Metal Ureteral Stent for Benign and Malignant Ureteral Obstruction

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Purpose: Metal ureteral stents are a relatively new version of a device with a long history of relieving ureteral obstruction. Metal stents are effective for relieving ureteral obstruction but success regarding patient tolerability has been variable. We present our single institution experience with long-term metal ureteral stent placement.

Materials and Methods: The charts of patients undergoing metal ureteral stent placement for chronic ureteral obstruction were reviewed. Data collected included patient age, gender, diagnosis/cause of obstruction, laterality, duration of indwelling metal stent, number of routine metal stent changes, complications and early discontinuations or stent changes.

Results: A total of 23 patients underwent placement of metal ureteral stents between February 2008 and September 2010. Bilateral stents were placed in 5 patients and 9 underwent a yearly metal stent exchange for a total of 42 ureteral units treated with metal ureteral stents. All metal stents were placed to relieve ureteral obstruction due to ureteral stricture, ureteropelvic junction obstruction, retroperitoneal fibrosis or extrinsic malignant obstruction. There were 3 metal stent failures in 2 patients with malignant ureteral obstruction. There were no complications, or early discontinuations or changes due to adverse symptoms, patient dissatisfaction, worsening renal function or progressive hydronephrosis.

Conclusions: Metal ureteral stents are effective for benign and malignant ureteral obstruction in the absence of urolithiasis. Good tolerability and annual stent exchange make metal stents an appealing alternative for patients with chronic ureteral obstruction treated with indwelling ureteral stents.

Key Words: metals, stents, ureteral obstruction

Abbreviations and Acronyms

MUO = malignant ureteral obstruction

PCN = percutaneous nephrostomy

UPJ = ureteropelvic junction

UU = ureteral unit

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Ureteral stents have long been used for the management of ureteral obstruction of various causes. Silicone or plastic ureteral stents are the most commonly used ureteral stents owing to familiarity and ease of use. Despite the advantages, these standard ureteral stents have demonstrated relatively high failure rates in the management of chronic ureteral obstruction, especially in cases of advanced pelvic malignancy or retroperitoneal metastases.[1–3] The failure of these pliable stents in long-term and potentially progressive ureteral obstruction may be due to compressibility and the propensity for encrustation. The risk of stent encrustation due to long stent dwell time[4] also occurs with certain causes of nonmalignant or intrinsic ureteral obstruction requiring chronic indwelling ureteral stents such as UPJ obstruction or recurrent/refractory ureteral stricture.

Subsequently various stent designs have been developed, including metal

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or spiral coiled ureteral stents. The metal Resonance® stent has gained notoriety since it was first reported to relieve ureteral obstruction caused by metastatic breast cancer and retroperitoneal fibrosis.[5] Since this introductory report this metal ureteral stent design has demonstrated relative success in treating chronic ureteral obstruction compared to polymer stents.[6,7] However, more rigid metal ureteral stents may lead to more bothersome lower urinary tract symptoms such as pain, dysuria and gross hematuria.[8,9] Poor tolerability may lead to early removal and more procedures (eg polymer stent changes) to treat the chronic obstruction. Without bothersome symptoms the Resonance stent has the potential to decrease significantly the number of procedures required for the treatment of chronic ureteral obstruction. We present our experience with metal ureteral stents for the treatment of chronic ureteral obstruction of various etiologies.

MATERIALS AND METHODS

The records of 23 consecutive patients who underwent initial metal ureteral stent placement from February 2008 through September 2010 were reviewed. All stents placed were metal Resonance ureteral stents. All patients were preoperatively evaluated with a history, physical examination and imaging including excretory urography, computerized tomography, retrograde pyelography or nuclear renography that demonstrated chronic unilateral or bilateral obstruction. Each patient had previously undergone a minimum of 1 polymer ureteral stent placement requiring anticipated removal or exchange within 3 or 4 months. Patients were thoroughly counseled on treatment options for chronic ureteral obstruction which included metal stent placement. Metal ureteral stent placement was not offered to patients with ureteral obstruction secondary to urolithiasis. Balloon dilation of ureteral stricture was not required or performed in any patient for metal stent placement. Patients who tolerated the stents and had continued resolution of hydronephrosis underwent scheduled stent exchanges annually.

Data from these clinical interactions were then prospectively collected and analyzed, and included patient age, diagnosis, laterality, stent size/length, current status with or without the stent, number of stent exchanges, length of followup, complications and premature discontinuations. Patients continuing with the metal stent exchanges or who died of their disease with the stent without complication were considered successes, while stent related complications, defined as premature removal or symptoms refractory to oral medications, were considered failures.

Metal ureteral stent placement was performed in a retrograde fashion in all patients. A retrograde pyelogram was performed to assess the ureteral obstruction and ureteral length. Since the ends of the metal Resonance stent are not patent, it must be placed through a supplied sheath, which was placed over the guidewire under fluoroscopic guidance. The guidewire was then withdrawn and the metal ureteral stent was pushed through the sheath after choosing the appropriate length based on estimated ureteral length from the retrograde pyelogram or based on the length of the polymer stent that was removed. Under fluoroscopy the metal stent was pushed through the sheath until it curled within the renal pelvis proximally. The sheath was then withdrawn over the pusher using the Seldinger technique, thereby leaving the metal stent in place. The cystoscope was used to confirm a curl of the distal aspect of the stent within the bladder. Retrograde pyelogram images before and after stent placement are shown in figures 1 and 2, respectively.

RESULTS

Between February 2008 and September 2010 a total of 23 patients underwent placement of the metal Resonance ureteral stent for chronic ureteral obstruction. Bilateral ureteral stents were placed in 5 (22%) patients and 9 (39%) underwent ureteral stent change after 1 year. One patient underwent 2 annual metal ureteral stent changes. A total of 42 UUs were managed with metal ureteral stent placement. In 2 patients with malignant ureteral obstruction a metal stent was placed in each for nearly 12 months before they died of disease with the stent in place. In 1 patient a metal stent was in place for 23 months before muscle invasive urothelial carcinoma of the bladder developed and was managed with radical cystectomy. One patient with metal stent placement for symptomatic left UPJ obstruction and another

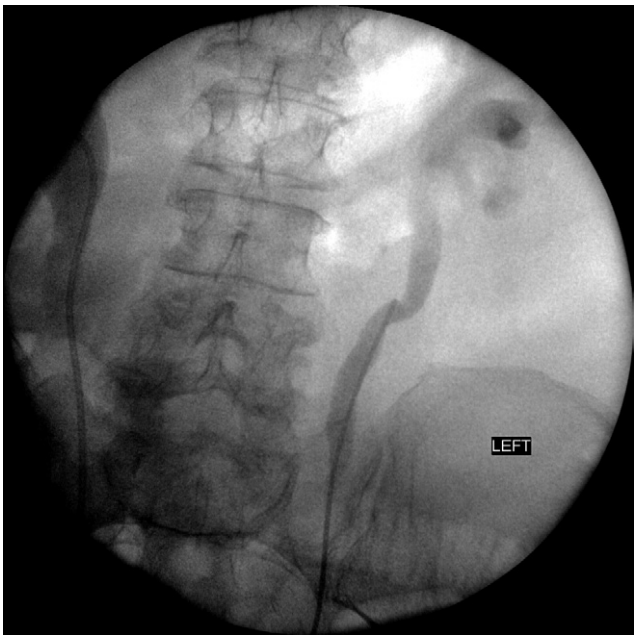

Figure 1. Left retrograde pyelogram before metal stent placement demonstrating renal collecting system and ureteral dilation extending down to area of narrowing in distal ureter. Ureteral access catheter is present within ureter.

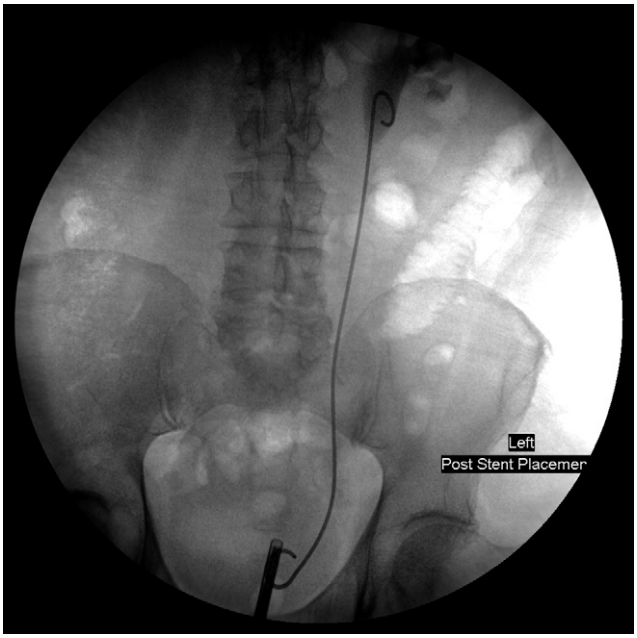

Figure 2. Left retrograde pyelogram following metal stent placement demonstrating appropriate positioning of metal ureteral stent with proximal curl within renal pelvis and distal curl within bladder.

patient with nonmalignant retroperitoneal fibrosis died of other causes with a metal stent in place for 13 and 23 months, respectively. There were no stent related complications or premature ureteral stent discontinuations due to refractory symptoms. We did not experience any technical difficulty in stent exchanges due to urothelial hyperplasia or stent encrustation. There were also no early metal stent changes for worsening hydronephrosis or progressive renal failure.

However, 3 metal stent failures occurred due to extrinsic malignant ureteral compression. Of these failures 2 occurred in a male patient with bilateral metal stents for prostate cancer metastatic to the retroperitoneum. Only 2 months after placement of bilateral metal stents secondary to the failure of bilateral polymer ureteral stents, he experienced acute renal failure and renal ultrasound revealed new bilateral hydronephrosis. The metal stents were left in place to avoid losing potential ureteral access in the future and the obstruction was treated with bilateral PCN tubes. The third instance of failure occurred in a patient with endometrial carcinoma metastatic to the retroperitoneum who required PCN drainage for treatment of acute renal failure. These cases account for the overall stent failure in only 3 of 42 (7.1%) UUs and 3 of 14 (21.4%) UUs with malignant obstruction. The overall median duration with metal ureteral stents was 13 months (range 2 to 32). Further results can be seen in the table.

DISCUSSION

Chronic ureteral obstruction, whether unilateral or bilateral, is a possible complication of advanced pelvic or retroperitoneal malignancy and indicates worsening prognosis.[10] However, PCN for the treatment of malignant ureteral obstruction may yield little benefit in addition to decreasing patient quality of life.[11] Available polymer ureteral stents used to treat this complication of malignancy have demonstrated high failure rates (up to 58%).[12,13] Likewise chronic obstruction from other noncalculus causes such as UPJ obstruction or retroperitoneal fibrosis may present difficult management scenarios in poor operative candidates, patients with refractory stricture disease, or in those who do not desire surgery more invasive than endoscopic ureteral stent placement.

Multiple ureteral stent designs ranging from spiral metal coil reinforcement within polymer stents to permanent implantable metal alloy stents were

Diagnosis and demographics for patients with metal ureteral stent

	No. Pts	Mean Pt Age	No. Bilat	Median Mos Followup	No. Complications
Benign:	15	72.3	3	14	0
Ureteral stricture	9	71.6	2	13	
UPJ obstruction	5	69.4		13	
Retroperitoneal fibrosis	1	79	1	24	
Malignant:	8	65.8	2	9.5	2
Prostate	2	65.5	1	6	1*
Endometrial	2	61.5		18.5	1*
Uterine	1	75	1	5	
Multiple myeloma	1	76		7	
Ovarian	1	59		7	
Colon	1	62		8	
Overall	23	70	5	13	2

No patients had early stent removal.

* Stent failure requiring PCN drainage due to obstruction and acute renal failure.

created to counter the chronic nature and potentially increasing compression of malignant obstruction or recurrent ureteral stricture disease. Tschada et al compared novel 7.5Fr metal wire reinforced polymer ureteral stents in 16 UUs to 7Fr conventional polymer stents in 73 UUs with benign ureteral obstruction, and reported significantly higher success rates in the coil reinforced stents (86% vs 40%, $p < 0.01$).[9] The authors also reported a lower complication rate than standard stents (36% vs 54%, $p < 0.01$) but noted that production cost may be a prohibitive factor. The polymer construction may also be a disadvantage as these stents would still require frequent exchanges for maintenance, increasing the likelihood of encrustation and further adding to the overall cost.

Other previous metal stent designs functioned similarly to cardiac or biliary duct stents with incorporation into the ureteral wall. Specifically the cobalt alloy Wallstent® was designed to span the length of ureteral narrowing upon placement, which was followed by balloon dilation for seating into the ureter and eventual urothelial ingrowth. Subsequently ureteral lumen narrowing led to secondary procedures in many cases, essentially negating the potential advantage of decreased followup procedures such as routine stent exchanges.[13,14] The primary patency rate of the Wallstent was reported to have reached only 58% at 2 years.[15]

Coated metal stents were designed to function similarly to the implanted Wallstent with the goal of overcoming the drawback of significant urothelial hyperplasia/edema leading to poor primary patency rates. In a 2004 study a self-expanding polymer coated nitinol stent led to only nonobstructive urothelial hyperplasia in 28% and no cases of obstruction, but seemed to trade this advantage for a 22% stent migration rate.[16] Although these coated metal stents are meant to preclude urothelial hyperplasia and avoid ureteral occlusion, the opposite problem of stent migration became a common complication.[17]

In terms of overall success an exception to the expandable ureteral stent category may be the thermo-expandable nickel-titanium alloy Memokath® 051. Unlike permanent expandable stents, this implantable ureteral stent achieves its functional form at 50 to 55C and has decreased rigidity at less than 10C, allowing for removal if required.[18] Agrawal et al recently reported on an 11-year followup of the Memokath 051, which demonstrated promising results with an 89% success rate in 28 patients with MUO.[19] The overall stent encrustation and migration rates for this series were 3.7% and 18%, respectively. However, other series report these rates to be up to 27% and 45%, respectively.[20] The Memokath 051 demonstrated successful outcomes in MUO and may be at least as effective as the metal Resonance stent, but direct comparison is impossible. Overall expandable ureteral stents designed to counter increasing or recurrent ureteral obstruction have poor tolerability due to decreased flexibility (eg balloon expandable), or require endourological expertise and considerable time for placement followed by high rates of stent migration or encrustation (eg thermo-expandable).[13,21]

The spiral coiled metal ureteral stent design (ie Resonance) is composed of a nonmagnetic nickel-cobalt-chromium-molybdenum alloy (MP35N®), and is 6Fr, double pigtail, flexible, full-length without patent ends, intended to remain indwelling for up to 12 months before a stent exchange. Small clinical reports have demonstrated promising results with the use of the spiral coiled metal stent in terms of clinical effectiveness, stent related complications and technical requirements for placement.[5–7,22] However, bothersome symptoms and poor tolerability have been described in other series.[8] Overall the spiral coiled metal stent design has become a viable option for the management of nonstone chronic ureteral obstruction.

Mechanical factors of the spiral coiled metal stent are likely responsible for its clinical efficacy in maintaining sufficient renal drainage as well as the tendency to produce urinary irritation and poor tolerability. In pig models the overall flow through the ureter was higher with a polymer stent. However, these stents could be completely occluded by increasing extrinsic pressure whereas the metal Resonance stent is significantly more resistant to compression[23] and could not be occluded regardless of external force.[24] The comparatively high tensile strength of the spiral coiled metal design may prevent buckling and subsequent ureteral occlusion.[25] This mechanical characteristic may be enhanced by urine flow via diffusion between and around coils, which allows flow regardless of potential kinking, rather than through a lumen. These mechanical aspects are likely the basis for the promising results of spiral coiled metal stents in managing benign and malignant ureteral obstruction.

However, these same factors are also the probable basis for clinical scenarios requiring premature discontinuation of the metal stent. In studies reporting good overall results, early discontinuation of metal stents is commonly due to significant irritative symptoms or persistent/recurrent gross hematuria.[7,8] Such bothersome symptoms may have been due to increased stent rigidity and previous lack of various length availability, and not necessarily metal ureteral stent composition.[8] Likewise the coiled, nonsolid design or stent material may allow urothelial hyperplasia between the coils or stent encrustation.[6] Both of these problems may contrib-

ute to stent failure or technical difficulty. Such complications have not been reported frequently and, thus, these unique mechanical factors seem more apt to benefit than bother this patient population.

Our experience with metal Resonance stent placement for the treatment of chronic ureteral obstruction by malignant or benign disease is consistent with previously reported promising results. However, we did not note reported stent related irritative symptoms or recurrent gross hematuria requiring early removal. These favorable results might be attributed to our contemporary series when more metal Resonance stent lengths were available to better fit the patient and possibly result in better tolerability. As with any other procedure, technique may also contribute, but is less likely since this metal coiled stent lacks patent ends, thus limiting the number of variations in retrograde placement technique. Balloon dilation of ureteral strictures was not required for stent placement in any case including benign stricture disease. This lack of balloon dilation may suggest a more benign or nonproliferative type of ureteral stricture disease than that of other series causing obstruction requiring balloon dilation (in up to 38%) and possibly contributing to metal Resonance stent failure in benign ureteral obstruction.[6,26]

We have not directly encountered any technical difficulty related to urothelial hyperplasia or invasion between the metal coils. However, in our single case of stent failure in a patient with bilateral ureteral obstruction secondary to metastatic prostate cancer, urothelial hyperplasia or urothelial invagination between coils is a probable cause of failure as these metal stents operate by fluid diffusion around the coils and can resist significant compression. However, this hypothesis has yet to be confirmed by direct examination. The bilateral metal stents were left in place despite PCN placement to preserve future ureteral access. In a total of 42 UUs there were only 3 (7.1%) treatment failures in 2 patients with MUO, but no failures in the benign ureteral obstruction patient population. In 23 patients there were no stent related complications or premature stent removals due to bothersome symptoms in our series. Considering this success in a relatively sizeable population among the literature, our experience augments and supports a promising future for the management of chronic ureteral obstruction with spiral coiled metal ureteral stents.

CONCLUSIONS

This series demonstrates the overall clinical effectiveness of the metal Resonance stent for treating chronic ureteral obstruction of malignant and benign nonstone etiology. The majority of MUOs was effectively managed by these metal stents and the failure rate in MUO cases was low. Utility was also demonstrated in benign ureteral obstruction, which was likely nonproliferative in nature as balloon dilation was not required to place the metal stent nor was subsequent difficulty from urothelial hyperplasia encountered. Therefore, considering the low complication rate and nonexistent failure rate, metal ureteral stent placement may well manage this type of benign ureteral obstruction in poor operative candidates or in patients electing to avoid invasive surgery. The metal Resonance stent appears to have good tolerability, which may have been improved by the variety in available lengths. Overall the coiled metal stent appears to be a good option for the long-term management of ureteral obstruction in the absence of urolithiasis or proliferative ureteral stricture disease.

REFERENCES

1. Docimo SG and Dewolf WC: High failure rate of indwelling ureteral stents in patients with extrinsic obstruction: experience at 2 institutions. J Urol 1989; **142:** 277.
2. Chung SY, Stein RJ, Landsittel D et al: 15-Year experience with the management of extrinsic ureteral obstruction with indwelling ureteral stents. J Urol 2004; **172:** 592.
3. Wong LM, Cleeve LK, Milner AD et al: Malignant ureteral obstruction: outcomes after intervention. Have things changed? J Urol 2007; **178:** 178.
4. Vanderbrink BA, Rastinehad AR, Ost MC et al: Encrusted urinary stents: evaluation and endourologic management. J Endourol 2008; **22:** 905.
5. Borin JF, Melamud O and Clayman RV: Initial experience with full-length metal stent to relieve malignant ureteral obstruction. J Endourol 2006; **20:** 300.
6. Liatsikos E, Kallidonis P, Kyriazis I et al: Ureteral obstruction: is the full metallic double-pigtail stent the way to go? Eur Urol 2010; **57:** 480.
7. Polcari AJ, Hugen CM, López-Huertas HL et al: Cost analysis and clinical applicability of the Resonance metallic ureteral stent. Expert Rev Pharmacoecon Outcomes Res 2010; **10:** 11.
8. Nagele U, Kuczyk MA, Horstmann M et al: Initial clinical experience with full-length metal ureteral stents for obstructive ureteral stenosis. World J Urol 2008; **26:** 257.
9. Tschada RK, Henkel TO, Jünemann KP et al: Spiral-reinforced ureteral stent: an alternative for internal urinary diversion. J Endourol 1994; **8:** 119.
10. Ishioka J, Kageyama Y, Inoue M et al: Prognostic model for predicting survival after palliative urinary diversion for ureteral obstruction: analysis of 140 cases. J Urol 2008; **180:** 618.
11. Kanou T, Fujiyama C, Nishimura K et al: Management of extrinsic malignant ureteral obstruction with urinary diversion. Int J Urol 2007; **14:** 689.
12. Radecka E, Magnusson M and Magnusson A: Survival time and period of catheterization in patients treated with percutaneous nephrostomy for urinary obstruction due to malignancy. Acta Radiol 2006; **47:** 328.
13. Sountoulides P, Kaplan A, Kaufmann OG et al: Current status of metal stents for managing ma-

lignant ureteric obstruction. BJU Int 2010; **105:** 1066.

14. Liatsikos EN, Karnabatidis D, Katsanos K et al: Ureteral metal stents: 10-year experience with malignant ureteral obstruction treatment. J Urol 2009; **182:** 2613.
15. Richter F, Irwin RJ Jr, Watson RA et al: Endourologic management of malignant ureteral strictures. J Endourol 2000; **14:** 583.
16. Trueba Arguinarena FJ and Fernandez del Busto E: Self-expanding polytetrafluoroethylene covered nitinol stents for the treatment of ureteral stenosis: preliminary report. J Urol 2004; **172:** 620.
17. Barbalias GA, Liatsikos EN, Kalogeropoulou C et al: Externally coated ureteral metallic stents: an unfavorable clinical experience. Eur Urol 2002; **42:** 276.
18. Kulkarni RP and Bellamy EA: A new thermo-expandable shape-memory nickel-titanium alloy stent for the management of ureteric strictures. BJU Int 1999; **83:** 755.
19. Agrawal S, Brown CT, Bellamy EA et al: The thermo-expandable metallic ureteric stent: an 11-year follow-up. BJU Int 2008; **103:** 372.
20. Klarskov P, Nordling J and Nielsen JB: Experience with Memokath 051 ureteral stent. Scand J Urol Nephrol 2005; **39:** 169.
21. Wakui M, Takeuchi S, Isioka J et al: Metallic stents for malignant and benign ureteric obstruction. BJU Int 2000; **85:** 227.
22. Wah TM, Irving HC and Cartledge J: Initial experience with the resonance metallic stent for antegrade ureteric stenting. Cardiovasc Intervent Radiol 2007; **30:** 705.
23. Christman MS, L'Esperance JO, Choe CH et al: Analysis of ureteral stent compression force and its role in malignant obstruction. J Urol 2009; **181:** 392.
24. Blaschko SD, Deane LA, Krebs A et al: In-vivo evaluation of flow characteristics of novel metal ureteral stent. J Endourol 2007; **21:** 780.
25. Pedro RN, Hendlin K, Kriedberg C et al: Wire-based ureteral stents: impact on tensile strength and compression. Urology 2007; **70:** 1057.
26. Garg T, Guralnick ML, Langenstroer P et al: Resonance metallic ureteral stents do not successfully treat ureteroenteric strictures. J Endourol 2009; **23:** 1199.