introduced. A prostatic stent was first described by Fabian et al in 1980.[1] Since then there were several attempts to design better prostatic urethral stents using different designs and materials that gained variable degrees of acceptability. The Urolume (American Medical Systems, Minnetonka, MN, USA) and Memokath (Engineers and Doctors A/s Hornbaek, Denmark) were some of the most commonly tested stents. While these presented a new hope initially, disappointment was the hallmark result of most of the studies that examined their patient urinary outcomes and satisfactions.[2,3]

As such, the use of urethral stents then developed a negative connotation and did not gain wide acceptance as a permanent solution for bladder outlet obstruction. Its use was narrowed to specific indications such as temporary use to relieve transient urinary retention after focal therapy for benign prostatic hyperplasia (BPH)[4-6] or as a diagnostic procedure to unveil any subtle incontinence when a concomitant bladder dysfunction is suspected.[7,8] In these circumstances, temporary prostatic urethral stents (TPUS) presented a convenient alternative to indwelling urinary catheters (IUCs).

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One of the main complications associated with IUCs is the high risk of catheter associated urinary tract infections (CAUTIs).[9] A standard urethral catheter is an externalized foreign body that traverses natural defense mechanisms and facilitates ascending infections through extraluminal and intraluminal routes.[10] However, information about the infection rates in TPUS is limited and knowledge about its use is largely unknown in the clinical setting. In fact, the center for disease control and prevention guidelines for the prevention of CAUTIs encouraged further research on the use of stents as an alternative to indwelling catheters to decrease the risk of infection and considered this as one of the key questions that may help prevent CAUTIs.

Spanner stent (SRS Medical, Feeding Hill, MA, USA) is the only FDA approved TPUS that provides temporary drainage for bladder outlet obstruction secondary to BPH. It has no external parts and it was first introduced to relieve retention secondary to BPH in 2004. It provides some improvement in patient symptom scores and flowmetry variables.[11] To our knowledge there are no studies that examined the infectious complications associated with this stent. The aim of this study is to report the infectious outcomes associated with the use of this stent in a group of male patients with BPH.

Materials and methods

Subjects and data collection

After institutional review board approval we retrospectively collected data for all BPH patients who received a TPUS at our institution between November 2007 and September 2012. All patients had an established diagnosis of BPH that was refractory to medical management at time of presentation. TPUS insertion was offered to morbid patients who could not undergo a surgical intervention at the time of presentation or as a provocative test for patients who had suspected detrusor dysfunction.[8] Collected data included the baseline demographic variables, detailed past medical and past surgical history, stent culture results after each stent exchange. Baseline American Urological Association Symptom Score (AUASS) and uroflowmetry were obtained for patients who were able to void at baseline. All study data were collected and managed using Research Electronic Data Capture (REDCap) which is a secure electronic data capture tool hosted at Mayo Clinic in Arizona.[12]

Description of device and stent exchange procedure

TPUS is an internal device that resembles the proximal part of an indwelling Foley catheter. It is composed of an inflatable balloon that anchors it in the bladder and a tube that traverses the obstructing prostatic urethra. The tube ends proximal to the external urethral sphincter and thus allows the patients to use their own innate continence mechanism. While the balloon prevents distal migration of the stent, a flexible silastic anchor is attached to the other end of the stent and lies in the bulbar urethra to prevent its proximal migration. The stent is attached to a thread that is used to retrieve the stent at the time of exchange or removal. The stent is supplied with a measuring tool that helps choose the right length of the stent for each patient depending on the prostatic length. In our practice, the stents were routinely exchanged every 4 to 6 weeks and they were permanently removed at any point if patient could not tolerate them or at time of definite surgical intervention. All stents were inserted and exchanged in an outpatient setting using standard flexible cystoscopy equipment and intraurethral local anesthesia. A detailed description of this procedure is described by Shore et al.[6] All patients were required to have a negative urine culture prior to first stent insertion and stents were routinely sent for culture at the time of stent exchange or final removal regardless of symptomatology. Precautions to prevent contamination of the stents at the time of collection were routinely exercised. Symptomatic patient were treated with empirical antibiotics that were changed to a culture specific antibiotic when results became available.

Outcomes, definitions and statistical analysis

Colonization was defined as any positive stent culture in the absence of symptoms. Infection was defined as symptoms requiring treatment with antibiotics in the presence of a positive culture. A culture was considered positive if 10^5 colony forming units per mL were identified. The infection and colonization rates and specific type of organisms were reported. Means and standard deviations were used to describe continuous variables and frequency and percentages were used for categorical variables. Logistic regression was used to examine the predictors of infection at any point. Both rates were determined based on the first five stent exchanges for any subject. Predictors examined were age, body mass index, history of prostate cancer, diabetes mellitus, hyperlipidemia, coronary artery disease, presence of neurologic disorders, erectile dysfunction and the sequence of the stent if it was first, second placement etc. Statistical analyses were performed using R software version 3.1.2. P value of less than 0.05 was considered significant.

TABLE 1. **Baseline demographic and clinical variables**

	Mean	SD	Frequency
Age (years)	76.1	± 14.4	
BMI (kg/m^2)	36.9	± 4.3	
Diabetes mellitus			1
Hypertension			19
Coronary artery disease			9
Neurological disorders			4
Nephrolithiasis			3
Erectile dysfunction			5
Prostate cancer			3
Chronic kidney disease			2
Previously using catheter			14
History of urinary tract infection			10
Voided volume (mL)	160	166.6	
Maximum flow rate (mL/sec)	10.3	8.9	
Average flow rate (mL/sec)	4.9	3.5	
Post void residual (mL)	283	219	
TRUS volume (cc)	58.6	54.4	

BMI = body mass index; TRUS = transrectal ultrasound

Results

There was a total of 90 stents used in 33 patients. The baselines demographic, past medical, past surgical and urologic history are shown in Table 1. The mean age was 76 years (SD ± 14.4). The mean body mass index was 36.9 kg/m^2 (SD ± 4.3). There were 14 patients who were using a urethral catheter prior to the TPUS placement secondary to urinary retention. Among the patient who could void prior to stent insertion, the mean maximum and average flow rate was 10.3 mL/sec (SD ± 8.9) and 4.9 mL/sec (SD ± 3.5) respectively. The post void residual urine volume was significant for most patients with a mean of 283 mL (SD ± 54.4). Insertion of TPUS resulted in a significant decrease in the post void residual volumes but not in other uroflowmetry parameters, Table 2. The mean prostate volume as measured by transrectal ultrasound was 58.6 cc (SD ± 54.4).

The majority of patients (24/33) had a stent size of 6 or 7. The number of stent exchanges in each patient ranged from 1-14 where 72%of subjects (24/33) had 1-2 stents, 9.0% (3/33) had 3-4 stents, 6.0% (2/33) had 5-6 stents, and 12% (4/33) had more than 6 stents. No spontaneous migration took place during the study period. However, one patient had an attempt of indwelling catheterization at an outside institution which resulted in iatrogenic proximal migration. The stent was then retrieved endoscopically under general anesthesia at our hospital.

There were 21 stents with missing microbiology results that were excluded. The culture results were available for 69 stents. For these stents the symptomatic infection rate was 16% (11/69) (95% CI 8.2%-26.7%). The colonization rate was 58% (40/69) (95%CI: 45.5%-69.7%). The types of isolated microorganisms are shown in Table 3. There were 25 TPUS that were used in 14 patients who were previously using IUCs. Among those the rate of symptomatic infection was 12% (3/25) whereas the rate of asymptomatic colonization was 80% (20/25).

None of the predictors examined in our multivariate analysis model were identified as a predictor of infection. This included the number of previous stents and whether the stent was the first, second … etc. Since some of these stents were removed prematurely when patient could not tolerate them anymore, we wanted to study the relationship between the duration of catheterization and the incidence of TPUS colonization or infection and we found that there was no colonization or infection identified in the catheters that were removed in the first 20 days. Colonization rate ranged between 40%-100% for every 10 day period following the first 20 days after insertion which may suggest that the risk of colonization increases after 3 weeks, see Figure 1.

TABLE 2. **Results of uroflowmetry before and after temporary prostatic urethral stent insertion**

Parameter	Pre-stent (n = 23)	Post-stent (n = 18)	p value
Volume (mL), mean (± SD)	160.1 (± 166.6)	164.8 (± 191)	0.245
Maximum flow (mL/sec), mean (± SD)	10.28 (± 8.9)	10.5 (± 8.6)	0.843
Average flow (mL/sec), mean (± SD)	4.9 (± 3.5)	5.8 (± 3.5)	0.234
Post void residual volume (mL), mean (± SD)	283.1(± 54.4)	174 (± 167.1)	0.005

TABLE 3. **Types of microorganisms and incidence of isolation**

	Culture no. 1	Culture no. 2	Culture no. 3	Culture no. 4	Culture no. 5	Total
Staphylococci	5	3	4	2	1	15 (32.6%)
MRSA	3	1	0	1	1	6 (13%)
Klebsiella	0	0	1	0	0	1 (2.2%)
Ureaplasma urealyticum	1	1	0	1	1	4 (8.7%)
Candida	0	1	0	1	1	3 (6.5%)
Other	6	2	1	1	1	11 (23.9%)
No species reported	2	2	1	0	1	6 (13%)
Total	17	10	7	6	6	

Discussion

Among the various indications for urinary catheterization, the need for immediate drainage of the bladder in cases of urinary retention is perhaps the most pressing and unavoidable. The catheter remains for variable durations until spontaneous voiding is resumed or a surgical intervention takes place in refractory cases. While IUCs offer immediate relief, they are often associated with the inevitable risk of colonization and urinary tract infections. Bacteriuria occurs via multiple routes and the daily risk with IUCs is estimated to be 3% to 10 %.[10,13,14] In fact, this risk of colonization approaches 100% after 30 days, which is considered the delineation between short and long term catheterization.[15] Suprapubic catheterization have delayed onset of bacteriuria compared to IUC but have an equal eventual rate of colonization on the long term.[16,17] Despite the lack of direct comparative studies, clean intermittent catheterization (CIC) seems to be associated with less risk of infectious complications where the risk of infection is approximately 1% to 3%.[18] However, the use of CIC is associated with discomfort and requires good manual dexterity for safe and successful utilization.

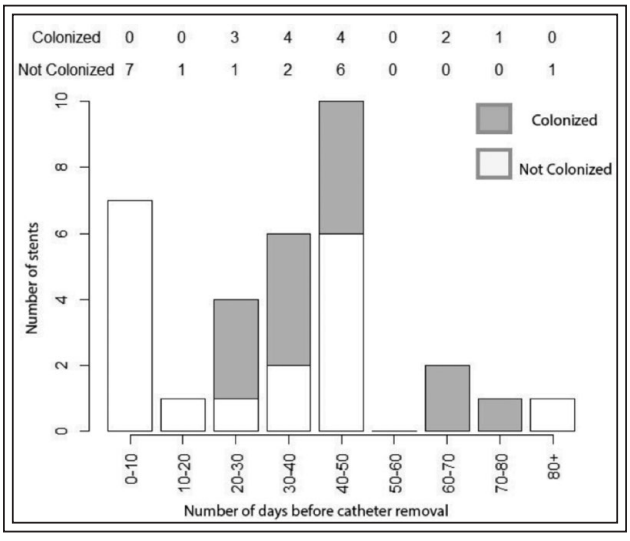

Figure 1. Results of stent cultures for each 10 day period after stent insertion. Shadowed areas colonized. White areas not colonized.

Despite the presence of multiple minimally invasive options for the treatment of BPH, many elderly patients are still not fit enough to undergo these procedures. The unfortunate fact that most of these patients are old and have significant degree of comorbidities may results in prolonged (or indefinite) need for catheterization. This in turn results in higher risk of postoperative urinary tract infection.[19] Once a urinary tract infection is established the risk of recurrent urinary tract infection becomes exponentially higher.[20,21] When this is combined with urinary obstruction and stasis the risk of infection becomes worrisome in frail patients with higher risk of sepsis.[22]

Since the introduction this type of stents as a novel treatment option for bladder outlet obstruction secondary to BPH, there have been several studies that explored its applicability in various clinical settings.[11] It provided benefits in relieving urinary obstruction and improving urinary flow parameters.[23] However, its long term use was not found to be possible when Grimsley et al studied the outcomes of using this stent in 43 patients who were unfit for a definite surgical intervention.[24] In this study the authors changed the catheter every 3 months and found unsatisfactory outcomes in more than 50% of patients rendering this stent unsatisfactory for long term use. One of its current indications is to relieve temporary postoperative urinary retention after transurethral microwave therapy and brachytherapy.[4-6]

Additionally, it had been evaluated as a diagnostic tool when Tyson et al[8] tested this stent as a provocative measure to determine surgical eligibility in complex bladder outlet obstruction and to identify patients who do well with definitive outlet obstruction.

To our knowledge no previous study has reported the infectious outcomes after the use of this TPUS. We postulated that since this stent is completely intracorporeal and maintains the body's natural defense mechanisms, it may potentially decrease the risk of urinary tract infections. In our study the indication to use the TPUS was either as a temporary measure to provide relief of bladder outlet obstruction until time of surgery or as a test of bladder behavior before undergoing definite surgical therapy. The intent of this was to give the patient a clear perspective of what his quality of life will be like after surgery and was specifically performed in patients who demonstrated bladder dysfunction during urodynamic evaluation. In our study, all men had a negative urine culture before first insertion. About 50% of them had to use urinary catheters before presentation. With this specific methodology we found that the rate of symptomatic infection at any point was 16% and this required immediate treatment at time of removal or exchange, while the rate of stent colonization was found to be 58% (at any point, regardless of duration). Interestingly, colonization was not identified in any of the stents that were removed early (around 3 weeks in this study). Although a direct relationship between colonization and duration of catheterization is expected but the duration of colonization-free interval was longer than expected. The subsequent colonization rate was widely variable and ranged between 40%-100%. Our multivariate analysis was performed to explore any predictors of infection or colonization however; we could not identify any risk factor.

A previous direct comparative study looked at the infection rates between nitinol urethral stents and IUCs after 1 month in 76 patients and found that risk of infection at 1 month was 40.9% versus 79.4% in urethral stents and IUC respectively.[25] However, the stent examined in our study is made of a different material (silicone elastomer) and this makes extrapolating this information difficult. Moreover, the previously designed stents were completely isolated from the bulbar urethra through an intact sphincter, whereas this TPUS has a small thread traversing the urethra and connect to an anchor that resides in the bulbar urethra which may potentially increase the risk of ascending infections. To our knowledge there was no published study that looked specifically into the rates of UTI or colonization in this TPUS.

Despite the fact that this study shows that the risk of UTI may be decreased when the Spanner stent is used, the following limitations should be kept in mind. First this study is a retrospective study with small sample size. Second, our multivariate analysis should be considered exploratory only secondary to small number of observed independent and dependent variables. More complex predictive models such as the generalized estimation equations and generalized linear model could not be generated for the same reason and inability to test for intrasubject correlation. Third, this descriptive study did not analyze the cost effectiveness of using this stent. Finally, culture results were missing in 21 patients and this limited the results to the first five stent exchanges. Different result may potentially exist when patient continue to use the stent for more than five times.

Conclusion

In conclusion the symptomatic infection is rare with the first utilization of a TPUS. When used in presugical patients awaiting surgery, these results may provide a reasonable data to council patients receiving these stents, but more research is needed to better document outcomes and infection rates. □

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