Five-Year Experience with Metallic Stents for Chronic Ureteral Obstruction

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Purpose: We present 5 years of outcome data on metallic ureteral stents in a cohort of patients treated for chronic ureteral obstruction.

Materials and Methods: We retrospectively identified and analyzed the records of all patients in whom a Resonance® Metallic Ureteral Stent was placed between early 2007 and late 2011 at our institution. We performed a descriptive analysis of key outcomes, including the failure and death rates, and stenting duration, defined as the time from initial stent placement to last stent failure or patient death. We also performed a secondary comparative analysis of patients with a benign vs malignant etiology of obstruction.

Results: A total of 139 metallic stents were placed in 47 patients, including 27 (57%) with malignant and 20 (43%) with a benign etiology. Of the patients 15 (32%) had bilateral obstruction. Maximum followup was 59 months (mean 20, median 13, IQR 4–31). Stent failure occurred in 13 patients (28%), including 4 in the benign and 9 in the malignant group ($p = 0.35$). The median duration of stenting for benign and malignant obstruction was 22 (IQR 9–39) vs 7 months (IQR 3–25) ($p = 0.106$). Stenting duration was equivalent when controlling for the higher death rate in the malignant group.

Conclusions: Resonance metallic stents are an adequate management strategy for benign and malignant ureteral obstruction. A subset of patients in each group continued to do well at more than a 3-year overall duration of stenting. Failure rates were similar for benign and malignant etiologies.

Key Words: ureter, ureteral obstruction, etiology, stents, equipment failure

Abbreviations and Acronyms

LUTS = lower urinary tract symptoms

XRT = radiation therapy

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Urologists have an array of treatments with which to approach the obstructed ureter, including percutaneous nephrostomy, various types of indwelling stents and formal reconstructive operations. A subgroup of patients with an obstructed ureter is best served by a chronic indwelling stent. Certain drawbacks of chronic stenting, including the need for periodic stent changes and the potential for stent obstruction/failure due to external compression, spurred the development of the metallic ureteral stent. Early generation metallic stents were self-expandable devices used primarily for malignant obstruction.[1,2] The Resonance metallic ureteral stent is an occluded end stent composed of a tightly coiled, nickel-cobalt-chromium-molybdenum alloy, which has now been in use for several years.[3]

Potential advantages of the occluded end metallic stent vs a traditional polymer based stent include a longer dwell time, improved resistance to external compression[4] and perhaps increased cost-effectiveness.[5,6] Multiple retrospective reports suggest that metallic stents are a safe, effective option for

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chronic ureteral obstruction.[7–10] However, many of those series included relatively few patients and had limited followup. For those reasons the natural history of the metallic stented ureter is less well documented.

We describe and analyze our 5-year experience with the Resonance metallic stent. We also provide a comparative analysis of the outcomes of malignant and benign obstruction.

PATIENTS AND METHODS

All patients in whom a Resonance metallic stent was placed between 2007 and 2011 at our institution were retrospectively identified for this institutional review board approved study. Pertinent data were collected by reviewing the electronic medical record.

Patients in whom stents were placed had ureteral obstruction at the level of the ureterovesical junction, ureter or ureteropelvic junction. Most patients were first treated with a Double-J® polymer stent. They were offered a metallic stent so that the stent could be changed less frequently, provided that the polymer stent was well tolerated and the option of definitive reconstruction was not feasible. Some patients with malignant obstruction were offered the metallic stent up front if hydronephrosis was mild, creatinine was only slowly trending up and life expectancy was thought to be reasonable (1 year or more) according to our service or the consulting service. Stented patients understood the expected 1-year dwell time of the metallic stent. Stents were only changed earlier if issues such as stent migration or repeated infection occurred.

All stents were placed in standard retrograde fashion by passage of a guidewire, followed by insertion of a coaxial inner sheath and an outer catheter. The metallic stent was inserted through the sheath after removing the guidewire and inner catheter. Patients were followed with serial serum creatinine measurement at regularly scheduled visits at approximately every 3 to 6 months. Routine imaging was only done if progression to renal insufficiency, repeat infections and/or pain was present.

We first performed a descriptive analysis of the entire cohort. Primary outcome measures were the failure and death rates, and the overall duration of stenting. Failure was defined as any event that necessitated conversion to nephrostomy tubes or plastic stents, eg progressive hydronephrosis or renal insufficiency, recurrent urinary tract infections or intolerance to stent related symptoms. Overall stenting duration was defined as the time from initial stent placement to any event that led to the patient not being treated with a metallic stent. On the other hand, mean dwell time was defined as the average time that a given metallic stent remained in a patient.

Some patients in whom this treatment failed had multiple reasons for failure. In others failure of a given stent, eg due to stent migration, was simply managed by stent exchange. Cases in the latter category were not considered failures on final analysis. However, failure of the stent was considered when calculating the mean dwell time of a given stent.

Secondarily, we performed a comparative analysis between patients with benign or malignant ureteral obstruction. Outcome measures were identical to those used for the descriptive analysis.

Statistical analysis was done with the Mann-Whitney U and/or Fisher exact test, as appropriate, using SPSS®, version 17.0. Regression testing was used to examine the effect of preoperative variables on outcomes. Kaplan-Meier curves and log rank comparisons were used to describe stent survival, ie time to failure or death, in a given patient, and to compare stent duration and failure rate in patients with benign vs malignant obstruction. For the descriptive analysis the observed events were stent failure and death. Censored events were loss to followup and survival with a stent in place at the conclusion of the study period. This yielded what amounted to survival curves for the event-free duration of stenting or, looked at in another way, a time to event curve with last stent failure or death as the event. On comparative analysis the observed events were also stent failure and death. However, we controlled for differences in the death rate by including death as an observed event in one Kaplan-Meier curve and as a censored event in the other.

RESULTS

A total of 139 metallic stents were placed in 47 patients with a mean ± SD age of 62 ± 15 years (range 33–92), of whom all were included in final analysis. Stent insertion was achieved in 100% of patients and there were no intraoperative complications. Mean followup was 20 months. The etiology of obstruction was malignant in 27 patients (57%), 15 (32%) had bilateral obstruction requiring bilateral stents and 14 (30%) received prior XRT. Table 1 shows a comprehensive list of the clinical characteristics of the cohort.

During the study period 13 patients (28%) ultimately experienced stent failure, they could no longer be treated with a metallic stent, and 11 (23%) died. Four patients per group (17% overall) were lost to followup. Reasons for the failure of a given stent included pain in 4 cases, progressive renal insufficiency in 5, recurrent urinary tract infection in 7, stent migration in 2, and preference for nephrostomy tubes in a palliative setting, progressive hydronephrosis, hematuria, LUTS and stent encrustation after loss to followup for 2 years in 1 each. The most common cause of early stent exchange was repeat infections, which developed in 3 patients with a total of 5 stents since 2 patients had bilateral obstruction.

The maximum duration of stenting in the entire cohort was 59 months (mean 19.5, median 13, IQR 4–31). Mean dwell time of a given metallic stent that was terminated or exchanged for any reason was approximately 8 months. The mean time to stent exchange, ie in patients doing well with the stent, was 10 months. At the end of the study period

Table 1. *Clinical characteristics of 47 patients*

	No. Pts (%)
Male	10 (21)
Benign etiology	20 (43)
Malignant etiology:	27 (57)
Ovarian	3
Endometrial	2
Cervical	7
Colorectal	4
Lymphoma	5
Esophageal	1
Prostate	1
Sarcoma	2
Lung	1
Urothelial	1
Obstruction site:	
Ureteropelvic junction	9 (19)
Ureter	35 (75)
Ureterovesical junction	2 (4)
Unknown	1 (2)
Bilat obstruction	15 (32)
Prior management:	
Nephrostomy	7 (15)
Polymer stent	38 (81)
None	2 (4)
Prior XRT	14 (30)

15 patients (32%) were still being treated with a metallic stent.

Figure 1 shows the corresponding Kaplan-Meier time to event curve. In patients with stent failure the median overall duration of stenting was 5 months (IQR 2–6). Regression testing showed no significant difference in the duration of stenting or the failure rate for certain variables, including prior XRT, obstruction etiology and bilateral obstruction ($p = 0.421$, 0.316 and 0.195, respectively).

Table 2 lists comparative analysis results. The median duration of stenting in patients with benign obstruction was 22 months (IQR 9–39) vs 7 (IQR 3–25) in those with malignant obstruction ($p = 0.106$). The death rate trended toward being higher in the malignant group (33% vs 10%, $p = 0.086$). The failure rate did not significantly differ between the groups (33% vs 20%, $p = 0.350$). Figure 2 shows comparative Kaplan-Meier curves for stenting duration in the groups, including stent failure and death as observed events and only stent failure as an observed event. A significant difference in stenting duration was only noted for the first comparison ($p = 0.016$, fig. 2, *A*).

DISCUSSION

To our knowledge this study represents the most robust report of clinical experience with the Resonance metallic ureteral stent since it includes a relatively large patient cohort and a substantially longer followup than in other published series. Thus, it provides important information on the natural history of the chronically obstructed, metal stented ureter. It could also better explore differences between subgroups as well as factors that may affect the success or failure of metallic stenting.

A primary disadvantage of chronic stenting is the need for periodic stent changes, during which the patient incurs the risks and costs associated with urinary tract manipulation. Polymer stents are typically changed every 3 to 6 months,[11] while the Resonance stent was approved for a 12-month dwell time. Although the metallic stent is more costly (approximately $900 vs $100 at our institution), the increased mean dwell time of the metallic stent (8 months in our study) decreases the frequency of the costs and charges associated with changing the stent, which can total thousands of dollars. Another potential negative aspect of chronic stenting is stent failure, which typically necessitates the placement of nephrostomy tubes. The metallic stent performs at least as well as polymer stents, with an approximately 35% failure rate for each.[8,10,12,13] Reasons for failure include progressive obstruction, intolerance to stent related symptoms and recurrent infections. Some groups also reported bothersome LUTS leading to removal of the metallic stent. One of our patients with severe LUTS significantly improved when the stent was exchanged for a shorter stent.

The results of our study confirm and build on these prior observations. Findings show that the longer approved dwell time for metallic stents translates to actually longer dwell times with an average dwell time of a given stent of approximately 8 months. The 28% failure rate is also in line with prior series. Patients who did not experience failure generally did well, as evidenced by the median 13-month stenting duration (mean 19.5) in the entire

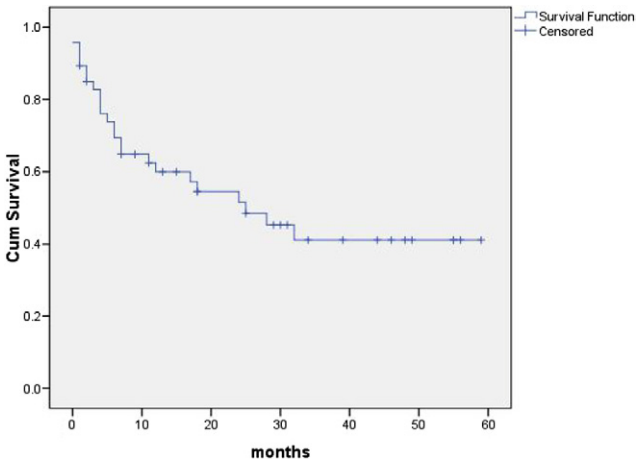

Figure 1. Kaplan-Meier curve of time to event analysis in entire cohort. Observed events were stent failure and death. *Cum,* cumulative.

Table 2. *Primary clinical outcomes*

	All	Malignant	Benign	p Value
Stent time (mos):				
Median/max retention (IQR)	13/59 (4–31)	7/59 (3–25)	22/59 (9–39)	0.106 (Mann-Whitney U test)
Mean ± SD indwelling	7.8 ± 4.8	7.1 ± 5.4	8.6 ± 3.6	0.297 (independent sample t test)
No. last event (%):	47 (100)	27 (100)	20 (100)	
Stent failure	13 (28)	9 (33)	4 (20)	0.348 (Fisher exact test)
Death	11 (23)	9 (33)	2 (10)	0.086 (Fisher exact test)
Lost to followup	8 (17)	4 (15)	4 (20)	0.707 (Fisher exact test)
Alive with stent	15 (32)	5 (19)	10 (50)	0.030 (Fisher exact test)

cohort. A subset of patients in each group did well with a stenting duration of more than 24 months and at least 1 per group did well with a stent for almost 5 years. In most patients who experienced stent failure the stent failed relatively soon after placement. Figures 1 and 2 show these results as Kaplan-Meier time to event curves, which demonstrate a relatively steep early drop off, followed by a more plateau-like curve with time.

Other issues related to the natural history of metallic stented ureters are less clear. One of the most important questions centers on factors that may influence stent failure or success. Several possible factors were proposed, including the etiology of obstruction, eg benign vs malignant, ureteroenteric stricture or intrinsic vs extrinsic, XRT history and obstruction site. For example, Wang et al reported an association between XRT and stent failure,[10] while Goldsmith et al recently noted an association between failure and distal obstruction due to locally advanced prostate cancer.[8] In one of the larger published series Liatsikos et al described an association between benign etiology and stent failure.[9] Unfortunately, most series have been too small to enable meaningful conclusions to be drawn about the factors. As such, their possible effects remain essentially hypothetical.

In our study no pre-stent factor was significantly associated with stent failure. There are at least 3 possible reasons for this. 1) The factors that we examined may not in fact have an effect on the failure rate. 2) We did not have enough patients to demonstrate a trend. 3) Stent failure is not a well controlled or reliable outcome measure because it has many causes and variable thresholds for development. For instance, a given degree of flank pain or stent related symptoms may cause failure in 1 patient but not in another. Similarly, a given degree of progressive hydronephrosis or renal insufficiency may cause one urologist but not another to recommend nephrostomy tubes. It is unlikely that anything short of a prospective study designed with specific failure criteria could reliably define such factors. As such, careful patient selection with attention to certain factors, such as the degree of hydronephrosis, progression of renal insufficiency and

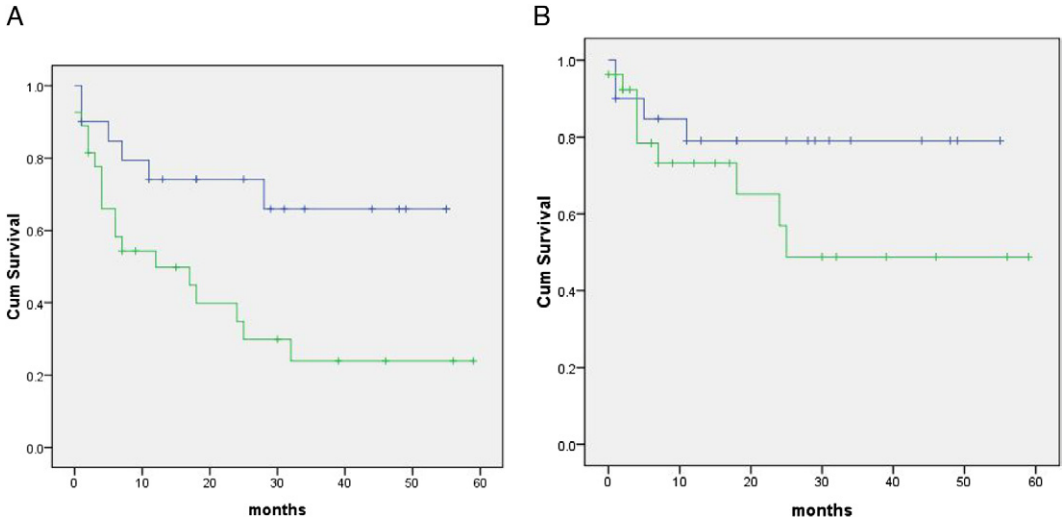

Figure 2. Kaplan-Meier curves of event-free stent retention by obstruction etiology in benign (blue curves) and malignant (green curves) groups. *A*, observed events were stent failure and death (benign vs malignant log rank test p = 0.016). *B*, observed event was stent failure (benign vs malignant log rank test p = 0.178). *Cum*, cumulative.

degree of tolerance to polymer stents, will continue to be the best method to minimize stent failure.

We compared outcomes between benign and malignant disease for several reasons. 1) This comparison allowed for a reliable, reproducible grouping variable compared to, for example, intrinsic vs extrinsic obstruction, which may be more difficult to reliably ascertain. 2) We wanted to sensibly account for differences in the death rate between the groups since many patients who are candidates for chronic stenting are at high risk for death from active malignancy or a medical comorbidity that may discourage formal reconstruction. 3) Anecdotally, we believed that patients with benign disease seemed to retain a stent longer.

Some results of this comparative analysis are intriguing. While some data suggested that patients with benign disease did better than those with malignant disease, as shown by the trend toward a longer stenting duration in patients with benign disease, the only analyzed variable with a statistically significant difference in favor of benign disease was the proportion of patients in each group who were alive with a stent in place at the study conclusion (table 2). Although the median duration tended to be shorter and the failure rate tended to be higher in the malignant group, neither variable was statistically different, which was somewhat unexpected. Moreover, based on our experience and assumptions, we did not anticipate that the failure rate would not differ between the groups. The death rate was expectedly higher (statistical trend only) in the malignant group. It appears that this difference was the driving force behind the shorter median stenting duration in that group. Figure 2, which controls for differences in the death rate between the groups, best illustrates these differences.

In the end we believe that our results provide a solid argument that metallic stents are appropriate for patients with benign or malignant obstruction. This is an important addition to the literature on the subject. The average dwell time of any given stent was approximately 8 months across a wide range of obstructive etiologies, superior to the 3 to 4-month dwell time typically used for polymer stents.[11] In each group most failures developed within a few months. Some patients continued to do well with an annual stent change even after 3 or 4 years.

CONCLUSIONS

The Resonance metallic ureteral stent should continue to be a useful tool to manage chronic ureteral obstruction of benign and malignant etiologies. A subset of patients continues to be well served by this stent for up to 5 years. The stent failure rate of 28% is not significantly affected by obstruction etiology and failure usually occurs within a few months of initial placement. The overall stenting duration is longer in patients with benign disease but most of the difference is likely due to the lower death rate compared to their counterparts with malignant disease. A larger, multi-institutional series could provide new or stronger findings.

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