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ORIGINAL ARTICLE

Allium ureteral stent in the management of ureteral stenoses. Multicenter retrospective study

The Allium ureteral stent in the management of ureteral stenoses, a retrospective, multicenter study

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KEYWORDS
Ureter;
Stenosis;
Fistula;
Ureteral stent

Summary
Introduction. —Post-traumatic ureteral injuries are mainly treated with a double J catheter. A minority requires additional treatment. Ureteral stents present a surgical alternative. To evaluate the results of the installation of Allium prostheses®ureteral in the management of patients with long-term double J catheters for ureteral stenoses.

Materials and methods. —Retrospective, multicenter cohort study of 36 patients who benefited from the placement of 37 Allium ureteral stents®(metallic 24 Ch) from September 2011 to January 2015 in three French university hospital centers. The average age of the operated patients was 63.8 years (33 to 88 years). The majority of patients were women (70%). A percentage of 5.6 had a ureteral fistula and 94.4% had a stenosis. The length

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average stenosis was 4.15 cm (0.5 to 12 cm). All analyzes were carried out in a bilateral formulation for a risk of type 1 error of 5%. A difference was considered statistically significant when the level of significance (*p*) was less than 0.05 (risk - = 5%). The results are expressed in terms of hazard ratios (HR), associated 95% confidence intervals and *p*-values.

Results. —Thirty-seven percent of stents were removed after follow-up for complications such as migration (18.9%), infection (10.8%) and intolerance (8.1%). The other stents were removed after one year. The effectiveness of stent placement, defined as the absence of recurrence of stenosis or fistula, was 52.8% with a mean follow-up of 7.1 months.

Conclusions. —The placement of Allium ureteral stents offers an alternative in patients with indwelling double J catheters with an effectiveness of more than 50%.
Level of proof.—4.

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Summary
Objective. —To evaluate the performance of the Allium ureteral stent in the management of patients initially treated with double J stents for the long-term treatment of stenoses. *Materials and methods.* —We performed a retrospective multicenter study involving 36 patients who received 37 Allium ureteral stents (metallic 24 Fr) between September 2011 and January 2015 in one of three French teaching hospital centers. The mean age of the patients was 63.8 years (min-max: 33—88 years) and most were women (70%). Of these patients, 5.6% had ureteral fistulae and 94.4% stenoses. Mean stenosis length was 4.15 cm (min-max: 0.5—12 cm). All analyzes were two-tailed with an alpha risk of 0.05. Statistical significance was set at $P<0.05$. Results were expressed as hazard ratios (HR) with 95% confidence intervals and *P*-values.
Results. —During the follow-up period, 37% of the stents were removed due to migration (complication occurring in 18.9% of the studied population), infection (10.8%) or intolerance (8.1%). The other stents were removed after 1 year. Clinical effectiveness, defined as a lack of stenosis or fistula recurrence, was 52.8% after a mean follow-up of 7.1 months.
Conclusion. —Clinically effective in more than 50% of cases, the Allium ureteral stent appears to be an alternative to indwelling double J stents.
Level of evidence.—4.

Introduction

Post-traumatic ureteral injuries are rare, the ureter being protected by adjacent structures during external trauma. It is after surgical interventions that there is a significant risk of ureteral injury. Most ureteral lesions are found at the level of the pelvic ureter (80%)[1]. Since the advent of laparoscopic surgery, ureteral lesions are secondary to gynecological (50%), urological (30%) and digestive (15%) surgeries. [2—4].

Several types of lesions are found and lead either to obstruction or to immediate or secondary fistulization[5.6]. In the majority of cases, the installation of a double J stent solves the problem in a simple and non-aggressive manner. [7]. However, in a minority of cases, they may be ineffective or poorly tolerated, requiring other treatment. Surgery provides a solution after treatment failure endoscopic but cannot necessarily be applied to all patients, taking into account the general condition, surgical history and the patient's wishes. For around ten years, ureteral stents have offered an alternative in the management of these patients.[8—11], but little scientific work has been published in this area.

In this study, we aimed to evaluate the clinical effectiveness of the Allium ureteral stent as an alternative to maintaining a double J catheter for patients not candidates for reconstructive surgery due to their medical or surgical history.

Materials and methods

The placement of the Allium ureteral stent has been proposed in the event of inability to wean the double J probe, poor tolerance of the double J probe or in the event of impossibility of performing reconstructive surgery due to medical history or surgical procedures of patients.

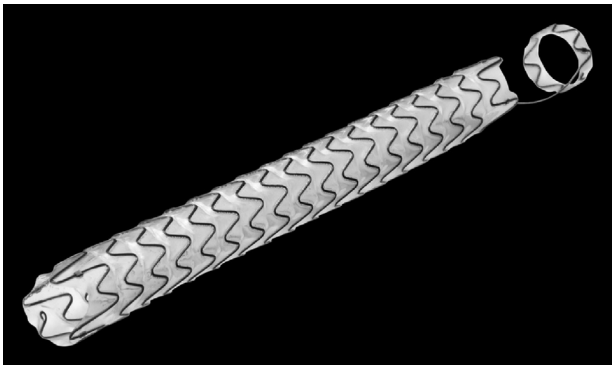

Figure 1. Allium ureteral stent®.

Ureteral stenting is a procedure that aims to restore or improve drainage of the upper urinary tract, to provide a pathway for urinary flow through a stenotic or fistulae ureteral segment.

The Allium URS stent®(Allium Medical Solutions, Caesarea, Israel) comes in two configurations (Fig. 1 and 2), with or without anchor. The intravesical anchor segment is used to prevent upward migration of the stent. Its configuration with a radial force segment makes it possible to maintain dilation of the stenotic area or to cover a fistula area. The stent costs 832.33 euros excluding tax.

The stent has a metal structure with a radial self-expanding design (24 or 30F in diameter) and in two lengths (10 cm and 12 cm). It is covered with a layer of polymer material to facilitate its removal. It has three radiopaque markers on both ends and one on the anchor to improve fluoroscopic visibility.

The stent is placed under scopic control using an image intensifier. The double J probe initially placed is removed and a retrograde ureteropyelography is performed in order to find the pathological area. The ureter is then d

either with the help of
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24F, then the stent is inserted. Following deployment, a retrograde ureteropyelography is performed at the end of the procedure to ensure the removal of the obstacle or ureteral fistula.

Removal of the stent is carried out in the operating room under scopic control. In a university hospital, stents were systematically removed after 1 year. The other stents were left in place throughout follow-up. There have been no reports of encrustation or difficulty removing the Allium stent to date.

All procedures are performed under general anesthesia combined with antibiotic prophylaxis with cefazolin 2 g in the absence of allergy. Infected patients are not implanted but benefit from changing the double J probe to allow implantation on sterile urine. The patients were seen again at 1 month, then at 6 months with control imaging by injected abdominopelvic scanner with late urological time and serum creatinine at each consultation.

The primary endpoint is defined as the absence of recurrence of ureteral stenosis or fistula at the last CT scan.

All analyzes were carried out in a bilateral formulation for a type 1 error risk of 5% using Stata software (version 13, StataCorp, College Station, United States). A difference was considered statistically significant when the level of significance (p) was less than 0.05 (risk - = 5%).

These analyzes were supplemented by analyzes considering effectiveness as censored data estimated by the Kaplan-Meier method. Comparisons between groups were performed by log-rank test and Cox proportional hazards regression model. The results are expressed in terms of hazard ratios (HR), associated 95% confidence intervals and values of$p$.

Results

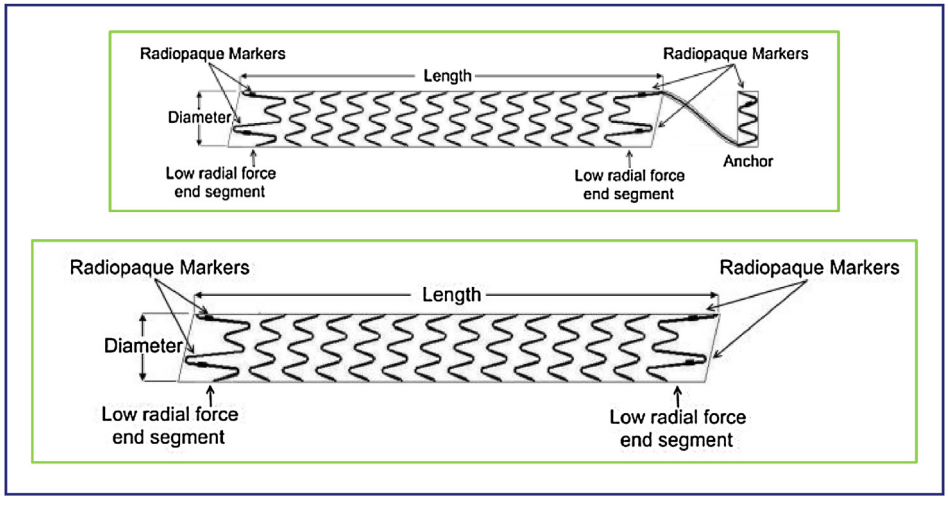

Figure 2. Structure of Allium ureteral stent®.

March 2015 in 3 university hospitals. We have 21 patients implanted at the Lyon Sud hospital center, 8 patients at the Nîmes hospital center and 7 at the Grenoble hospital center.

The general characteristics of the population found 70% women (25). The average BMI was 25.6. The average ASA score was 2.7.

No patient was lost to follow-up. The indication for stent placement was mainly ureteral stenosis (94.4%). Two patients (5.6%) benefited from prosthesis placement in the context of a ureteral fistula. The average length of the stenosis was 4.2 cm (0.5 to 12 cm). The majority of patients initially benefited from the placement of a double J catheter (94.4%).

The different causes of ureteral lesions are found in the Table 1. They are mainly caused by gynecological surgery, including 25% of cases following a hysterectomy.

A percentage of 27.8 of patients with secondary ureteral injury benefited from previous pelvic radiotherapy.

The distribution of the different lesion levels is grouped on theFig. 3. We find an Allium stent placement®at the level of a ureterostomy and one at the level of a graft

ureterovesical anastomosis

Table 1 Distributions of the causes of the lesions ureteral.

Cause	Number of patients	%
Rectal surgery	2	5.6
Colonic surgery	5	13.9
CHIP	2	5.6
Hysterectomy	10	25
Pelvic cleansing	3	8.3
Pyeloplasty	6	16.6
Pelvic radiotherapy	10	27.8

No intraoperative complications were reported. The median length of stay was 2 days (1 to 8 days). The reported operative time was on average 87.5 minutes (35 to 167 minutes), variable depending on the experience of the operator. Renal function was not modified following the surgical procedure with an average preoperative MDRD of 63.4 mL/min compared to 63.5 mL/min postoperatively. The additional analysis comparing pre- and postoperative renal functions in terms of effectiveness did not find any significant difference. Indeed, if the stent is effective, the average MDRD pre-

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knows one

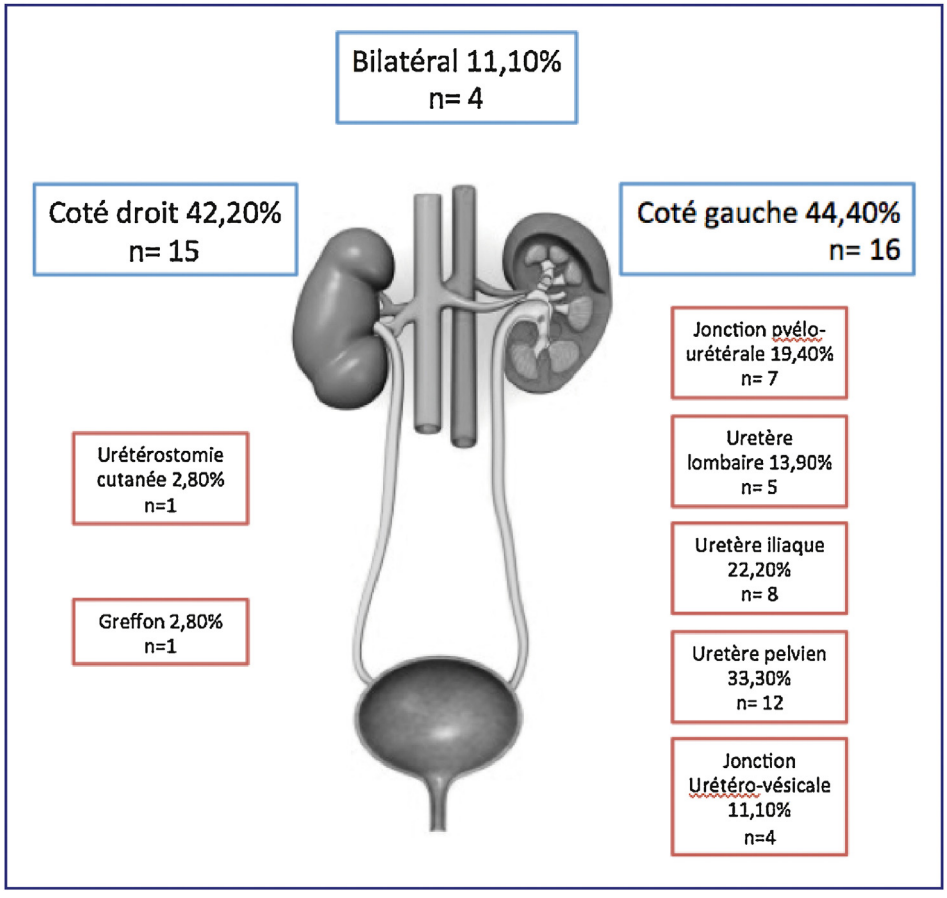

Figure 3. Lesion location.

Table 2 Postoperative complications.

Complications	Number of patients	%
Residual pain	10	27
CPC Dilation	8	21.3
Migration	7	18.9
Urinary infection	6	16.2
Acute pyelonephritis	6	16.2
Septic shock	2	5.4
Hematuria	1	2.7
Acute renal failure	1	2.7

difference of 3.8 (*P*=0.14). In case of stent ineffectiveness, the mean preoperative MDRD was 62.5 (CI 52.7—72.3) and the mean postoperative MDRD was 65.6 (CI 54.1—77.1), which made a difference of 3.1 (*P*=0.27).

Twenty-one patients presented a complication during their follow-up, i.e. 58.3% of the population studied. Twenty-seven percent of patients had residual pain, but this included stent migration that could explain the pain. Patients presenting pain solely secondary to implantation represented 18.9% of the population. We note 33.3% of intolerance or pain in patients who benefited from the placement of a stent with anchor.

We also find 21.3% dilation of the secondary pyelocalicial cavities, 18.9% migration. The rest of the complications are detailed in theTable 2. Stent migration was greater for patients who had a stent with an anchor placed, i.e. 25% of stents.

Thirty-seven percent of stents were removed after follow-up for complications such as migration (18.9%), infection (10.8%) and intolerance (8.1%).

Fourteen patients presented an infectious complication but without any real difficulty with insertion or other factors found apart from cytobacteriological examinations of polymorphic preoperative urine but rechecked twice.

The other stents were systematically removed after one year according to the implantation duration recommended by the manufacturer when the stent was placed.

Nineteen patients, or 51.80%, are considered to have stent effectiveness with an average follow-up of 7.1 months. We found 100% effectiveness in patients with a ureteral fistula and 48.60% in patients with stenosis. The efficiency analysis according to the Kaplan-Meier method is shown on the Fig. 4.

Residual pain was found in 10 patients (27%) and 3 patients had the stent removed for intolerance (8.1%). It should be noted that 15 patients (40.5%) were intolerant to the double J probe before placement of the Allium stent.®.

Comparative analysis in terms of effectiveness allows us to identify the factors of success or failure of the treatment. They are represented in theTable 3. Thus, an age > 60 years (HR at 3.62 [1.17—11.2],*p*=0.03) and female sex (HR at 2.84 [1.05—7.67],*p*=0.04) are a success factor in Allium prosthesis placement.

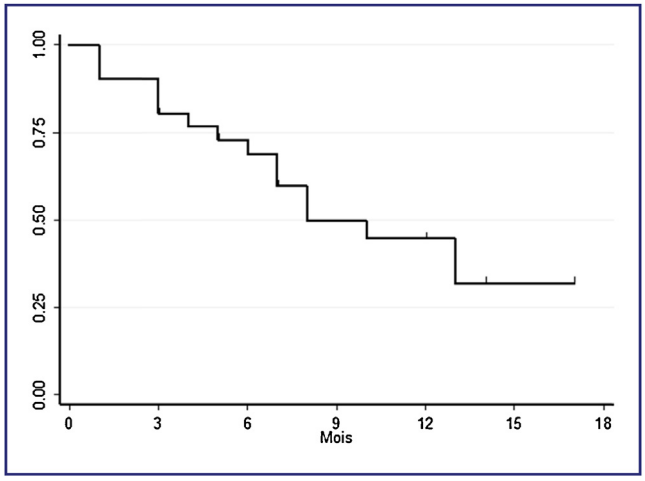

Figure 4. Analysis of efficiency over time.

Table 3 Parameters influencing success.

Criteria	HR	[95% CI]	Value*p*
Age > 60 years	3.62	1.17—11.2	0.03
Female gender	2.84	1.05—7.67	0.03
ATCD of insufficiency renal chronic	0.60	0.13—2.67	0.48
ATCD of insufficiency cardiac	0.74	0.17—3.29	0.68
ATCD irradiation pelvic	0.93	0.30—2.93	0.90
Surgery gynecologist-gic	0.66	0.21—2.06	0.46
Surgery rectal	1.88	0.41—8.56	0.39
Syndrome junction pyelo-ureteral	2.33	0.72—7.50	0.13
Length st-nose > 3 cm	0.83	0.31—2.23	0.70

Discussion

In our study, 51.80% of patients benefited from the placement of an Allium stent.®. Before implantation, 40.5% of patients were intolerant to the double J probe and another alternative had to be offered. We noted 27% of residual pain requiring or not analgesic treatment, although 3 patients presented with stent migration which could explain the pain. We therefore finally find 18.9% of residual pain attributable to the stent. The Allium prosthesis® presents good tolerance compared to a simple double J probe. On the other hand, Allium prostheses with anchor are less well tolerated with signs

bladder irritants much more present, with 33.3% residual pain. Few studies report pain during ureteral stent placement[12,13], but in our study these represent 8.1% of stent ablations. The use of anchors for stents placed at the ureterovesical level allows better initiation at the bladder level but this causes significant pain.

Our study deals with Allium stent placement®which is relatively simple and does not require the use of hyperthermia for stent deployment compared to the Memokath stent®[12,13]. There are no failures during placement of the stent, which remains relatively accessible but initially requires a suitable tutorial to facilitate its placement and therefore imposes a certain learning curve on operators. But we find a secondary migration rate of 18.9% comparable to the literature and other types of stents, whether Memokath stents.®or Uventa®[8.13—16]. An animal model study found migration rate of 33%[17].

The entire stent is covered with a biocompatible polymer to make it a non-permeable tube except at the ends. Thus, due to the total coverage of the stent, encrustation and intraluminal tumor growth is limited and could allow treatment of malignant stenoses. Therefore, this option would allow the management of ureteral fistulas that fail endoscopic treatment. In our experience, 2 patients benefited from the placement of this stent in the indication of ureteral fistula with a success rate of 100% and perfect coverage of the fistula in the long term. For the moment, these stents have not yet been removed and will only be removed after at least one year of maintaining the stent. Extension of the recommended duration of implantation of the Allium prosthesis®at 3 years, in this treatment could allow long-term maintenance in order to avoid surgical treatment which could be deteriorating in these multiple-operated patients. Indeed, a double J catheter should be replaced at best every 6 months, a nephrostomy should be changed every 6 weeks.[18]. An Allium stent could in the years to come be left for at least 3 years or more depending on the results of future studies and could thus avoid the iterative change of double J probes and thus repeated anesthesia.

In our series, we found 16.2% urinary infection, 16.2% acute pyelonephritis, 5.4% septic shock. These results are comparable to the series by Agrawal et al.[14].These patients initially have a greater susceptibility to infections, because they presented chronic colonization due to the iterative change of double J catheter and nephrotomy. But this infection rate remains high because it is only 10% in the study by Elsamra et al.
[19].

Our study allowed us to identify different factors of ineffectiveness in Allium URS stent placement such as pre-existing heart failure or renal failure. For Witters et al., a lack of vascularization leads to poor ureteral healing, which could lead to failure in stenting for ureteral fistula[20]. In several studies, radiotherapy[20,21] is considered a factor in the appearance and failure in the management of ureteral wounds. Our analysis did not find this risk factor to be significant but remains very limited due to the small number of people studied.

The placement of the Allium URS stent could provide a benefit in terms of reducing healthcare costs in these patients. Indeed, the study by López-Huertas et al.[22] describes a reduction in implantation costs by comparing iterative double J catheter change and ureteral stent implantation. Metal stent placement is more expensive than implantation of a double J lead, but reducing the frequency of double J lead changes could reduce the total costs of various hospitalizations.[19]. The annual cost associated with the use of a double J catheter versus a metal stent was $23,999 versus $11,183, respectively. This was equivalent to an annual reduction of $10,394 for each patient, or a 43% reduction in the annual cost of care for each patient. For Azizi et al.[23], a Memokath stent was marketed around 2000D, against 832.33Dfor an Allium and 70 stentDfor a JJ probe[23]. It appears necessary to avoid a minimum of two JJ probe changes for this device to become economically profitable. An average duration of 18 months of maintaining the ureteral stent would be necessary to allow financial savings.

In our study, we found a success rate of 51.8% with no recurrence of stenosis for an average follow-up of 7.1 months. Complications accounted for 37% of ureteral stent removals, with a percentage of urinary tract infection and postoperative pyelonephritis of 16.2%. Antibiotic impregnation of stents could provide a solution to infectious complications and improve stent maintenance[24]. There is a significant failure rate after Allium stent implantation in patients with chronic stenosis with a higher rate of complications. For Ki Hong Kim et al.[19], 22.5% of patients implanted with a permanent metal stent underwent a second intervention linked to obstruction of the pyelocalicial cavities.

In our series, 33.3% of the stents placed included an anchor. The Allium stent is the only one to feature bladder anchoring to prevent stent migration. We found 25% migration during stent placement with bladder anchoring, which is higher than in the various published series where we only found 14 to 18% migration.[6.11—14]. Other studies hypothesize an increased risk of stent encrustation if it comes into contact with urine intravesically, which was not observed in our series and remains to be studied.[25].

Conclusion

The placement of the Allium URS stent appears to provide an alternative to the iterative change of the double J catheter in patients with ureteral stenoses. In the management of ureteral fistulas, this stent would present a therapeutic option in patients who are difficult to operate on. Longer-term follow-up appears necessary to optimize this new therapy.

Declaration of links of interest

The authors have not specified their possible links of interest.

References

[1]Selzman AA, Spirnak JP. Iatrogenic ureteral injuries: a 20-year experience in treating 165 injuries. J Urol 1996;155(3):878—81.

[2]Symmonds RE. Ureteral injuries associated with gynecologic surgery: prevention and management. Clin Obstet Gynecol 1976;19(3):623—44.

[3]Bai SW, Huh EH, Jung da J, et al. Urinary tract injuries during pelvic surgery: incidence rates and predisposing factors. Int Urogynecol J Pelvic Floor Dysfunct 2006;17(4):360—4.

[4]Vakili B, Chesson RR, Kyle BL, et al. The incidence of urinary tract injury during hysterectomy: a prospective analysis based on universal cystoscopy. Am J Obstet Gynecol 2005;192(5):1599—604.

[5]Lask D, Abarbanel J, Luttwak Z, Manes A, Mukamel E. Changing trends in the management of iatrogenic ureteral injuries. J Urol 1995;154(5):1693—5.

[6]Sakellariou P, Protopapas AG, Voulgaris Z, et al. Management of ureteric injuries during gynecological operations: 10 years experience. Eur J Obstet Gynecol Reprod Biol 2002;101(2):179—84.

[7]Richter F, Irwin RJ, Watson RA, Lang EK. Endourologic management of benign ureteral strictures with and without compromised vascular supply. Urology 2000;55(5):652—7.

[8]Moskovitz B, Halachmi S, Nativ O. A new self-expanding, large-caliber ureteral stent: results of a multicenter experience. J Endourol 2012;26(11):1523—7.

[9]Markovic Z, Markovic B, Tulic C, et al. Recanalization of urethral strictures using a temporary curved biocompatible new generation metal endoprosthesis. Acta Chir Iugosl 2007;54(3):123—7.

[10]Lugmayr H, Pauer W. Self-expanding metal stents for palliative treatment of malignant ureteral obstruction. AJR Am J Roentgenol 1992;159(5):1091—4.

[11]Wang HJ, Lee TY, Luo HL, et al. Application of resonance metallic stents for ureteral obstruction. BJU Int 2011;108(3):428—32.

[12]Bonniol R, Meria P, Safsaf A, Albouy B, Sibert L. The thermoformable spiral metallic stents in the treatment of localized ureteral stenosis: an alternative to JJ stent? Prospective multicenter study. Prog Urol 2011;21(6):397—404.

[13]Kim KS, Choi S, Choi YS, et al. Comparison of efficacy and safety between a segmental thermo-expandable metal alloy spiral stent (Memokath 051) and a self-expandable covered metallic stent (UVENTA) in the management of ureteral obstructions. J Laparoendosc Adv Surg Tech A 2014;24(8):550—5.

[14]Agrawal S, Brown CT, Bellamy EA, Kulkarni R. The thermoexpandable metallic ureteric stent: an 11-year follow-up. BJU Int 2009;103(3):372—6.

[15]Zaman F, Poullis C, Bach C, et al. Use of a segmental thermoexpandable metal alloy stent in the management of malignant ureteric obstruction: a single center experience in the UK. Urol Int 2011;87(4):405—10.

[16]Leonardo C, Salvitti M, Franco G, et al. Allium stent for treatment of ureteral stenosis. Minerva Urol Nefrol 2013;65(4):277—83.

[17]Morcillo E, Sánchez-Margallo FM, Serrano A, et al. Effects of preventive double-J stent placement in ureteral obstruction treatment with metal stents on animal model. Arch Esp Urol 2015;68(9):701—9.

[18]Harzmann R, Haacke C, Bichler KH. New development of a one-way-system for percutaneous nephrostomy. Urologe A 1981;20(1):63—7.

[19]Elsamra SE, Leavitt DA, Motato HA. Stenting for malignant ureteral obstruction: tandem, metal or metal-mesh stents. Int J Urol 2015;22(7):629—36.

[20]Witters S, Cornelissen M, Vereecken R. Iatrogenic ureteral injury — aggressive or conservative treatment. Am J Obstet Gynecol 1986;155(3):582—4.

[21]McIntyre JF, Eifel PJ, Levenback C, Oswald MJ. Ureteral stricture as a late complication of radiotherapy for stage IB carcinoma of the uterine cervix. Cancer 1995;75(3):836—43.

[22]Lopez-Huertas HL, Polcari AJ, Acosta-Miranda A, Turk TM. Metallic ureteral stents: a cost-effective method of managing benign upper tract obstruction. J Endourol 2010;24(3):483—5.

[23]Azizi A, Pasticier G, Benard A, et al. Tolerance and effectiveness of Memokath(R) 051 ureteral stents: a prospective 3-year follow-up study. Prog Urol 2012;22(5):266—72.

[24]Elayarajah, Rajendran R, Venkatrajah, et al. Biodegradable tocopherol acetate as a drug carrier to prevent ureteral stent-associated infection. Pak J Biol Sci 2011;14(5):336—43.

[25]Kulkarni R, Bellamy E. Nickel-titanium shape memory alloy Memokath 051 ureteral stent for managing long-term ureteral obstruction: 4-year experience. J Urol 2001;166(5):1750—4.