Original Article

Experiences in managing different consequences of forgotten ureteral stents

Donghua Xie, Chenbo Hu, Di Gu, Cong Cai, Yongda Liu, Guohua Zeng, Ming Lei

Department of Urology, Minimally Invasive Surgery Center, Guangdong Key Laboratory of Urology, The First Affiliated Hospital of Guangzhou Medical University, Guangzhou, China

Abstract

Purpose: We reported the different consequences of forgotten stents and share our managing experiences.

Patients and Methods: From July 2011 to August 2019, eight patients (five men and three women) with forgotten encrusted ureteral stents were treated by different endoscopic procedures in our center. Plain-film radiography (kidney, ureter, and bladder [KUB]) and computed tomography were used to evaluate the position of stents, the site of encrustation, and the stone burden. Various sole or combined endoscopic techniques including percutaneous nephrolithotomy, retrograde ureteroscopic lithotripsy, and cystolitholapaxy were used to achieve stent removal.

Results: The average age of the patients was 50.9 years (range: 25–72 years). The mean indwelling time of the stents was 32.9 months (range: 12–83 months). Mean stent stone burden was 15 mm × 10 mm. Three patients had stent stone burden larger than 20 mm. Three patients had a preoperative positive urine culture before treatment. The stent was fragmented in two patients. The ureteral stents and related stones were successfully removed without any complications by a sole or combined endoscopic techniques with stone-free status achieved in all patients. There is no complications occurred.

Conclusion: Forgotten stents can lead to complicated urinary tract calculi, stent encrustation, urinary tract infection, vesicoureteric reflux, and even ureteral polyps. Various sole or combined endourological techniques can be used to manage the forgotten encrusted ureteral stents.

Keywords: Complications, forgotten stents, management

Address for correspondence: Dr. Ming Lei, Department of Urology, Minimally Invasive Surgery Center, Guangdong Key Laboratory of Urology, The First Affiliated Hospital of Guangzhou Medical University, Guangzhou, China.
E-mail: lmlm_leiming@yahoo.com

Received: 12.10.2020, **Accepted:** 16.06.2021, **Published:** 15.02.2022.

INTRODUCTION

Since its first introduction by Zimskind *et al.* in 1967,[1] ureteral stent has been widely used in urology practice. It is commonly used for both endoscopic and open urological surgeries, such as surgeries to relieve ureteral obstruction due to stones, ureteropelvic junction, retroperitoneal fibrosis, iatrogenic injuries to ureter, and so on.[2-4] The indwelled ureteral stent should be removed for a given period of time. Even with routine office follow-up visits, ureteral stents may be overlooked and forgotten. The long-term retention of ureteral stents often leads to complications such as stent fragmentation, stent encrustation, stone formation, urinary tract infection (UTI), and vesicoureteric reflux,[5] and some of them could be difficult to manage. Here, we report

Access this article online	
Quick Response Code:	Website: www.urologyannals.com
	DOI: 10.4103/UA.UA_165_20

How to cite this article: Xie D, Hu C, Gu D, Cai C, Liu Y, Zeng G, *et al*. Experiences in managing different consequences of forgotten ureteral stents. Urol Ann 2022;14:141-6.

our experience in endoscopic management of forgotten ureteral stents with complicated encrustation or stone.

PATIENTS AND METHODS

From July 2011 to August 2019, eight patients with forgotten encrusted ureteral stents were treated by different endoscopic procedures in our center. Plain-film radiography (kidney, ureter, and bladder [KUB]) and computed tomography (CT) were used to evaluate the encrustation, stone burden, and fragmentation of the forgotten stents. Patients with positive preoperative urine culture were treated with suitable antibiotics based on the culture susceptibility result starting from at least 72 h before surgical treatment. Patients who had negative urine culture received a single dose of broad-spectrum antibiotic prophylaxis right before the procedure.

Patients were managed by different endoscopic procedures designed individually. Under fluoroscopic guidance, retrograde ureteroscopic lithotripsy (URL) was carried out using a 8/9.8 F semirigid ureteroscope (Wolf, Germany). Percutaneous nephrolithotomy (PCNL) was performed using a rigid 18F nephroscope. In cases with severe encrustation, cystolitholapaxy (CLT) and URL were performed with a pneumatic lithotripter in a dorsal lithotomy position. Following this, a gentle attempt was made to retrieve the stent with the help of an ureteroscopic grasper. If the stent failed to uncoil, a ureteric catheter was placed adjacent to the encrusted stents for injection of radiocontrast material to delineate the renal pelvis and the calyces. Finally, the patient was changed to a prone position and PCNL was performed with a pneumatic lithotripter and the stent was removed at the end. For other patients with minimal encrustation, URL was performed and the stent was removed in one session.

RESULTS

Eight patients including five males and three females were included in the study. All the patients had stent placement in outside hospitals. The patients' demographic data, initial indication for stenting, and indwelling time were described in Table 1. The mean indwelling time was 32.9 months (ranged from 12 to 83 months), and the average patient age was 50.9 years old (ranged from 25 to 72 years). Of the eight patients, three patients had severe encrustation (stones larger than 20 mm within the bladder or kidney) and five patients had minimal encrustation in the forgotten stents. In one case, the encrustation happened in both upper and lower coils of the stent, looked like a barbell [Figure 1]. Stent fragmentation was found in two cases with one case having all parts still in place but the other one with only renal fragment left in place [Figure 2]. There were two cases with stent migration, with one migrating upward and the other one migrating downward [Figures 3 and 4].

The case with the longest stent indwelling time (83 months) was admitted to the hospital in August 2019 for right lower back discomfort for 1 week. Subsequently, a left renal mass, right multiple nephrolithiases with hydronephrosis, and retained bilateral stents were found by CT scan. The patient recalled that bilateral URL and extracorporeal shockwave lithotripsy (ESWL) were performed 7 years ago for bilateral ureteral calculi. For some reason, she did not return postoperatively to get the stents removed. Fortunately, the stents remained intact and were pulled out smoothly under cystoscopy. There was only a small amount of encrustation noted on the stents. Of note, the patient recalled that she did not have chronic kidney disease (CKD) 7 years ago but most recent evaluation showed that she has Stage 3 CKD. The patient then underwent transabdominal laparoscopic left partial nephrectomy in August 2019, followed by right PCNL with bilateral holmium laser ureteroscopic polypectomy in the reclining position 1 month after. Final pathology diagnoses included left renal lower pole papillary renal cell carcinoma (Grade 1), left kidney atrophy, and bilateral ureteral inflammatory polyps [Figure 5].

All the forgotten stents were removed completely. There were no complications. The treatment procedure, main stone component, site of encrustation, and condition of the stent were shown in Table 2. The stone composition analysis was performed in five cases, and the main components of the encrustation included trioxypurine and carbapatite, with three cases and two cases, respectively.

Figure 1: Plain-film radiography of the kidney, ureter, and bladder shows a retained stent with both ends encrusted predominantly

Table 1: Patient characteristics, initial indications for, indwelling, and infection

Number	Age/sex	Initial Indications for stenting	Indwelling time (months)	Infection		Profession
				Before stenting	After stenting	
1	27/male	Left URS	12	+	+	Farmer
2	60/male	Left PCNL	24	–	+	Farmer
3	72/male	Left ESWL	13	+	+	Farmer
4	57/male	Bilateral PCNL	36	–	–	Farmer
5	25/female	Right URS	24	+	+	Farmer
6	56/female	Right PCNL	21	Unknown	+	Farmer
7	56/male	Left URL	50	Unknown	–	Farmer
8	54/female	Bilateral URS/ESWL	83	–	+	Farmer

+: Infection; -: No infection, URL: Ureterorenoscopic lithotripsy, ESWL: Extracorporeal shock wave lithotripsy, PCNL: Percutaneous nephrolithotomy, URS: Ureteroscopy

Figure 2: Kidney, ureter, and bladder show a fragmented stent in the left kidney. The stent had disintegrated and broken, part of it had been discharged from the body

Figure 3: Stent migration, with the lower coil being left inside ureter more than 13 months

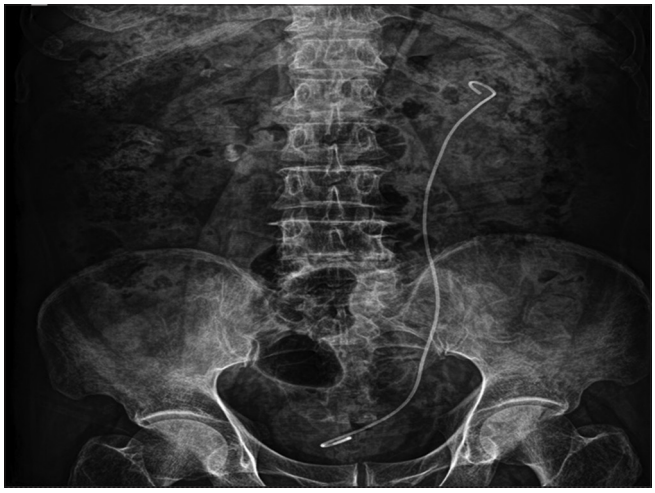

Figure 4: The stent remained intact after migrating toward the bladder

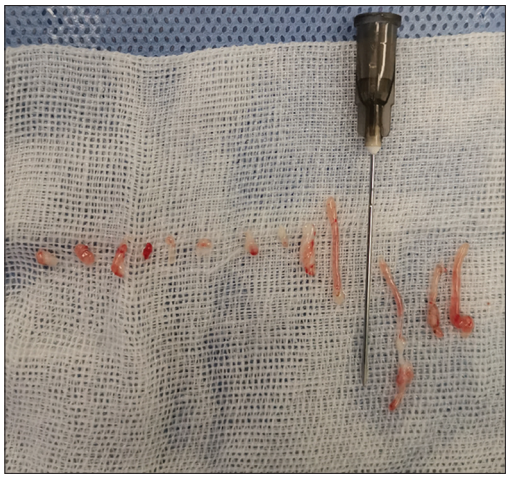

Figure 5: Multiple polyps inside the left ureter were removed by holmium laser polypectomy

DISCUSSION

It is common that a ureteral stent was overlooked or forgotten to be extracted. The common reasons for retention of the forgotten stent included poor compliance of the patient and the failure of the treating surgeon to counsel the patient sufficiently. Complicated urinary tract calculi could develop from the retained stent, commonly on the renal coil and the vesical coil, as well as other complications.[6]

UTI is a common complication of the forgotten stent. The stent, left *in situ*, could provide a surface for bacterial

Table 2: Procedure, main calculus component, site of encrustation, and condition of the stent

Number	Procedure	Main calculus components	Site of encrustation			Condition of the stent
			Kidney	Ureter	Bladder	
1	CLT, URL, and PCNL	Unknown	+	+	+	Intact
2	URL and PCNL	Unknown	+	−	−	Fragmented
3	URL	Trioxypurine	−	+	−	Intact
4	URL	Trioxypurine	−	+	−	Intact
5	URL	Carbapatite	+	+	−	Intact
6	CLT, URL, and PCNL	Carbapatite	+	+	+	Fragmented
7	URL and PCNL	Trioxypurine	+	+	+	Intact
8	PCNL and bilateral URS	Unknown	+	−	+	Intact

+: Infection; -: No infection, URL: Ureterorenoscopic lithotripsy, PCNL: Percutaneous nephrolithotomy, CLT: Cystolithotripsy, URS: Ureteroscopy

colonization and increase the risk of UTIs. The risk of bacteriuria and colonization of the J stent tip is significantly enhanced by the duration of stent retention, and the systemic disease, such as diabetes mellitus, chronic renal failure, and diabetic nephropathy.[7] In the present study, UTI occurred in four cases before the stent removal. The indwelled time for all 4 cases was longer than 12 months.

Encrustation is a well-established complication of retained biomaterials in the urinary tract. Damiano *et al*.[8] evaluated 143 stents and noted an encrustation rate of 21.6%. The etiology of encrustation is not completely clear. Risk factors include UTI, prolonged stenting time, and certain types of material of the stent. Once the UTI happened, organic components in the urine would crystallize out onto the surface of the biomaterial, which finally results in encrustation. Meanwhile, the urease produced by the adhered bacteria hydrolyze the urea to ammonia that will elevate urinary pH, promote the precipitation of magnesium and calcium to struvite and hydroxylapatite.[9,10] The indwelling time is a major factor of the degree of encrustation. One study showed that the encrustation rate increased from 9.2% at <6 weeks to 47.5% at 6 to 12 weeks to 76.3% at >12 weeks of indwelling time.[11] In another study, Damiano *et al*.[8] reported that when the stent was kept *in situ* for more than 3 weeks, it was associated with increased frequency of encrustating calculus formation and obstruction of the stent. The silicone was found to be least prone to fragmentation and encrustation.[12] In the current study, the stenting time was longer than 12 months in all cases, and varying degrees of encrustation happened in all the cases. As shown in Figure 1, the encrustation happened in both upper and lower coils of the stent, looked like a barbell. Compared with the stent body, the upper and lower coils of the stent were clung by larger encrustation. Bladder is a half open organ with high compliance, and urine storage and elimination are the major functions of the bladder. Kidney is also an important organ of the human body with a major function of excretion. In brief, to filter the formation of urinary and metabolic waste discharges, and to regulate electrolyte and acid-base balance *in vivo*. The function of ureter is to introduce urine into the bladder. Given the fact that the upper and lower coils of the stent are usually soaked in urine, it might be more likely to lead to crystallization onto the surface of the coils.

Stent migration, another serious complication of the forgotten stent, occurred in two patients in our study. As what we can see from Figure 3, the distal end of stent had moved to the central section of the ureter. Even with an appropriately positioned stent, stent migration is common, especially the distal end. In one study, stent migration was found in 9.5% of the patient.[8] In another study, Ringel *et al*.[13] observed that the stent migration rate was 8.2% of all cases. Multiple factors could play a role in accelerating stent migration within the urinary tract, including stent length, and material. 4.8 Fr silicone stents were found to have an increased distal migration rate compared with 6 Fr polyurethane stents.[14-16] The renal movement with respiration and longer stent indwelling time can accelerate the occurrence of migration. For the migrated stent without much encrustation, URL is usually sufficient to remove the stent. For a complicated case like what have shown in Figure 3, PCNL is often required.

Fragmentation is another significant complication of the forgotten stents. This may be due to loss of tensile strength the stent, which leads to hardening and degeneration of the stent polymers.[17] The type of material could also be a risk factor of fragmentation of the stent.[12] In our current study, the stent indwelling time for the two cases with fragmentation were only 21 and 24 months, respectively, while there was no fragmentation for the other three cases with stent indwelling time ranging from 36 to 83 months. When it is placed in the urinary tract, the deformation of the stent starts to occur. The accumulation of the deformation may lead to an increase in the yield strength of the material and a subsequent decrease in ductility, which finally leads to stent fracture and further fragmentation.[18] Some fragments could be discharged spontaneously. PCNL or a combined endoscopic approach is often required for the residual or all fragments.[19-21]

The forgotten stents can be a tremendous problem for surgeons because of their encrustation, migration, and fragmentation. The method of access and treatment depends on the site of encrustation, associated stone burden [Table 2]. The findings on KUB usually dictate our approach toward the management of these stents. ESWL, URL, and PCNL have been reported for forgotten ureteral stent management, but there are no guidelines for it. ESWL was first reported for treating of calcified stents in 1990.[22] Before attempting stent removal, the use of ESWL can achieve a good therapeutic effect for treating low-volume encrustations. However, ESWL was not used in our series, because of the extensive stone burden in majority of cases. The URL with the help of pneumatic lithotripter on stents could be carried out on stents with minimal encrustation and those with lower coil encrustation.[23] As demonstrated in three cases of our study, the stents with minimal encrustation on body and lower coil were removed by URL. It is common that multiple endourological approaches are needed because of significant encrustations and stone burden that may involve bladder, ureter, and kidney. Moreover, for some complicated cases, multiple endoscopic treatment sessions are needed to remove the encrusted stents. In rare occasion, open surgery to remove the encrusted or fragmented stent is needed. Combined endoscopic procedures were performed in five cases of our study, with CLT, URL, and PCNL included. PCNL and URL are essential to treat a severely encrusted forgotten stent with significant stone burden. Using the above-mentioned approaches, all the forgotten stents were successfully removed.

In a study by Murtaza and Alvi,[24] forgotten ureteral stents had clinical presentations ranging from recurrent UTI to end-stage renal disease (ESRD). In their serial of 38 patients, seven patients (18.4%) reported with CKD, including ESRD in two cases. Chronic renal failure caused by encrusted stents in a functionally solitary kidney could be a disastrous complication of forgotten stents.[25] We found CKD in one of the eight patients with a forgotten stent for 7 years. In the same patient, significant bilateral ureteral polyps and one side renal cell carcinoma were found. The ureteral polyps could well be complicated from the forgotten stents,[26] and the majority of the polyps could be managed by endoscopic approach successfully.[26,27] It is unclear whether the renal cell carcinoma was caused by the long-time indwelling of the stent. We have not seen related literature report so far.

The occurrence of the forgotten stents was primarily due to the unawareness or ignorance of the patients and their relatives regarding the stent. In the study by Murtaza and Alvi,[24] majority of patients (n = 23, 60.5%) were not even aware of the placement of these stents while 8 (21.0%) knew but were reluctant about its removal. In 3 cases (7.8%), the relatives knew about the stent but never informed the patients. One case (2.6%) each had a misconception about the permanent placement of the stents such as cardiac stents and regarding degradation of the stents *in situ*. In our study, all eight patients were having relatively lower education and financial ability, which could play a significant role in the cause of the forgotten stents. Nevertheless, forgotten stents are preventable, and several measures including an autoregistration monitoring system,[28] a mobile social networking service application,[29] and a smartphone-based stent tracking application[30] have been reported recently being successful.

CONCLUSION

Forgotten stents can lead to complicated urinary tract calculi, stent encrustation, UTI, vesicoureteric reflux, ureteral polyps, and renal insufficiency. The external stimulus, stent indwelling time, and the type of stent material all could be a risk factor. Various endoscopic technique combinations can be used to manage the forgotten encrusted ureteral stents. There are encouraging and innovative measures being reported to prevent the forgotten stents.

Financial support and sponsorship
Nil.

Conflicts of interest
There are no conflicts of interest.

REFERENCES

1. Zimskind PD, Fetter TR, Wilkerson JL. Clinical use of long-term indwelling silicone rubber ureteral splints inserted cystoscopically. J Urol 1967;97:840-4.
2. Saltzman B. Ureteral stents. Indications, variations, and complications. Urol Clin North Am 1988;15:481-91.
3. Chew BH, Knudsen BE, Denstedt JD. The use of stents in contemporary urology. Curr Opin Urol 2004;14:111-5.
4. Gogas J, Markopoulos C, Kouskos E, Gogas H, Kiriakou V. Metastatic retroperitoneal and mediastinal fibrosis as first sign of recurrence of breast cancer. Eur J Surg 2001;167:715-8.
5. El Khader K. Complications of double J ureteral stents. J Urol (Paris) 1996;102:173-5.
6. Singh V, Srinivastava A, Kapoor R, Kumar A. Can the complicated forgotten indwelling ureteric stents be lethal? Int Urol Nephrol 2005;37:541-6.
7. Kehinde EO, Rotimi VO, Al-Awadi KA, Abdul-Halim H, Boland F, Al-Hunayan AA, *et al*. Factors predisposing to urinary tract infection after J ureteral stent insertion. J Urol 2002;167:1334-7.
8. Damiano R, Oliva A, Esposito C, De Sio M, Autorino R, D'Armiento M. Early and late complications of double pigtail ureteral stent. Urol Int 2002;69:136-40.

9. Robert M, Boularan AM, El Sandid M, Grasset D. Double-J ureteric stent encrustations: Clinical study on crystal formation on polyurethane stents. Urol Int 1997;58:100-4.
10. Wollin TA, Tieszer C, Riddell JV, Denstedt JD, Reid G. Bacterial biofilm formation, encrustation and antibiotic adsorption to ureteral stents indwelling in humans. J Endourol 1988;12:101-11.
11. El-Faqih SR, Shamsuddin AB, Chakrabarti A, Atassi R, Kardar AH, Osman MK, *et al*. Polyurethane internal ureteral stents in treatment of stone patients: Morbidity related to indwelling times. J Urol 1991;146:1487-91.
12. Tunney MM, Keane PF, Jones DS, Gorman SP. Comparative assessment of ureteral stent biomaterial encrustation. Biomaterials 1996;17:1541-6.
13. Ringel A, Richter S, Shalev M, Nissenkorn I. Late complications of ureteral stents. Eur Urol 2000;38:41-4.
14. Damiano R, Autorino R, De Sio M, Cantiello F, Quarto G, Perdonà S, *et al*. Does the size of ureteral stent impact urinary symptoms and quality of life? A prospective randomized study. Eur Urol 2005;48:673-8.
15. Erturk E, Sessions A, Joseph JV. Impact of ureteral stent diameter on symptoms and tolerability. J Endourol 2003;17:59-62.
16. Gadzhiev N, Gorelov D, Malkhasyan V, Akopyan G, Harchelava R, Mazurenko D, *et al*. Comparison of silicone versus polyurethane ureteral stents: A prospective controlled study. BMC Urol 2020;20:10.
17. Zisman A, Siegel YI, Siegmann A, Lindner A. Spontaneous ureteral stent fragmentation. J Urol 1995;153:718-21.
18. Hajdinjak T, Patel M, Papatsoris A, Masood J, Buchholz N, Birch M. *In vitro* simulation of stent fracture mechanisms in ureteric nitinol wire stents. Urol Res 2008;36:241-5.
19. Kandemir A, Sönmez MG. Treatment of fragmented and severely encrusted ureteral double-J stent forgotten for 11 years through multimodal endourological methods. Urol Ann 2019;11:310-3.
20. Farshid S, Sharifi-Aghdas F, Varyani M. Fragmented ureteral stent extraction by antegrade and retrograde access: using ureteroscope and nephroscope. Urol Case Rep 2019;24:100871.
21. Mahmood SN, Toffeq HM, Hussen M, Karim A, Jamal C, Said AA, *et al*. Endourologic management of a 15-year-old neglected, fragmented, and encrusted ureteral stent. J Endourol Case Rep 2018;4:201-4.
22. Flan T, Broshard M, Zerbib M, Debre B, Sleg A. Extra corporal shock wave lithotripsy to remove calcified Ureteral stents. Urology 1991;26:2.
23. Kawahara T, Ishida H, Kubota Y, Matsuzaki J. Ureteroscopic removal of forgotten ureteral stent. BMJ Case Rep 2012 Jun 14;2012:bcr0220125736. doi: 10.1136/bcr.02.2012.5736.
24. Murtaza B, Alvi S. Forgotten ureteral stents: An avoidable morbidity. J Coll Physicians Surg Pak 2016;26:208-12.
25. Aron M, Ansari MS, Singh I, Gautam G, Kolla SB, Seth A, *et al*. Forgotten ureteral stents causing renal failure: Multimodal endourologic treatment. J Endourol 2006;20:423-8.
26. Childs MA, Umbreit EC, Krambeck AE, Sebo TJ, Patterson DE, Gettman MT. Fibroepithelial polyps of the ureter: A single-institutional experience. J Endourol 2009;23:1415-9.
27. Sheng L, Zhang ZY, Qian WQ, Zhang HJ, Sun ZQ. Treatment of ureteral fibroepithelial polyp by ureteroscopy combined with holmium laser or thulium laser: A retrospective study. Photomed Laser Surg 2016;34:456-9.
28. Lin KJ, Chen PC, Fan YH, Huang WJ. Preventing forgotten double J ureteral stents in a high-volume service medical center: An autoregistration monitoring system. J Chin Med Assoc 2020;83:382-5.
29. Wang Y, Xu M, Li W, Mao Y, Da J, Wang Z. It is efficient to monitor the status of implanted ureteral stent using a mobile social networking service application. Urolithiasis 2020;48:79-84.
30. Ulker V, Atalay HA, Cakmak O, Yucel C, Celik O, Kozacioglu Z. Smartphone-based stent tracking application for prevention of forgotten ureteral double-J stents: A prospective study. Int Braz J Urol 2019;45:376-83.