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Ureteral Metal Stents: A Tale or a Tool?

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ABSTRACT

There are four types of ureteral metal stents: self expandable, balloon expandable, covered, and thermoexpandable shape-memory. Insertion of metal stents requires expertise with transurethral and percutaneous techniques. The stricture is traversed with the aid of a guidewire via a percutaneous nephrostomy, and the stenotic segment is dilated using a high-pressure balloon catheter. The stent is then inserted over the guidewire, such that the upper end bypasses the obstruction by at least 3 to 4 cm, while the lower end extends intravesically for 0.5 to 1 cm from the ureteral orifice. If necessary, two or more stents are placed in sequence, overlapping by at least 2 to 3 cm. Metal stents were initially used for the relief of end-stage malignant disease, and their role in the treatment of benign ureteral strictures is still undefined. Patients often complain of abdominal discomfort and mild pain after stent insertion, which soon resolve spontaneously. Hematuria usually stops after a few days and does not necessitate any treatment. Mild urothelial hyperplasia in the stent lumen is common but usually regresses after 4 to 6 weeks. Many authors suggest the use of a double-pigtail catheter for the first 4 to 6 weeks to avoid narrowing of the ureteral lumen. The influence of stents on ureteral peristalsis is a major but poorly documented issue. Encrustation is a significant problem that needs to be addressed. The characteristics of both the patient and the stent influence its likelihood. Migration of coated metal stents was seen in 81% of patients at our center. Virtual endoscopy has recently been introduced as a tool for the follow-up of patients with stented ureters. Further design development is necessary to obtain the ideal ureteral metal stent. In a recent study in female pigs, paclitaxel-eluting metal stents engendered less inflammation and hyperplasia of the surrounding tissues.

INTRODUCTION

URETERAL STRICTURES ARE ROUTINELY TREATED by transvesical or antegrade placement of double-pigtail stents, percutaneous nephrostomy, transluminal dilation of the ureter via a balloon catheter, or some combination of these techniques. Researchers have focused on developing the ideal stent with “friendly” maneuverability to the user, stability after placement, radiopacity, resistance to encrustation and infection, ability to relieve intraluminal and extraluminal obstruction, long-term patency, and low cost. 1,2

The previous successful use of metal stents (MS) in the vascular system and biliary tree has led several investigators to propose their use for applications in the urinary tract, such as the treatment of benign prostatic hyperplasia, urethral strictures, and detrusor–sphincter dyssynergia. 3 Such stents have also been used in the treatment of both malignant and benign ureteral obstruction by others and us, with encouraging results.

The aim of the present paper is to highlight the use of ureteral MS by a thorough literature review.

TYPES OF METAL STENTS

There are four types of ureteral MS: self expandable (SEMS), 4 balloon expandable, 4 covered, 5–7 and thermoexpandable shape-memory.
pandable shape-memory (Memokath 051; Engineers & Doctors a/s, Hornbaek, Denmark). 1,8,9 There is a plethora of SEMS and balloon-expandable MS described in the medical literature. Stents covered externally with ultrathin woven polyester fabric with shape memory have been recently introduced, although the experience with their use is limited. They have the advantage of minimal luminal tissue ingrowth but have a tendency to migrate from their initial position. Thus, the positive experience gained in the vascular system is not duplicated when these stents are used in the ureter. 5 The Memokath 051 has a unique tight spiral structure that prevents endothelial ingrowth. It is a shape-memory stent that softens at <10°C and regains its initial shape when reheated to 50° to 55°C. 1,8 Because of its thermal shape memory, it is easily removable if indicated.

Insertion of MS requires expertise with transurethral and percutaneous techniques within the ureteral lumen. 5,6,9-12 The lengths of the MS used for alleviation of ureteral obstruction range from 3 to 12 cm, and the diameter is 7 mm. 2,4-6,13-17 The technique of insertion has been described in detail. 2,10,12-14 The procedure begins with a standard percutaneous nephrostomy followed by nephropyeloureterography, localizing the exact site of the obstruction. Passage through the stricture is performed with the aid of a 0.018-, 0.038-, or 0.035-inch guidewire, depending on the pathology (Fig. 1). 1,2,6,10,11,13,14,16,18–20 The stenotic segment is dilated using a high-pressure balloon catheter 5 to 6 mm in diameter. Repeated dilatations are sometimes necessary to treat resistant strictures. Following dilatation, the stent is inserted over the guidewire, such that the upper end bypasses the obstruction by at least 3 to 4 cm while the lower end extends intravesically for 0.5 to 1 cm from the ureteral orifice. If necessary, two or more stents are placed in sequence, overlapping by at least 2 to 3 cm, in order to bridge longer obstructed ureteral segments. In cases in which the stents do not expand to the desired diameter, supplementary balloon dilatation is performed. 1,2,6,10,11,13,14,16,18–20

FIG. 1. Stricture at distal end of right ureter. (A) Guidewire has passed through stenotic segment into bladder. (B) Dilation with high-pressure balloon.

FIG. 2. Excretory urogram shows right ureteral patency is secured even though there is hyperplastic reaction of stented ureteral lumen.
We have extensively reported our experience with MS for the management of malignant ureteral obstruction, ureteroileal anastomotic strictures, and ureteropelvic junction (UPJ) obstruction.5,13,14,16,21

**INDICATIONS AND RESULTS**

Metal stents were initially used for the relief of end-stage malignant disease, where the ureteral stricture is secondary to either primary tumor or extrinsic pressure from pelvic tumor or lymph-node metastasis.1,2,11,17–20 Pauer and Lugmayr first introduced the use of ureteral MS and implanted 15 Wallstents in 12 patients with malignant extrinsic obstruction. Thirteen stents remained patent during a mean follow-up period of 27 weeks.15 Other centers,2,6,10,12 including ours,5,13,14 applied MS in an attempt to prove their efficacy and safety for the management of malignant obstruction. Since then, research interest has focused on improving stent design and thus expanding the indications for MS insertion.

The role of MS in the treatment of benign ureteral strictures is still undefined. Herrero and colleagues22 showed that MS are useful in the management of ureteral obstruction after renal transplantation. They used Wallstents in two cases of obstructive uropathy after renal transplantation. No complications were reported, and ureteral patency was maintained during the follow-up period without any other management.22 We used MS for the management of four anastomotic strictures after ureteroileal urinary diversion with encouraging results. In three patients, there was no restenosis, while in the remaining patient, the stricture recurred 1 month after stent placement, and additional intervention was necessary, with placement of a totally coaxial overlapping metal stent.16 Pauer and Eckerstorfer23 implanted SEMS and Memokath 051 tubes in 13 patients with benign ureteral obstruction. They reported primary ureteral patency in seven patients, and in five, patency was achieved with additional intervention, whereas in only one case was the kidney removed because of progressive malfunction.23 Kulkarni and Bellamy1,8 implanted the Memokath 051 in 10 patients with ureteral obstruction secondary to recurrent benign disease (endometriosis, fibrosis after radiation, etc.); the mean follow-up period was 10.6 months, and complete relief of obstruction was reported in all patients.1,8 In a recent study, Kulkarni19 further addressed the use of MS in benign disease and recommended their use in recurrent benign strictures only in selected patients. Wakui and coworkers4 drew the same conclusions after implanting SEMS and balloon-expandable MS in 11 ureters of 9 patients, 4 with benign and 5 with malignant obstruction. In addition, Arya et al24 inserted 13 Memokath 051 stents in 11 patients with benign lower-ureteral obstructions. During a mean follow-up of 18 months, no stent-related complications were noted except for encrustation of three stents, which had to be removed at 4, 11, and 33 months.24 Daskalopoulos and colleagues18 presented similar results.

In a recent report,21 we introduced the practice of applying MS for the management of UPJ obstruction. Four patients were treated with placement of Wallstent SEMS. Immediate patency was achieved in all cases. During the follow-up period, three patients required no further manipulations, and the stented UPJ remained patent. In the remaining patient, the stricture recurred 2 months after stent insertion secondary to ingrowth of scar tissue through the prosthesis, and an additional intervention—placement of a longer totally coaxial overlapping MS—was necessary.

![Fig. 3. Double-pigtail stent positioned within stented left ureter.](image)

![Fig. 4. Radiograph of nephrostomy tract of right kidney after injection of contrast material 48 hours after stent placement. Patency has been achieved.](image)
Patients often complain of abdominal discomfort and mild pain after MS insertion, which resolve spontaneously after a few days. Neither urinary-tract infections nor allergic reactions to the stents have been reported. Hematuria has been observed in some patients but usually stops after a few days and does not necessitate any additional treatment. Mild urothelial hyperplasia in the stent lumen is a common phenomenon that may influence the patency of the stented ureter. In our previous publications, we noted a trumpet-like configuration of the ureter adjacent to the upper extremity of the MS, which did not hinder ureteral patency. Urothelial hyperplasia can be verified endoscopically and usually regresses 4 to 6 weeks after insertion of the stent. Many authors suggest the use of a double-pigtail catheter for the first 4 to 6 weeks, aiming to avoid narrowing of the ureteral lumen. The grade of urothelial hyperplasia seems to be dependent on the degree of force exerted on the ureteral wall, as well as on the extent of ureteral overstretching and the resulting urothelial trauma, as corroborated experimentally by Thijssen et al.

The role of radiation therapy or adjuvant chemotherapy for cancer in the urothelial reaction to MS placement is controversial. Lugmayr and Payer showed a significant reduction of the mucosal reaction in patients having previous radiation therapy, whereas Flueckiger and colleagues did not find any correlation between the extent of the urothelial reaction and adjuvant chemotherapy or radiation therapy. In a series of 14 ureters, we saw temporary mild hyperplasia of the urothelium that did not influence ureteral patency. In a single patient, however, this reaction led to ureteral obstruction in the first month, necessitating placement of a totally coaxial overlapping metal stent in order to reestablish patency. Hekimoglu et al inserted Wallstents into 10 cancer-obstructed ureters and reported hyperplasia in all of them, with stenosis of 30% to 60% at 3 months. However, all the patients who survived at 6 months after stent placement showed regression of the hyperplasia to <30%. Kulkarni and Bellamy reported no urothelial hyperplasia.

**FIG. 5.** Excretory urography 1 month after bilateral stent placement. Both stented ureters are patent.

**FIG. 6.** Virtual endoscopy. (A) Patent stented ureteral lumen. (B) Stenotic segment is evident at distal edge of endoprosthesis.
The influence of stent placement on peristalsis of the ureter is another major but poorly documented issue.17 Hekimoglu and colleagues26 reported complete inhibition of peristalsis in some stented ureters. On the other hand, Flueckiger and associates10 observed normal peristalsis proximal and distal to the stent in all ureters, as recorded by antegrade ureterography 1 and 2 weeks after stent placement.

Encrustation of the MS is a significant problem that needs to be addressed. The characteristics of both the patient and the stent, such as history of stone disease, poor renal function, hypercalciuria, biofilm formation, and stent material, are influencing factors.9,24 Hekimoglu et al26 suggested that the aperistaltic stented ureteral segment, in conjunction with urothelial hyperplasia, caused urinary stasis and thus encrustation of the uncovered areas of the metal stent. Pauer and Lugmayr15 observed encrustations in a small area of the Wallstents implanted in 2 of 12 patients examined 30 weeks after the procedure. This area was not covered by urothelium because it did not embrace the ureteral wall.15 In another publication, the same authors reported reocclusion in 3 of 54 ureters as a result of encrustations, which were observed in the area where the stent had not been incorporated totally into the ureteral wall.2 Kulkarni and Bellamy8 reported no encrustation during a mean follow-up of 19.3 months after the implantation of Memokath 051 stents in 28 patients with benign and malignant diseases.

Migration of coated metal stents was reported in 81.2% of patients in a previous publication from our center.5

**FOLLOW-UP**

The first day after stent placement, a plain radiograph of the kidneys, ureters, and bladder (KUB film) is obtained.1,7,8 Ultrasonography or antegrade nephrostomography should be performed during the first and second day after stent insertion to confirm ureteral patency (Fig. 4). After patency confirmation, the nephrostomy tube can be removed.5,14

The serum creatinine concentration is measured 1, 3, and 7 days after stent insertion, then once a month during the first 3 months and every 3 months thereafter unless indicated by worsening renal function.2,18,19 Transabdominal ultrasonography and urinalysis and cultures are performed at 1, 2, 4, and 6 months and thereafter every 3 months, whereas excretory urography (IVU) is performed at 1 and 6 months (Fig. 5).5,13,14,16,27 Renography with DTPA can be performed when indicated, and ureteroscopy may be necessary to assess and treat encrustations.1

Virtual endoscopy has recently been introduced as a diagnostic tool for the follow-up evaluation of patients with stented ureters (Fig. 6). In a recent study, we performed this technique in six patients with malignant ureteral obstruction who were treated successfully by placement of Wallstent stents and correlated the results with those of antegrade nephrostomography 48 hours after stent placement. In two patients, restenosis was observed, and in the remaining four patients, the stented ureters remained patent. Virtual endoscopy and antegrade nephrostomography were concurrent as to their findings.21,27

**UNIVERSITY OF PATRAS EXPERIENCE**

We reviewed our 10-year experience with the use of MS for the treatment of extrinsic ureteral obstruction in 102 patients with malignant (N = 90) or benign (N = 12) ureteral obstruction treated by MS insertion. In 40 patients, stents were placed bilaterally, for a total of 142 stented ureters. The following stents were used: Wallstent (Schneider, Zurich, Switzerland) in 46 patients, Accuflex (Meditech Boston Scientific Corp., Boston, MA) in 6, Strecker (Meditech Boston Scientific) in 6, Sinus (OptiMed, Ettingen, Germany) in 9, Protége (EV3, Plymouth, MN) in 13, LumineXX (Bard Angiomed, Karlsruhe, Germany) in 6 patients, and Passager (Boston Scientific, Natick, MA) in 16. The mean patient age was 59 years, and the mean follow-up was 15 months (range 8–38 months) and 38 months (range 18–72 months) for malignant and benign strictures, respectively. Primary patency was achieved in 94 ureters (66.2%), while secondary interventions were needed in 31. In 13 cases (9.1%) with externally coated Passager stents, the prostheses migrated into the bladder, hindering ureteral patency, and in another 4 (2.8%), stenting failed to alleviate obstruction, thus necessitating insertion of a percutaneous double-J nephrostomy tube. The survival rates of patients with malignant obstruction were 54% and 25% after 12 and 24 months, respectively, and were unrelated to stent placement.

**NEW PERSPECTIVES**

The ideal MS for ureteral use has not been yet found. Coated stents initially appeared promising but failed to demonstrate efficacy when used in the ureter. The use of biomaterials for stent lining or drug-eluting stents may generate less inflammatory reaction.

We have recently performed an experimental study with 10 female pigs. Ten ureters were stented with an R-Stent (Orbus Medical Technonlogies, Hoevlaken, The Netherlands) and ten with a Paclitaxel-Eluting Coronary Stent (Boston Scientific). Patency was measured by virtual endoscopy and nephrostomography 24 hours and 21 days after the procedure. Our results suggested that the paclitaxel-eluting metal stents generated less inflammation and hyperplasia of the surrounding tissues (unpublished data).

**CONCLUSION**

Malignant and benign ureteral obstructions can be alleviated by placement of MS. Further experimental and clinical evaluation is necessary to resolve concerns regarding their use and to define the ideal lining material, thus establishing their safety and efficacy within the ureteral lumen.

**REFERENCES**


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