Urol Res (2012) 40:317–325
DOI 10.1007/s00240-011-0409-3

ORIGINAL PAPER

Treatment of forgotten ureteral stents: how much does it really cost? A cost-effectiveness study in 27 patients

Ahmet Ali Sancaktutar · Haluk Söylemez · Yasar Bozkurt · Necmettin Penbegül · Murat Atar

Received: 23 April 2011 / Accepted: 25 July 2011 / Published online: 11 August 2011

Abstract Aim of study was to present costs of forgotten ureteral stents extraction so as to distract attentions of the urologists on this issue. Medical files of 27 accessible patients who referred to our clinics between 2001 and 2010 because of forgotten ureteral stent were retrospectively analyzed. The indwelling time of double-j stents (DJS) was calculated from the time of its insertion. Costs related to radiological investigations, all invasive, and noninvasive interventions, duration of hospital stay, and medical treatments used were calculated. These estimations were based on 2010 prices determined by Turkey Ministry of Health. Mean age of the patients was 31.2 (8–86 years) years. Mean indwelling time of ureteral DJSs was 36.7 months (14–84 months). Seventy-one [extracorporeal shock wave lithotripsy (ESWL), $n = 26$; invasive/noninvasive interventions, $n = 32$] procedures were applied for 27 patients. In six patients without incrustation, after a single session of ESWL DJSs could be removed cystoscopically. A various combination of a multimodal therapy was used for other 21 patients. Total financial burden of 27 patients was US $ 34,300. Cost of treatment was estimated to be 6.9-fold (1.8- to 21-fold) higher than an average timely stent extraction. Financial burden of the treatments increased in parallel with the duration of the stent retention ($p = 0.001$). Management of forgotten DJS is time consuming, difficult, complicated, risky, and costly. Therefore; financial burden, increased labour loss, and impaired quality of life brought by the application of these modalities must not be forgotten.

A. A. Sancaktutar (✉) · H. Söylemez · Y. Bozkurt · N. Penbegül · M. Atar
Department of Urology, University of Dicle, Diyarbakır, Turkey
e-mail: aasancaktutar@gmail.com

Keywords Forgotten ureteral stent · Lithiasis · Management · Cost affectivity

Abbreviations

DJS	Double-J stents
FUSs	Forgotten double-J stents
KÜB	Kidney üreter bladder graphy
US	Urinary ultrasound
ESWL	Extracorporeal shock wave lithotripsy
SCSR	Simple cystoscopic stent retrieval
EnCL	Endoscopic cystolithotripsy
Pccl	Percutaneous cystolithotripsy
URS	Ureteroscopy
URS-SE	Urteroscopic-stone extraction
PCNL	Percutaneous nephrolithotomy
PcN	Percutaneous nephrostomies

Introduction

Double-J stents (DJS) are more frequently preferred in the urological practice due to the extended indications of usage. Occasionally, DJSs can be left dwelling in situ for long periods of time because of negligence of the patient and/or the physician [1]. Despite all meticulous vigilance, even in many special situations such as in transplanted kidneys [2], solitary kidneys [3], and after neobladder [4] and cystectomy surgery [5], cases of forgotten double-J stents (FUSs) have been reported in the literature. The morbidity, and mortality of the extraction method applied varies with the indwelling time of the stent, and the degree of incrustation. Thus, various management options ranging widely from a simple cystoscopic intervention to open surgery have been required [6–8].

Although many trials related to FUSs have been found in the literature [9–11] to our knowledge, any study emphasizing the cost of delayed removal of FUSs has not been cited in the medical literature in English language.

In this study we aimed to use many management options within the frame of an algorithm, and present costs of stent extraction so as to distract the attentions of the urologists on this issue.

Materials and methods

Medical files of 33 accessible patients (male $n = 15$, female $n = 18$) who referred to our clinics between January 2001 and July 2010 because of FUS were retrospectively analyzed, and six patients whose stents retained less than 12 months were excluded from the study. A total of 27 patients included in the study. Based on the information derived from their medical files the rationale for placement of DJS was revealed, and the reasons for neglected timely six DJS removal was determined. The indwelling time of DJS was calculated from the time of its insertion.

All patients excluding a pregnant woman were evaluated using kidney üreter bladder graphy (KÜB), urinary ultrasound (US), intravenous pyelography or computerized tomography. Based on radiographic findings, renal scanning with 99 mTc diethylenetriamine pentaacetate was performed for patients with presumptive renal parenchymal damage. On admission, routine biochemical examinations, urinalysis, and urine cultures were performed. For infectious cases, prior to intervention, appropriate antibotherapy was instituted to disinfect the urinary tract. First, noninvasive alternatives were instituted. As a first step Extracorporeal Shock Wave Lithotripsy (ESWL) was performed, and then successively according to medical necessity, simple cystoscopic stent retrieval (SCSR), endoscopic cystolithotripsy (EnCL) or percutaneous cystolithotripsy (PcCL), ureteroscopy (URS), urteroscopic-stone extraction (URS-SE), percutaneous nephrolithotomy (PCNL) and percutaneous nephrostomies (PcN) were employed. In cases where these interventions were inconclusive, open surgery was planned. Extracted DJSs were evaluated macroscopically. During the postoperative period, the patients were assessed using urinary US, and KÜB. Costs related to radiological investigations, all invasive and noninvasive interventions with anasthetic costs**,** duration of hospital stay and medical treatments used were calculated. These estimations were based on 2010 prices determined by Turkey Ministry of Health. Prices converted Turkish Liras into American Dollars (US $) while this manuscript was written according to exchange rate. (1 American Dollar = 1.52 Turkish Liras).

In our country, prices of various urological procedures to apply for the treatment of FUS are shown in Table 1.

Table 1 Prices of various urological procedures to applied for treatment of FUS

Unit cost for Turkey ministry of health treatment ın the year 2010 (US dollars)		
1	ESWL	150
2	SCSR	190
4	PnC	600
5	EnCL	600
6	URS-SE	700
7	Nephrolithotomy (open surgery)	1,000
8	PCNL	2,000
9	Ureterolithotomy	600
10	Percutaneous nephrostomy	300
11	Daily hospitalisation costs	50

Treatment costs estimated individually for each patient were compared with the expenses related to simple cystoscopic stent removal (SCSR). Besides, treatment costs of the patients were compared with additional costs incurred by extra retention times of stents because of negligence of the patients and/or the attending physician.

Results

Mean age of the patients was 31.2 (8–86 years) years. Mean indwelling time of ureteral DJSs was 36.5 months (14–120 months).

DJSs of 17 patients were placed following endoscopic intervention, and in 22 patients stents were inserted after open surgery. Stents were inserted because of urolithiasis ($n = 22$), instillation of oncologic disorders ($n = 3$), and reconstructive urological interventions ($n = 2$).

All patients referred because of FUSs were hospitalized. Various degree of obstruction were found in all patients (Grade I hydronephrosis in eight patients, Grade II in five and Grade III in 14). Appropriate administration of fluid-electrolyte supplements, and parenteral antibiotherapy were initiated. Apart from one pregnant patient, all patients received a single session of ESWL aimed at kinked segments of DJSs under prophylactic antibiotherapy. Seventeen patients had negative urine cultures. Ten patients's urine cultures showed different microorganisms. Findings of urine cultures and antibiotics used is displayed in Table 2.

Seventy-one (ESWL, $n = 26$; invasive/noninvasive interventions, $n = 32$) procedures were applied for 27 patients. For each patient an average of 2.6 interventions were performed.

DJSs could be removed cystoscopically after a single session of ESWL in six patients with no incrustation as detected in KÜB. For other 21 patients, URS-SE ($n = 12$

Table 2 Findings of urine cultures and antibiotics used

Urine cultures	Numbers of patients	Sensitive antibiotics
Negative urine culture	17	Cefazolin
Escherichia coli	3	Ciprofloxacin/ceftriaxone/ trimetoprim + sulfametoksazol
Klebsiella supp	2	Ceftriakson/ciprofloxacin
Pseudomonas aeruginosa	2	Piperacillin tazobactam/ceftriakson
Candida albicans	1	Ketoconazole
Proteus mirabilis	1	Ceftriaxsone
Enterococcus supp	1	Ciprofloxacin

patients), EnCL for incrustated intravesical segment of the DJS ($n = 8$), PnCL ($n = 2$), nephropyelolitotomy ($n = 1$), PcN ($n = 1$) were used in single or in various combination as a multimodal therapy. At the end of these procedures, DJSs were removed successfully in all eight patients (29.6%) required retrial of DJS extraction.

In none of the patients early stage intraoperative and postoperative complications developed. Twenty-six patients (100%) were relieved of their stents/stones with multimodal therapy except one patient who did not accept the further treatment. We only performed percutaneous nephrostomy to him. Mean hospital stay was 5.5 days (1–23 days).

Total financial burden of 27 patients was US $ 34,300. Accordingly average treatment cost for each patient was calculated as US $ 1,225 (US $330–3,800). Cost of treatment was estimated to be 6.9-fold (1.8- to 21-fold) higher than an average timely stent extraction.

Information concerning the age, indications of DJS implantation, and reasons for delay in removal of the stent, indwelling time of the stent, interventions required for the removal of DJSs or their incrusted segments, hospital stay, need for reimplantation of the stent, and costs of the treatments were shown in Table 3.

The indwelling time of FUSs and extra cost of their extraction were compared with those of timely stent retrievals. Financial burden of the treatments increased in parallel with the duration of the stent retention (Fig. 1 and Table 4). Positive correlation was found when Pearson correlate of analysis bivariate. The in between difference was statistically significant ($p = 0.000$ and $R = 0.689$). For example; the estimated treatment cost of 13-month stent retention was 1.8-fold, higher than timely stent extraction, while for a 10 year indwelling time it increased 21-fold.

We were very attentive during DJS extraction procedures. Apart from a pregnant patient, we removed DJSs under the guidance of fluoroscopy, and also the segment where DJS was stuck was determined preoperatively. Pneumatic or laser lithotripsy was used for incrusted segment of DJS. Stents were released in compliance with strict extraction principles. We closely scrutinized the removed stents for their integrity. We attributed widespread usage of these modalities (varying from minimal invasive procedures to open surgery) to complicated and selective nature of these presented case reports. Some of the figures of special cases were shown in Figs. 2, 3, 4, 5. Our approach towards management and treatment of these difficult cases is based on an algorithm (Fig. 6).

For six patients without any evidence of incrustation in KÜB, FUSs were extracted under local anesthesia. PCNL, and open nephropyelotomy were performed under general anesthesia. For remaining patients spinal anesthesia was used.

Discussion

Associated with extended indications of DJSs, related complications also increased. One of these complications is the retention of the stent beyond the estimated indwelling time because of the negligence and/or oversight of the attending physician and/or the patient [12]. This fault is the result of disruption of patient–physician rapport or compliance. In our series eight patients had blamed them for this neglect, 19 patients indicated that they were unaware of ureteral DJS implantation or incognizant of the necessity of its removal. These results might herald the potential cases of litigation between the patients and their physicians, owing to day-to-day increase in patient's awareness.

The definition forgotten ureteral stent "FUS" has been used for stents forgotten inside the body for at least 12 months. Based on this definition, we excluded six cases of retained DJSs which were "forgotten" for less than 12 months [12].

Although many reminders have been cited in the literature so as to remember due retrieval times of DJSs, this issue still remains partially unsolved. A number of approaches have been proposed to resolve this healthcare problem, but none have resolved this issue completely [13–15]. Previously proposed approaches have monitored patients with implanted ureteral stents using file records or computer databases [13–15]. In the most recently proposed system, the patients were monitored with a relevant program that reminded the staff of the due date of the stent removal via e-mails in case the date was forgotten [15]. Thomas et al. used ureteric stent logbooks to monitor

Table 3 General information of the FUSs patients

N	Age/ sex	Duration of FUS (month)	Responsible for FUS doctor/patient	Degree of encrustation	Treatment for the removal of stent	Hospital period (day)	Cost account (dollar)
1	12/M	36	Doctor	*	ESWL URS-SE	2	1,050
2	24/M	28	Doctor	***	ESWL PcCL	5	1,000
3	34/F	120	Patient	****	ESWL EnCL URS-SE Open surgery	11	3,200
4	39/M	15	Doctor	**	ESWL URS-SE	2	1,000
5	76/M	18	Patient	**	ESWL SCSR	1	330
6	48/F	20	Doctor	**	ESWL EnCL	7	850
7	39/M	24	Patient	***	ESWL EnCL	2	900
8	27/F	36	Patient	***	ESWL PCNL	8	2,400
9	49/M	40	Doctor	*	ESWL PCNL	5	2,400
10	45/E	48	Doctor	**	ESWL SCSR	1	330
11	72/M	36	Doctor	**	ESWL URS-SE ReURS-SE	1	1,100
12	44/F	32	Doctor	**	ESWL URS-SE	2	1,100
13	86/M	96	Doctor	**	ESWL Percutaneous nephrostomy	23	2,500
14	18/F	18	Patient	*	ESWL SCSR	1	370
15	18/M	28	Patient	**	ESWL EnCL	3	800
16	21/M	36	Doctor	***	ESWL PcCL	3	1,000
17	60/F	48	Doctor	***	ESWL URS-SE Re-URS	14	1,800
18	41/M	36	Patient	**	ESWL SCSR	3	370
19	62/F	14	Patient	**	ESWL URS-SE	4	1,100
20	64/M	16	Patient	**	ESWL URS-SE	2	900
21	27/F	20	Doctor	* (Pregnancy)	URS-SE	7	1,150
22	8/F	15	Doctor	*	ESWL SCSR	13	1,150

Table 3 continued

N	Age/ sex	Duration of FUS (month)	Responsible for FUS doctor/patient	Degree of encrustation	Treatment for the removal of stent	Hospital period (day)	Cost account (dollar)
23	33/M	27	Doctor	**	ESWL EnCL	6	900
24	74/M	72	Doctor	***	ESWL EnCL URS-SE	8	1,800
25	17/F	72	Doctor	***	ESWL EnCL URS-SE	6	1,500
26	52/M	14	Doctor	*	ESWL SCSR	1	370
27	66/M	22	Doctor	**	ESWL EnCL URS-SE	6	2,100
Total/average		987/36.5				147/5.5	34,300/1270

*Light, **medium, ***severe, ****very severe encrustation

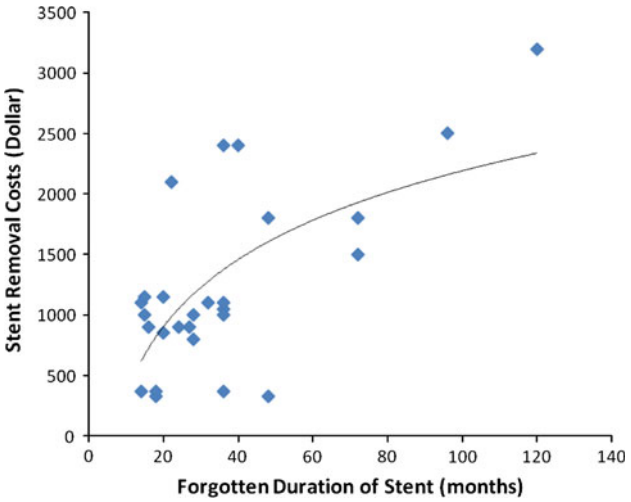

Fig. 1 Financial burden of the treatments increased in parallel with the duratin of the stent retention

Table 4 Pearson Correlate analyze bivariote

	Month	Dollar
Month		
Pearson correlation	1	0.689 (**)
Sig. (2-tailed)		0.000
N	27	27
Dollar		
Pearson correlation	0.689 (**)	1
Sig. (2-tailed)	0.000	
N	27	27

**Correlation is significant at the 0.01 level (2-tailed)

patients with stent implants. However, recognizing the inadequacy of this system, the authors recommended using a new system that included a patient education leaflet and a stent removal date that was planned prior to his/her discharge from the hospital [16]. Tang et al. retrospectively analyzed patients who had received stents within the previous 5 years and emphasized that their specific stent card tracking systems were ineffective during monitoring because of infrequent revisions and difficulties in updating the system [17]. In the system used by Ather et al. the staff enters information concerning the patients with implanted DJS into computerized files in the operating theater [14]. A urology team is then designated to check the computer reports on a weekly basis to identify the patients whose stents will be overdue in the following 2 weeks. The patients were then contacted by letter or phone. In our clinics, we started to send reminder short messages with cell phones to every patient with an implanted stent, and his/her physician who inserted the stent [18]. We believe that from the legal perspective, these short messages might protect physicins from relevant litigations in problematic cases.

The thickness of incrustations on DJSs is closely related to the extra indwelling time of the stent. The earliest incrustations on DJSs begin to appear 6 months after the implantation. Most of these incrustations occur after postprocedural 12 months [6]. In our study in five out of six patients without any evidence of incrustations in KÜB, the implanted stents were forgotten for less than 18 months. The most severe form of incrustation was encountered in one patient whose stent was negligibly retained for 10 years.

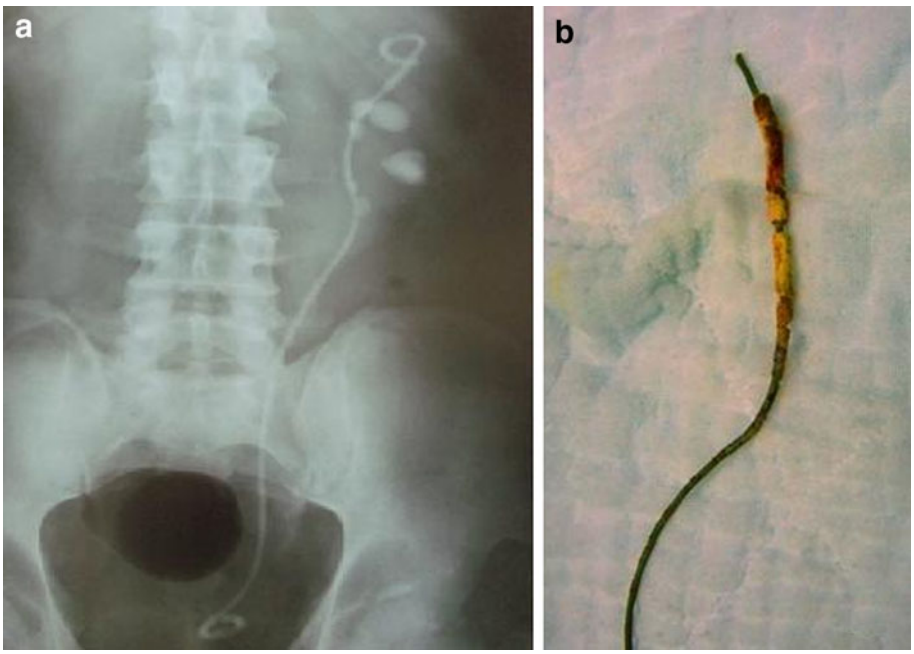

Fig. 2 **a** Preoperative apperance of a 48 months forgotten stent and **b** it was removal with open surgery

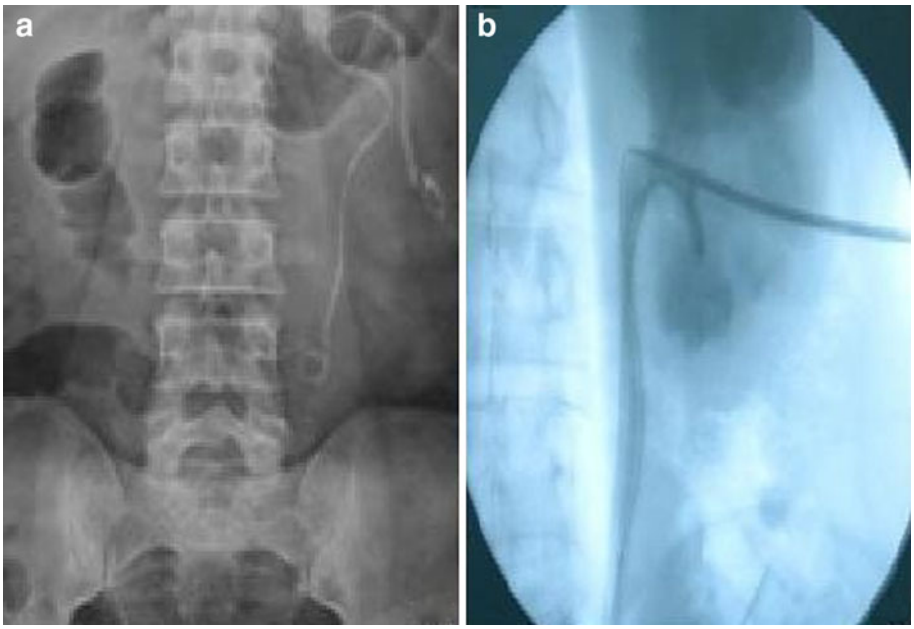

Fig. 3 **a** Preoperative appearance of a 36 months forgotten and migratted stent. **b** A succesfully percutaneous procedure was done to remove it

Broken DJSs are frequently encountered complications. DJSs usuallly start to break after 20 months [19]. We detected broken stents in three patients. The broken piece of the stent was removed using PCNL ($n = 1$) or URS ($n = 2$).

Incrustation on DJSs usually occurs on spiral ends of intravesical, and intrarenal segments of the stent. This phenomenon has been explained by intensive exposure of these segments of the stent to residual urine [20]. In accordance with the literature, we observed very intense incrustations on intravesical ($n = 4$), intrarenal ($n = 3$), and intraurethral ($n = 1$) segments of the stents.

Management alternatives in FUS vary according to the severity, and location of incrustation [6–12, 18–21]. FUS can be removed by simple cystoscopic procedures if there is no evidence of encrustation. In cases with mild and moderately incrusted stents, ESWL [22], URS [11], and traction [21] are preferred. However in severe incrustations, management modalities are more complex. Many investigators have employed ESWL, URS-SE, laser-lithotripsy, PCNL, chemolysis through a percutaneous nephrostomy tube using various chemolytic agents, and open surgery either alone or in varying combinations [9, 11, 23]. With widespread usage of endoscopic instruments, a tendency to use relatively

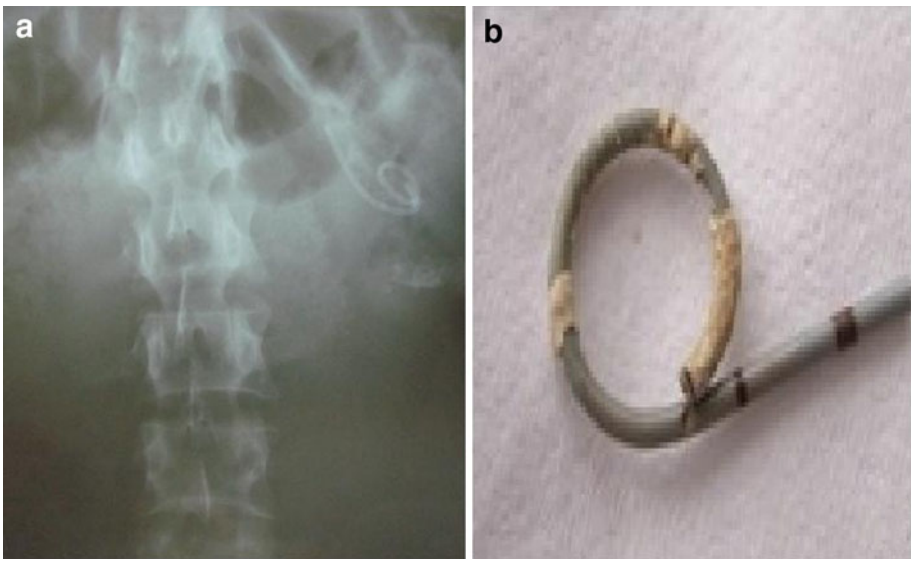

Fig. 4 **a** A 48 months forgotten stent was broken during retrieval. **b** Postoperative appearance of broken stent

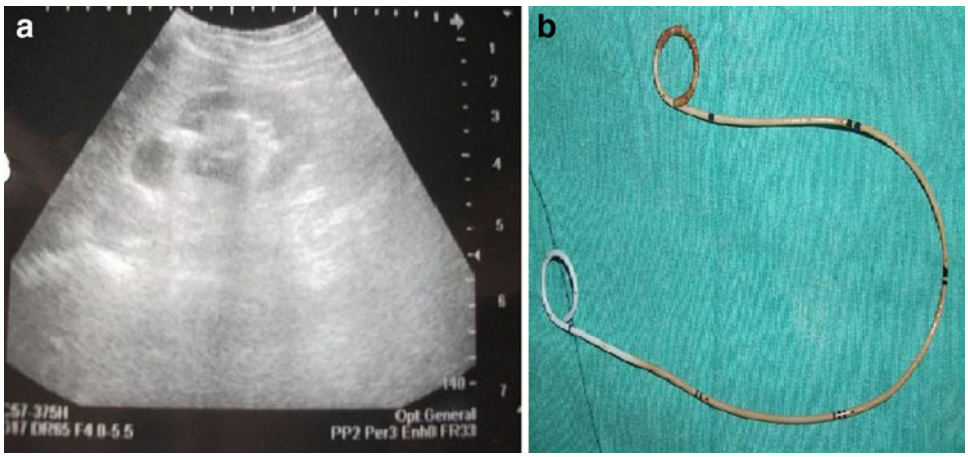

Fig. 5 **a** Ultrasonografic appearance of a 20 months forgotten stent in a pregnanat woman. **b** Stent was removed at 21-week of pregnancy

noninvasive interventions has been observed. However, in the literature frequent usage of multimodal treatment principles is remarkable [11, 12, 18, 24]. Especially in the presence of incrusted intrarenal segment of DJS, use of PCNL or open procedures has been frequently reported [25]. We attributed widespread usage of these modalities to complicated and selective nature of these presented case reports. We retrieved six stents without the evidence of encrustations according to KÜB after one session ESWL. However, USG showed hydronephrosis in the kidney at the stent side in these patients. The cause of hydronephrosis was thought to be micro-encrustation surrounding the stent which obstructed the urinary tract. Thus, ESWL was performed.

Timely extraction of DJS is performed under local anesthesia excluding children [26]. These patients are normally monitored on an out-patient basis. Whereas, management of FUSs is usually accomplished under recurrent anesthetic procedures that may increase rates of morbidity, and prolong hospital stay. For instance our 86 year-old male patient was referred to us with manifestations of septicemia caused by FUS. Since nephrostomic intervention improved clinical status of the patient, we refrained from extraction of DJS which deemed to be a risky procedure. On the postoperative 23 day the patient was discharged upon his request.

PcCL which is very popular in the management of primary bladder stones can be used for the retrieval of incrusted DJSs We also used percutaneous cystolithotripsy in two male patients with DJSs incrusted at their lower ends [26]. With this approach, calcified intravesical segment of DJS was fragmented, and removed percutaneously using pneumatic lithotriptor without recurrent transurethral interventions.

In clinical studies performed, 8–12 months after placement of DJS, incrustations began to form inside lumens, and on the external surfaces of the stents [6, 27]. Under the light of this information, we routinely used ESWL even in cases without any apparent incrustation as detected in KÜB, to relieve potential stent-mucosa adhesions, and avoid mucosal damage during the extraction of the stent.

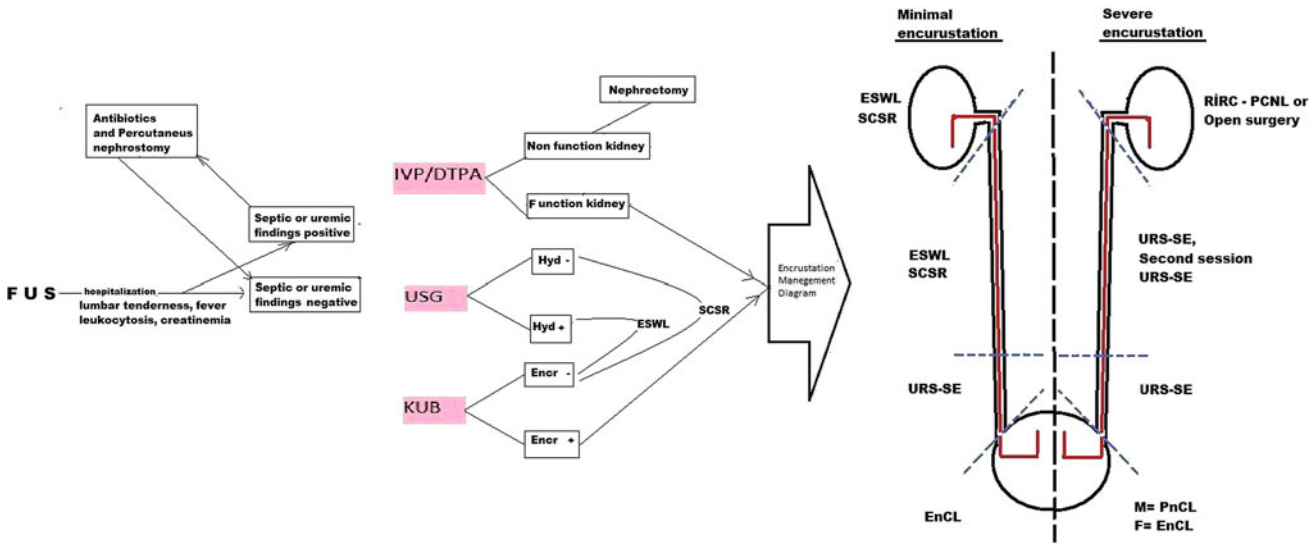

Fig. 6 Algorithm for the management of FUSs

The correlation between prolonged stent indwelling time, and degree of incrustation is clearly revealed. As retention time of FUS increases, incrusted ureteral segments lengthen, and thicken [8, 25] which require additional procedures for the extraction of the stent. Therefore, treatment cost of removal of FUS is expected to rise directly proportional to stent retention time. The association between extra retention time of FUS, and treatment costs was statistically significant ($p = 0.001$).

Usually first generation cephalosporines are being used prophylactically for timely cystoscopic removal of DJSs [28]. However, patients with FUS present generally with infectious manifestations. In our clinical applications, empirical antibiotherapy is initiated immediately after results of urinalysis and urine culture are obtained. In urine cultures of many patients, different bacterial colonizations, and resistant bacterial strains are detected. These factors prolong hospital stay, and increase costs of medications. This might affect patient's mortality, and morbidity. These risks can not be evaluated in terms of economic parameters.

Treatment costs for the extraction of FUSs are apparently higher when compared with timely removal of DJSs. We thought that this higher financial burden might be attributed to the separate interventions performed for bladder, ureter and kidney, and the most effective factor in these interventions is the unnecessarily prolonged retention time of the stent.

Conclusion

Despite all of these challenging issues in cases of forgotten stents with associated complications, extraction of an incrusted stent can be accomplished using a priorly planned multimodal approach combining appropriate medical, endourological or open surgical interventions suited for individualized indications. However; financial burden, increased labour loss and impaired quality of life brought by the application of these modalities must not be forgotten.

References

1. Chen ASC, Saltzman B (1993) Stent use with extracorporeal shock wave lithotripsy. J Endourol 7:155–162
2. Giustacchini M, Tazza L, Raguso M, Albino G (1999) Ureteral stent forgotten in renal transplanted patient: its removal. Arch Ital Urol Androl 71(4):223–224
3. Aron M, Ansari MS, Singh I, Gautam G, Kolla SB, Seth A, Gupta NP (2006) Forgotten ureteral stents causing renal failure: multimodal endourological treatment. J Endourol 20(6):423–428
4. Autorino R, Maschio A, Pane U, De Sio M, Cosentino L, Quarto G, Mordente S, Di Giacomo F, Santini L, D'Armiento M (2006) The forgotten stent: late complication in a patient with neobladder. ScientificWorldJournal 6:410–412
5. Thomas JA, Fenn NJ, Ponsford A, Bowsher WG (1998) Br Extraction by extracorporeal shock wave lithotripsy of a forgotten ureteric stent after cystectomy. J Urol 81(4):643–644
6. El Faqih SR, Shamsuddin AB, Chakrabarti A et al (1995) Polyurethane internal urethral stents in treatment of stone patients: morbidity related to indwelling times. J Urol 153:1817–1820
7. 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 58:100–103
8. Kadıoğlu TC, Tefekli A, Esen T, Tunç M (1998) Mechanical complications of double-J ureteral stents and ureterorenoscopy application. J Turkish Urol 24:159–163
9. Tsai CC, Shen JT, Huang SP, Chang SF, Tsai LJ, Wu WJ, Huang CH, Kaohsiung J (2009) Use of a holmium laser to treat a

forgotten double-J stent with whole stent encrustations: a case report. Med Sci 25(10):567–571
10. Eisenberg ML, Lee KL, Stoller ML (2009) Endoscopic management of retained renal foreign bodies. Urology 73(6):1189–1194 (Epub 2009 Apr 10)
11. Vanderbrink BA, Rastinehad AR, Ost MC, Smith AD (2008) Encrusrated urinary stents: evaluation and endourologic management. J Endourol 22(5):905–912
12. Kehinde EO, Al-Awadi KA, Tawheed A et al (2001) Factors affecting the fate of prolonged forgotten 'J' stents. Scand J Urol Nephrol 35:222
13. McCahy PJ, Ramsden PD (1996) A computerized ureteric stent retrieval system. Br J Urol 77(1):147–148
14. 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(3):189–192
15. Lynch MF, Ghani KR, Frost I, Anson KM (2007) Preventing the forgotten ureteral stent: implementation of a web-based stent registry with automatic recall application. Urology 70(3):423–426
16. Thomas AZ, Casey RG, Grainger R, McDermott T, Flynn R, Thornhill JA (2007) The forgotten ureteric JJ stent and its prevention: a prospective audit of the value of a ureteric stent logbook. Ir J Med Sci 176(2):117–119
17. Tang VC, Gillooly J, Lee EW, Charig CR (2008) Ureteric stent card register: a 5-year retrospective analysis. Ann R Coll Surg Engl 90(2):156–159
18. http://clinicaltrials.gov/ct2/results?term=turkey+stent+sms&view=results
19. Monga M, Klein E, Castañeda-Zúñiga WR, Thomas R (1995) The forgotten indwelling ureteral stent: a urological dilemma. J Urol 153(6):1817–1819
20. Finney RP (1982) Double-J and diversion stents. Urol Clin North Am 9:89–91
21. Singh I, Gupta NP, Hemal AK et al (2001) Severely encrusted polyurethane ureteral stents: management and analysis of potential risk factors. Urology 58(4):526–531
22. Thierry AF, Michel B, Zerbib M et al (1990) ESWL to remove calcified ureteral stents. J Endourol 26:164–165
23. Murthy KV, Reddy SJ, Prasad DV (2010) Endourological management of forgotten encrusted ureteral stents. Int Braz J Urol. 36(4):420–429
24. Santin M, Motta A, Denyer SP et al (1999) Effect of the urine conditioning film on ureteral stent encrustation and characterization of its protein composition. Biomaterials 20:1245–1251
25. Acosta-Miranda AM, Milner J, Turk TM (2009) The FECal Double-J: a simplified approach in the management of encrusted and retained ureteral stents. J Endourol 23(3):409–415
26. Lojanapiwat B (2005) Endourologic management of severely encrusted ureteral stents. J Med Assoc Thai 88(9):1203–1206
27. Karalezli G, Gögüş O, Bedük Y, Köküuslu C, Sarica K, Kutsal O (1993) Histopathologic effects of extracorporeal shock wave lithotripsy on rabbit kidney. Urol Res 21(1):67–70
28. Shandera KC (1997) Minimally invasive management of the calcified ureteral stent. Tech Urol 3:54–57