Urol Res (2012) 40:523–529
DOI 10.1007/s00240-011-0442-2

ORIGINAL PAPER

Single session removal of forgotten encrusted ureteral stents: combined endourological approach

Yakup Bostanci · Ender Ozden · Fatih Atac · Yarkin Kamil Yakupoglu · Ali Faik Yilmaz · Saban Sarikaya

Received: 3 October 2011 / Accepted: 23 November 2011 / Published online: 11 December 2011

Abstract Forgotten ureteral stents represent a difficult problem for urologists; the major complications are infection, migration, encrustation, stone formation, and multifractured stent, and a consensus on the best therapeutic approach is lacking. Here we present our experience with endoscopic management of this challenging problem and discuss the various endourological approaches for treating forgotten encrusted ureteral stents. From January 2005 to December 2010, 19 patients (11 women and 8 men) with encrusted ureteral stents were retrospectively analyzed. Combined endourologic therapies including extracorporeal shock wave lithotripsy (SWL), percutaneous nephrolithotomy (PCNL), ureterorenoscopic lithotripsy (URSL), and cystolithotripsy (CLT) were used to achieve stent removal. A total of 19 patients with encrusted ureteral stents were treated at our center. The mean patient age was 46.2 ± 18.5 years (8–81), the average indwelling time of the stent was 24.7 ± 19.0 months (8–93), and the mean hospital stay was 3.4 ± 4.0 days (range 1–15 days). Using the described combination of techniques, all stents and the associated stones were eventually removed without any complications and patients were rendered stone- and stent-free. A main element of the treatment strategy was to keep the number of interventions as low as possible. The use of various combinations of endourological techniques can achieve effective stent and stone treatment after a single anesthesia session with minimal morbidity and short hospital stay.

Y. Bostanci (✉) · E. Ozden · F. Atac · Y. K. Yakupoglu · A. F. Yilmaz · S. Sarikaya
Department of Urology, Faculty of Medicine, Ondokuz Mayis University, Kurupelit, 55139 Samsun, Turkey
e-mail: dryakupbostan@yahoo.com

Keywords Endourological technique · Encrustation · Forgotten ureteral stent · Indwelling time

Abbreviations

KUB	Kidney, ureter, and bladder
CT	Noncontrast computed tomography
IVU	Intravenous urogram
DMSA	Tc99m dimercaptosuccinic acid renogram
SWL	Shock wave lithotripsy
PCNL	Percutaneous nephrolithotomy
URSL	Ureterorenoscopic lithotripsy
CLT	Cystolithotripsy
DJS	Double-J stents

Introduction

Ureteral stents have a common place in all aspects of urology. They are mainly indicated after any ureteral surgery and for managing ureteral obstruction due to intrinsic or extrinsic causes [1–4]. They are also placed prior to any complex abdominal procedure for identification and protection of the ureters and after iatrogenic injuries to the ureters [5]. Management of forgotten DJS is time consuming, difficult, complicated, risky, and costly [6].

During the past decade, significant technological innovations and improvements have been made in stent design and materials in order to overcome problems related to stent manipulation and patients' tolerance [7, 8]. Despite substantial advances, the use of ureteral stents is not free of complications and consequences. Serious complications including encrustation, fragmentation, migration, and stone formation still occur, especially when stents have been left in situ for a long time [9, 10].

Although heavily encrusted stents clearly do pose significant problems, minor encrustations can also challenge for urologists, particularly if occurring frequently and repetitively. Various methods of treatment combinations of extracorporeal shock wave lithotripsy (SWL), cystolithotripsy (CLT) retrograde ureteroscopy with intracorporeal lithotripsy (URSL), percutaneous nephrolithotomy (PCNL) and open surgery have been used for retrieval of these encrusted stents [11–16]. However, there are no guidelines for the most effective management of this challenging situation.

Here we present our series of patients with unintentionally left in situ more than the desired time, encrusted ureteral stents and discuss the choice of treatment combinations in an attempt to identify the best endourologic approach to this distressing problem.

Materials and methods

Between January 2005 and December 2010, a total of 19 patients with unintentionally left in situ encrusted stents were treated at our center. During this period, we retrospectively reviewed the medical charts of all patients. All of them were double-J stents. The indwelling time of stent was calculated from the time of its insertion.

All patients were evaluated for stent encrustation and associated stone burden by KUB and/or noncontrast CT and/or IVU. In patients with non-visualized kidneys on IVU, DTPA renogram was done to estimate the renal functions. Treatment decision was made on clinical and radiological findings. Urine cultures with negative findings were documented for all patients before any endourologic intervention was undertaken, and preoperative antibiotic prophylaxis was given for all cases.

Percutaneous nephrostomy (PCN) was carried out in three patients with simultaneous antibiotic treatment who presented with acute pyelonephritis. Surgery was performed after obtaining negative bacterial culture of the blood and urine.

Combined multimodal endourological procedures cystoscopy, CLT, retrograde URSL, and PCNL were used to treat the patients in one session. Retrograde ureteroscopy was performed using 8/9.8F ureteroscope, under fluoroscopic guidance. PCNL was carried out using 24F rigid nephroscope. Holmium laser (StoneLight®, American Medical Systems) was used for intracorporeal lithotripsy. SWL was performed with an electrohydraulic shock wave lithotripter (PCK® Stonelith-V5 Lithotripter, Electronic Industry and Trade Co. Ltd., Ankara).

SWL with a PCK Lithotripter for minimally encrustated stent was performed first, and endourologic procedures were performed on the following day.

The patients were placed in the dorsal lithotomy position under general anesthesia and the various endourologic procedures were performed in one session. Stents with minimal encrustation on KUB, simple flexible cystoscopic removal of the stent under fluoroscopic guidance was done. A gentle attempt is made for removal with the help of grasping forceps passed through the cystoscope. For patients with encrustation and stone burden involving the lower coil, ureteric or whole of the stent, initially, the intravesical encrustation on the vesical coil was fragmented with a holmium laser. Subsequently, retrograde URSL was carried out. Ureteroscope under fluoroscopic guidance was introduced into the ureteral orifice beside the encrusted stent, with a guidewire, and intra corporeal lithotripsy was performed with a holmium laser to disintegrate the encrustation that had formed over the stent. Following this, a gentle attempt was made to retrieve the stent with the help of an ureteroscopic grasper. For stents with large stone burden (Fig. 1) and those stents which fail to be retrieved by the above-mentioned techniques, a ureteric catheter was placed adjacent to the encrusted stents for injection of radio-contrast material to delineate the renal pelvis and the calyces. Then the patient was placed in the prone position and PCNL of the upper coil of the encrusted stent along with calculus was done. Percutaneous access is established by a lower calyceal or middle calyceal puncture and the proximal coil of the stent along with stone is fragmented. Holmium laser was used for intracorporeal lithotripsy. The stent is gently removed under fluoroscopic guidance through the PCN tract. After completing the PCNL procedure, an 18F nephrostomy tube was placed for adequate drainage and to enable postoperative imaging exploration and routinely removed 2–4 days after surgery. Stone and encrustation analysis was done in all cases. Postoperatively, appropriate imaging was done to confirm the patients' stone- and stent-free status.

Results

The patients' demographics and operative data are summarized in Table 1. There were 11 women and 8 men with 19 unintentionally left in situ ureteral stents. Mean age was 46.2 ± 18.5 years (range 8–81 years), and the mean time for stent removal was 24.7 ± 19.0 months (range 8–93 months). The mean hospital stay was 3.4 ± 4.0 days (range 1–15 days).

The entire stent was encrusted in all patients. The predominating indication for stent placement was stone disease in 12 patients (63%). Of the 19 stents, 6 were inserted at our institution; the rest had been inserted at the referring hospitals. Poor compliance of patients and inability of the treating surgeons to counsel the patients were the main reasons for retention of these stents.

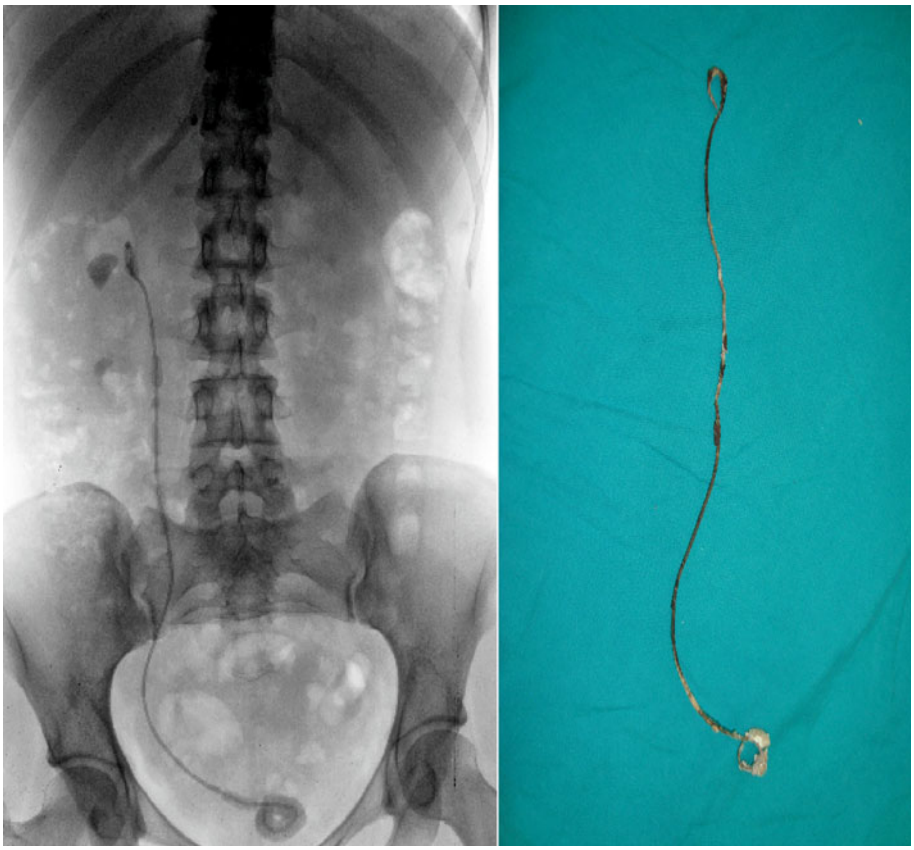

Fig. 1 KUB shows retained stent with large stone burden in bladder, ureter, and kidney and retrieved stent of same patient

All of the encrusted stents were successfully removed by endourologic techniques. A multimodal approach to treatment was used. As shown in Table 1, simple cystoscopic removal of the stent under fluoroscopic guidance was done in one case with minimal encrustation. In four patients, who had predominantly ureteric body encrustation, SWL was the initial treatment before cystoscopic removal, but this treatment was successful in one patient. In this case, cystoscopic removal of the stent was done after SWL. In remaining three cases, retrograde URSL was performed. CLT was required to treat the distal end of the stent in two cases, whereas one also required ureteroscopic intervention. Three stents were successfully removed with retrograde URSL alone. Six patients underwent a combination of URSL and PCNL. In three patients, combined multimodal endourological procedures CLT, URSL, and PCNL were performed in one session. The average stay of the nephrostomy tube in the nine patients was 2.4 days (range 2–4 days).

Using the described combination of techniques, all stents and the associated stones were eventually removed without any complications and patients were rendered stone- and stent-free. Stone analysis was only available for 13 patients which showed calcium oxalate and phosphate in the majority of cases. All evaluable patients were stone- and infection-free at the last follow-up visit.

Discussion

Double-J stenting of the kidney for different reasons is a very important part of daily urological practice [17]. On the other hand, unintentionally left in situ ureteral stents with encrustation represent a challenge for urologists and observed in urologic practice associated with poor compliance of the patients or failure of the physicians to adequately counsel the patients. Indwelling time increases prevalence and consequences of all complications. Serious complications, even death, may happen as a result of cases of unintentionally left in situ stents that stay longer than initially planned or more than 6 months [18]. These stents can produce considerable morbidity and mortality, due to extensive encrustation with significant stone burden, knot formation, upward migration and fragmentation [19, 20]. Usually their management necessitates combined endourologic approaches or rarely open surgery.

Stent encrustation is caused by the precipitation of uric acid or calcium oxalate onto the surface of the stent. Calcium phosphate and ammonium-magnesium-phosphate (i.e, struvite) can also precipitate, but require a higher pH level which can occur in association with certain urinary tract infections (urea-splitting bacteria produce ammonia) [21]. Severe encrustation with stone formation can lead to

Table 1 Patients' characteristics and operative data

N	Age (year)/sex	Stent indications	Indwelling time (months)	Location of encrustation			Preop SWL	Preop nephrostomy	Procedures	Hospital stay (days)
				Kidney	Ureter	Bladder				
1	57/M	Left nephrolithotomy	25	+++	++	+			URS + PCNL	3
2	30/F	Caesarean section	36	+++	++	++		*	CLT + URS + PCNL	7
3	41/F	Left URSL	18	++	++	+			URS + PCNL	3
4	42/F	Endometrium Ca	16	+	++	+	*		URS	1
5	36/F	Retroperitoneal fibrosis	27	+	++	++			CLT + URS	1
6	24/F	Pregnancy	8	+	++	+	*		Cystoscopy	1
7	36/M	Right nephrolithotomy	19	++	+	+			URS + PCNL	4
8	55/M	Testicular Ca	20	+	++	+			URS	1
9	63/M	Left pyelolithotomy	21	+++	++	+			PCNL + URS	4
10	21/F	Left pyeloplasty	51	++	++	+			PCNL + URS	3
11	8/M	Pre SWL	9	+	++	+	*		URS	1
12	81/M	Right pyeloplasty	16	+	+	+			Cystoscopy	1
13	70/M	Right nephrolithotomy	93	++	++	+++		*	CLT + URS + PCNL	15
14	65/F	Right URSL	12	+	+++	+			URS	1
15	58/M	Right nephrolithotomy	16	+	+++	+			PCNL + URS	3
16	42/F	Left nephrolithotomy	37	+++	++	+		*	CLT + URS + PCNL	13
17	49/F	Right ureterolithotomy	19	+++	++	++			CLT	1
18	62/F	Left URSL	11	+	++	+	*		URS	1
19	38/F	Pre SWL	17	+	++	+			URS	1

+, Light; ++, medium; +++, severe encrustation

urinary tract obstruction, urinary sepsis, and potential loss of kidney function [22].

The incidence of stent encrustation is not precisely known since this entity is not easily quantified and most studies evaluating it are small retrospective studies. Between January 2005 and December 2010, a total of 19 patients were treated for unintentionally left in situ encrusted ureteral stents at our center. Of the 19 stents, 6 were inserted at our center. In this period, a total of 932 double-J stents were used for stenting of the kidney for different reasons. The incidence of forgotten encrusted ureteral stents was calculated as 0,64% at our center.

The cause of encrustation is multifactorial. The most important risk factor for stent encrustation is stent indwelling time [21]. el-Faqih et al. [23] found that the stent encrustation rate increased from 9.2% at <6 weeks, to 47.5% at 6–12 weeks and 76.3% at >12 weeks. Other factors include a history of urolithiasis, high concentration of dissolved urinary materials, type of stent material, presence of bacterial colonization, and pregnancy [24, 25]. In our series, the mean time for stent removal was 24.7 ± 19.0 months and the predominant causative factor was lithogenic history.

Fragmentation is another important complication of the unintentionally left in situ stents. It is the result of loss of tensile strength, which is due to hardening and degeneration of the stent polymers [26]. Ureteral stent fragmentation rates range between 0.3 and 10% in the literature [18, 23]. The risk of encrustation and fragmentation is dependant on the type of material of the stent. Silicon was found to be least prone to encrustation, followed by polyurethane, silitek, percuflex and hydrogel coated polyurethane [24]. In our series, fragmentation of the stent is seen in three cases at the time of presentation.

Few studies have introduced algorithms for the management of retained indwelling ureteral stents. Singh et al. suggested the treatment of mild and moderate encrustations with SWL and traction, while a combination of SWL and URS was proposed for severe encrustations. PCNL was used in cases of stents with severe encrustation when SWL followed by URS and intracorporeal retrieval failed. For mid-stent encrustations, URS may be used, whereas the proximal portion should be managed by SWL, initially, and PCNL should be reserved for a large proximal stone burden or SWL failure [13]. Bultitude et al. advised using ureterorenoscopy to remove impacted stents with mild encrustation. In cases of ureterorenoscopy failure or marked encrustation, initial adjunctive use of SWL with URSL on the proximal portion may be efficacious. PCNL is often used as a second-line treatment, particularly in cases with a

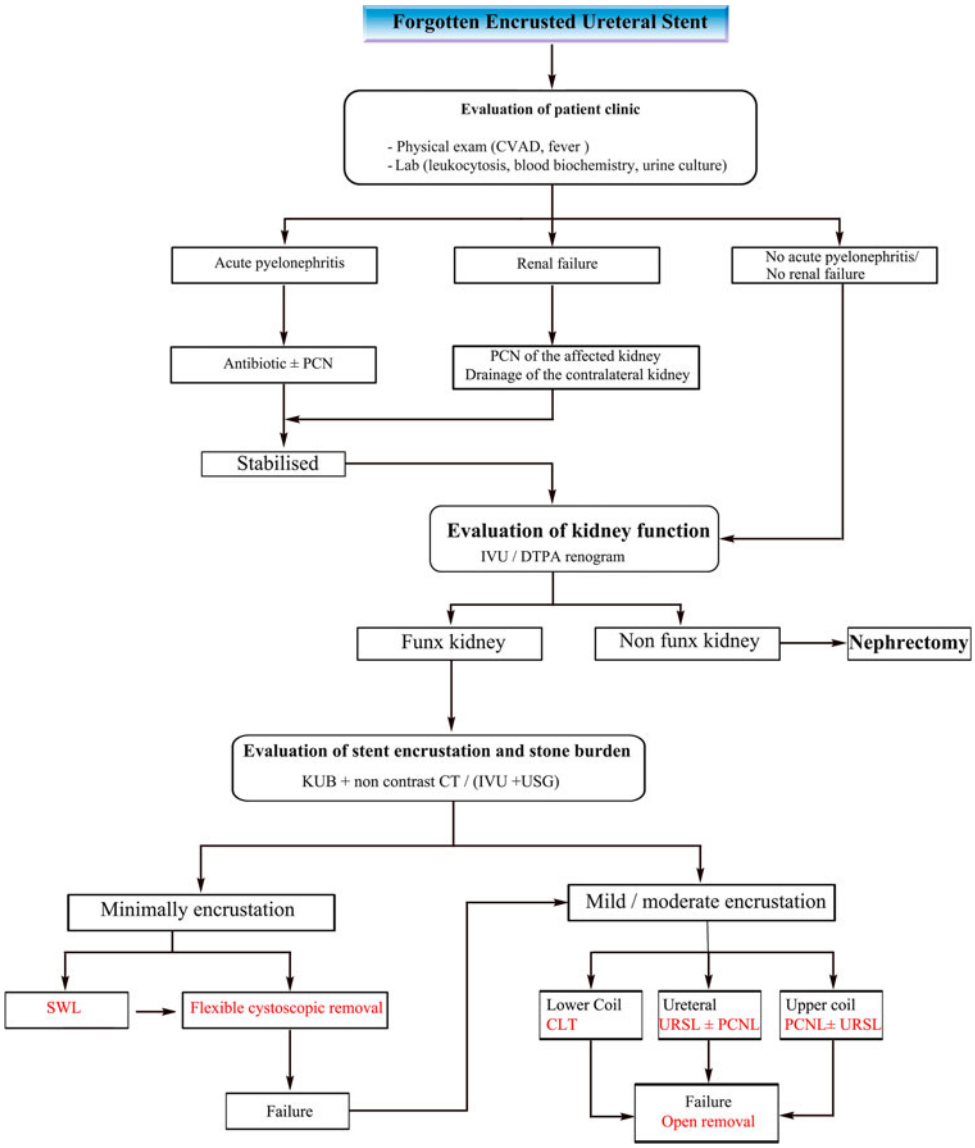

Fig. 2 Algorithm for the management of forgotten encrusted stents

large proximal stone burden or SWL failure [14]. Borboroglu and Kane also reported the endourological treatment of four patients with severely encrusted ureteral stents with a large stone burden. All patients required two to six endourological approaches (average 4.2) performed at one or multiple sessions, to achieve stone- and stent-free status. These authors concluded that PCNL and URS are often necessary for treating a severely encrusted stent and associated stone burden [15]. One stage removal of 12 encrusted retained ureteral stents has been reported by Bukkapatnam et al. in ten patients. Of these, 11 were managed by URS alone and in one patient the stone was treated through a percutaneous approach. They concluded that, these stents can be removed in one session with minimal morbidity and short hospital stay [16].

Clearly, there is no consensus on which method is the best for managing unintentionally left in situ stents efficiently. Successful treatment of encrusted ureteral stents requires careful planning and a multimodal endourologic approach. We have attempted to form a simplified algorithm for management (Fig. 2). Our approach includes a thorough preoperative imaging evaluation to decide the treatment strategy. The proximal, distal coils and the body of the stent are examined for encrustation, calcification and fragmentation. The site of encrustation, associated stone burden and the function of the affected kidney often determine the specific endourologic approach.

If there are no encrustations visible on KUB, our approach is flexible cystoscopic removal using a grasping forceps under local anesthesia with fluoroscopic guidance. A flexible grasper is passed through the cystoscope and used to break the deposits off the distal coil and then to grasp and gently pull the stent out under fluoroscopic guidance. It is important to avoid significant traction on the

stent which can lead to ureteral trauma, ureteral avulsion, or stent fracture and fragmentation [27]. If the stent does not uncoil, the procedure is abandoned.

SWL has been proposed by several authors for the management of encrustations because of its noninvasive nature. SWL is indicated only for localized, low-volume encrustrations in kidneys that have reasonably good function to allow spontaneous clearance of fragments [13]. In our series, in the case of stents with mild encrustations SWL was the initial treatment. We used SWL in four cases, but this treatment was successful in one patient. The remaining three cases necessitated the need for retrograde URSL for stone free satatus.

When encrustation of the distal stent is associated with stone formation, CLT can be performed [27]. In the case of moderate encrustations or associated stone burden visible on the KUB, we initially preferred distal end to manage the lower coil encrustation and the associated stone with the aid of a laser lithotripter. After adequate fragmentation achieved a gentle pull under fluoroscopic guidance was performed. This plan is in agreement with previous reports that recommend treatment of the distal component prior to the management of any other parts of the stents [15, 27].

If the cystoscopic approach fails, URS in combination with a holmium laser lithotripter represent an alternative minimally invasive treatment option. In patients with encrustation involving the ureteric portion of the stent, a safety guide wire is passed along the retained stent and ureteroscope is passed retrograde. Sometimes, the guidewire cannot be placed through the ureteral lumen. Under these circumstances, additional interventional techniques will be needed. Calcifications over the stent can be fragmented with a laser lithotripter while carefully advancing the ureteroscope into the renal pelvis. After all the encrustations and calcification have been fragmented, the ureteral segment of the stent is gently removed with the help of grasping forceps passed through the ureteroscope under fluoroscopic guidance. Following removal of the stent if any signs of ureteric injury or contrast extravasation present, the patient should be re-stented.

Management of the encrusted upper segment of the stent depends on the associated stone burden. For severe encrustation or calcification of the proximal stent, percutaneous nephrolithotomy in conjunction with antegrade ureteroscopy is preferred. The nephrolithotomy allows direct access to the renal pelvis to manage the encrusted proximal stent and ureteroscopy facilitates stent removal [27, 28].

A main element of the therapeutic strategy is to decrease the number of interventions. In our study there was an average of 1.9 interventions for the 19 patients. The reported average number of endourologic procedures per patient with a severely encrusted stent ranges from 2.43 to 4.2 [13–15, 27]. In most of our patients, PCNL and URS were used for the treatment. If we should have treated the bladder and ureteral segment of the stent first and performed SWL afterwards for the proximal end, we would have to come back for the distal part to retrieve the stent and the stone fragments, increasing the number of procedures. In addition, repeated SWL sessions may be required for the successful management of each case, resulting in a higher number of interventions. Thus, although URS and PCNL are more invasive options, they can reduce the number of interventions for huge encrustations. Another advantage of PCNL is that it allows renal stone fragments to be removed at the same time [29].

Although, endourological management of these stents achieves success in majority of the cases with minimal complications, the best treatment remains prevention. The treating physician should be very selective in placing the stents and they must be tracked very closely by documenting insertion and removal of the stents. All patients should be counseled with respect to the complications of long term use and advised when their stent should be changed. The ideal interval for changing or removing a stent has not yet been determined. As mentioned earlier, the degree of encrustation is dependant on the indwelling time, so, it is necessary to keep the indwelling time to as short as possible. It has been reported that a period between 2 and 4 months can be considered optimal [12, 15, 18, 23, 27]. However, patients with recurrent encrustations on stents, especially in patients with history of stone disease, should have the stents changed earlier (every 6–8 weeks). Timely cystoscopic removal or exchange of ureteral stents should minimize calcification and fragmentation.

On the other hand, poor compliance of the patients represents the main cause of an unintentionally left in situ stent. It seems that among our patients, there are some who simply do not follow our recommendations. To prevent this situation, patients should be reminded of the presence of an internal stent that could lead to problems if left indwelling for a prolonged period of time. It is also important to maintain a proper record of all stents inserted and keep a track of their due date of removal. The use of computerized tracking significantly lowers the incidence of overdue ureteral stent exchanges. Some authors have proposed a computerized tracking program for removal stents. In one trial, missed stent exchanges were reduced from 12.5 to 1.2 percent over 1 year [30].

Conclusion

Urologists should bear in mind the presence of severe encrustations when they have to deal with a forgotten stent. Combined endourologic techniques can achieve successful and safe management of forgotten stents, but treatment

should be tailored to the volume of encrustation and associated stone burden.

Another main element of the treatment strategy is to keep the number of interventions as low as possible because by the application of these increased modalities, financial burden and labour loss increase and impaired quality of life brought must not be forgotten.

References

1. Hepperlen TW, Mardis HK, Kammandel H (1979) The pigtail ureteral stent in the cancer patient. J Urol 121:17–18
2. Saltzman B (1988) Ureteral stents. Indications, variations, and complications. Urol Clin North Am 15:481–491
3. Chew BH, Knudsen BE, Denstedt JD (2004) The use of stents in contemporary urology. Curr Opin Urol 14:111–115
4. Park DS, Park JH, Lee YT (2002) Percutaneous nephrostomy versus indwelling ureteral stents in patients with bilateral nongenitourinary malignant extrinsic obstruction. J Endourol 16:153–154
5. Kuno K, Menzin A, Kauder HH et al (1998) Prophylactic ureteral catheterization in gynecologic surgery. Urology 52:1004–1008
6. Sancaktutar AA, Söylemez H, Bozkurt Y et al. (2011) Treatment of forgotten ureteral stents: how much does it really cost? A cost-effectiveness study in 27 patients. Urol Res. doi:10.1007/s00240-011-0409-3
7. Dunn MD, Portis AJ, Kahn SA et al (2000) Clinical effectiveness of new stent design: randomized single-blind comparison of tail and double-pigtail stents. J Endourol 14:195–202
8. Beiko BT, Knudsen BE, Denstedt JD (2003) Advances in ureteral stent design. J Endourol 17:195–199
9. Arvantinos E, Gravas S, Karatzas AD et al (2006) Forgotten, encrusted ureteral stents: a challenging problem with endourologic solution. J Endourol 20:1045–1049
10. Aron M, Ansari MS, Singh I et al (2006) Forgotten ureteral stents causing renal failure: multimodal endourologic treatment. J Endourol 20:423–428
11. Murthy KV, Reddy SJ, Prasad DV (2010) Endourological management of forgotten encrusted ureteral stents. Int Braz J Urol 36:420–429
12. Flam TA, Brochard M, Zerbib M et al (1990) Extracorporeal shock-wave lithotripsy to remove calcified ureteral stents. Urology 36:164–165
13. Singh I, Gupta NP, Hemal AK et al (2001) Severely encrusted polyurethane ureteral stents: management and analysis of potential risk factors. Urology 58:526–531
14. Bultitude MF, Tiptaft RC, Glass JM et al (2003) Management of encrusted ureteral stents impacted in upper tract. Urology 62:622–626
15. Borboroglu PG, Kane CJ (2000) Current management of severely encrusted ureteral stents with large stone burden. J Urol 164:648–650
16. Bukkapatnam R, Seigne J, Helal M (2003) 1-step removal of encrusted retained ureteral stents. J Urol 170:1111–1114
17. Lam JS, Gupta M (2004) Update on ureteral stents. Urology 64:9–15
18. Monga M, Klein E, Castañeda-Zúñiga WR et al (1995) The forgotten indwelling ureteral stent: a urological dilemma. J Urol 153:1817–1819
19. Damiano R, Oliva A, Esposito C et al (2002) Early and late complications of double pigtail ureteral stent. Urol Int 69:136–140
20. Eisner B, Kim H, Sacco D (2006) Repeat knot formation in a patient with an indwelling ureteral stent. Int Braz J Urol 32:308–309
21. Chew BH, Duvdevani M, Denstedt JD (2006) New developments in ureteral stent design, materials and coatings. Expert Rev Med Devices 3:395–403
22. Singh V, Srinivastava A, Kapoor R et al (2005) Can the complicated forgotten indwelling ureteric stents be lethal? Int Urol Nephrol 37:541–546
23. el-Faqih SR, Shamsuddin AB, Chakrabarti A et al (1991) Polyurethane internal ureteral stents in treatment of stone patients: morbidity related to indwelling times. J Urol 146:1487–1491
24. Tunney MM, Keane PF, Jones DS et al (1996) Comparative assessment of ureteral stent biomaterial encrustation. Biomaterials 17:1541–1546
25. Robert M, Boularan AM, El Sandid M et al (1997) Double-J ureteric stent encrustations: clinical study on crystal formation on polyurethane stents. Urol Int 58:100–104
26. Zisman A, Siegel YI, Siegmann A, Lindner A (1995) Spontaneous ureteral stent fragmentation. J Urol 153:718–721
27. Lam JS, Gupta M (2002) Tips and tricks for the management of retained ureteral stents. J Endourol 16:733–741
28. Vanderbrink BA, Rastinehad AR, Ost MC et al (2008) Encrusted urinary stents: evaluation and endourologic management. J Endourol 22:905–912
29. Xu C, Tang H, Gao X et al (2008) Management of forgotten ureteral stents with holmium laser. Lasers Med Sci 24:140–143
30. Ather MH, Talati J, Biyabani R (2000) Physician responsibility for removal of implants: the case for a computerized program for tracking overdue double-J stents. Tech Urol 6:189–192