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Case Study

One That Got Away: A Case of The Forgotten Ureteral Stent

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Key Learning Points

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Appropriate concordance between surgeon, patient and allied healthcare professionals is essential in preventing errors such as ureteric stents being left in situ. This case highlights the classic "Swiss cheese" model of errors leading to the described consequences. The case discusses pertinent points regarding appropriate pre-stent counselling of patients (although this may not always be feasible in the emergency setting), the emphasis on the surgeon who places a stent being responsible for arrange an appropriate management plan for the stent, the notification from the administrative team if a patient fails to attend follow up, as well as the joint responsibility between patient and surgeon to ensure the management plan is followed. Unfortunately, there is no widely used nationalised system in place for the recording and subsequent follow up of stent insertions. This usually either relies on the surgeon themselves to book / arrange follow up for the stent (sometimes with the help of the administrative team), and/or a stent registry such as the one described on the British Association of Urological Surgeons (BAUS) website. However, these locally arranged systems again may be prone to errors such as forgetting or incorrectly recording the stent insertion, emails to administrative teams being lost or not interpreted correctly, database corruption/errors/unavailability, or patients moving out of area.

Special care should be taken with patients who may be at a higher risk of having a forgotten stent. Specifically, those who may have no sensation of a stent, and those who may not fully understand the potential complications of not being followed up appropriately such as in this case. This report presents the case of Mr X, a 70-year-old man who presented with acute-on-chronic renal failure due to an extensively encrusted ureteral stent that had been placed to alleviate obstructive uropathy, and subsequently forgotten for almost two years.

Introduction

Stone Disease & Obstructive Uropathy

Obstructive uropathy refers to any blockage of normal urinary flow, broadly due to pathology within the urinary tract (intrinsic obstruction) or external compression of the system (extrinsic obstruction) (Table 1). Over time, back pressure may dilate the proximal urinary tract to cause hydroureter and hydronephrosis. Epidemiologically, chronic obstructive uropathy is the primary reason for development of obstructive nephropathy and may lead to renal failure[1]. Obstructive uropathy therefore requires high clinical suspicion, urgent diagnosis and close collaboration between urologists and nephrologists[1].

In the older adult, obstruction is primarily due to benign prostatic hyperplasia, malignancy or, as in this case, urinary tract calculi (urolithiasis), a common disease with lifetime risk of 10-15%[2]. Stones are typically composed of calcium (>80%), as either calcium oxalate, phosphate or a mixture. Other types of stone include struvite (5-15%) such as in staghorn calculi associated with urea-splitting organisms; urate (5-10%) associated with gout and metabolic syndrome; cystine (1-2.5%) associated with Fanconi syndrome and familial disorders of cystine metabolism; and highly uncommon types associated with drugs, for example[2]. Common modifiable risk factors include dehydration and excess oxalate or salt intake, all of which may cause urine supersaturation and drive crystal nucleation.

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Anatomical Location	Intrinsic Causes of Urinary Tract Obstruction	Extrinsic Causes of Urinary Tract Obstruction
Kidney	Calculi Cystic disease Renal cell carcinoma Transitional cell carcinoma Multiple myeloma Pyelonephritis Congenital fibrous ureteropelvic junction obstruction	Aberrant vessel crossing at ureteropelvic junction
Ureter	Calculi Stricture Transitional cell carcinoma Congenital megaureter	Aortic or iliac artery aneurysm Gynaecological malignancy Retroperitoneal malignancy Retroperitoneal fibrosis Pelvic lipomatosis
Bladder	Calculi Neurogenic bladder Bladder neck contracture Bladder cancer	Benign prostatic hypertrophy Prostate cancer Prostatitis
Urethra	Stricture (traumatic, inflammatory, malignant) Phimosis Meatal stenosis Urethral or penile malignancy	

Table 1: Causes of urinary tract obstruction in an elderly patient. The most common causes are underlined. Adapted from Tseng et al. (2009)[3]

with Fanconi syndrome and familial disorders of cystine metabolism; and highly uncommon types associated with drugs, for example[2]. Common modifiable risk factors include dehydration and excess oxalate or salt intake, all of which may cause urine supersaturation and drive crystal nucleation.

Stone-related obstructive uropathy is usually unilateral but may be bilateral depending on the level of obstruction. Management also depends on the level of obstruction. Early intervention is required to relieve pressure on the kidneys and reduce patient mortality, particularly where there is associated infection/urosepsis, or impending renal failure[2,4]. Here, the most recent European Association of Urology guidelines consider ureteral stents and percutaneous nephrostomy tubes equally effective for decompressing the acutely stone-obstructed urinary tract[5], supported by gold-standard evidence from a randomised control trial[6]. Definitive treatment centres around promptly addressing the obstructive process, and following-up on any inserted tubes or stents.

Case Description

Mr X is a 70-year-old retired forklift driver who first presented to the emergency department in July 2019 in renal failure with symptoms of lethargy, confusion, oliguria, and a burning sensation at the catheter site. Of note, Mr X has spinal stenosis following a cycling accident in 2007, with sensory deficit below the level of T10 but preserved motor function. Having lost the ability to feel the urge to urinate, Mr X has since used a long-term indwelling Foley catheter.

On admission, Mr X's blood tests told of worrying biochemical derangement consistent with chronic kidney disease stage 5: eGFR< 15 mL/min/1.73m^2, creatinine >1400 umol/L, urea 69.8 mmol/L. His potassium was 8 mmol/L without ECG changes, requiring immediate fluid resuscitation and treatment with calcium gluconate, insulin with dextrose and salbutamol before haemofiltration in critical care. His CRP was 126 with a normal white cell count (5.56 x 109/L). Urinalysis detected 300mg/dL proteinuria and significant non-visible haematuria (+++), nil else. He was treated empirically for a urinary tract infection but developed visible haematuria overnight. Renal ultrasound revealed severe bilateral pelvicalyceal dilation and right renal calculi. Unenhanced (u) CT-KUB additionally revealed an atrophic left kidney, bilateral hydroureter and hydronephrosis, and two large bladder stones.

Mr X underwent urgent bilateral ureteroscopy, during which a stent was placed to straighten the grossly tortuous and dilated right ureter. As there was no obvious

acute ureteric obstruction, the uropathy was presumed to be chronic and at the level of the vesicoureteric junction due to the bladder stones. However, Mr X was subsequently lost to follow-up.

I met Mr X in February 2021, after he was rushed to the emergency department with a similar clinical and biochemical picture of acute-on-chronic renal failure (eGFR 2mL/min/1.73m^2, creatinine 1,557 umol/L, and hyperkalaemia requiring treatment with insulin and dextrose). Mr X was unwell with nausea and vomiting, once again preceded by a presumed urinary tract infection that was treated with antibiotics in the community. On admission, Mr X had no lower urinary tract symptoms and a soft nontender abdomen. Repeated urine cultures showed mixed growth only.

uCT-KUB now revealed a right ureteral stent with multiple dense calcifications along its course and at both ends. The proximal pigtail is heavily encrusted with a 41 x 21mm stone in the renal pelvis of the now non-functional right kidney, whose marked dilation and parenchymal thinning are consistent with obstructive nephropathy. The encrusted distal pigtail sits alongside enormous bladder stones that have grown to 63 x 35mm and 37 x 44mm.

In addition to the extensive stone burden, Mr X's management is complicated by his staunch attitude of "I'll get to that when I get to that", expressing concern only for acute health issues and real reluctance to plan for anticipated ones. As such, he has a history of non-engagement and poor compliance with therapies not felt to be of immediate relevance, including interventions previously offered for his stone disease. Mr X, now haemodialysis-dependent, is currently on the urology waiting list.

Discussion

Mr X's case raise three immediate urological questions:

1. How did his stent get forgotten?
2. What are the options for its removal?
3. Where do we go from here to avoid future forgotten stents?

1. Ureteral stents are usually bothersome.

Ureteral stents are among the most commonly used tools to establish and maintain ureteral patency in the treatment of urolithiasis, ureteric injury, and benign and malignant urological disease. The hypothetical 'perfect stent' will ideally cause minimal discomfort; maintain excellent urinary flow to maximise upper tract drainage; resist biofilm formation, infection and encrustation; and be biodegradable if forgotten[7]. Most modern designs are made of polymeric materials, and feature a pigtail curl at each end, one anchored in the renal pelvis and the other in the bladder. Metal stents, with their decreased compressibility and lower propensity for occlusion, represent a useful alternative for relieving chronic ureteral obstruction[8].

Ureteral stents have well known associations with various complications. A prospective study using validated questionnaires to assess the prevalence and bother of urinary symptoms, found that 80% of patients with indwelling ureteral stents experienced at least one urinary symptom that interfered with their life[9]. These ranged from bladder and/or flank pain, to storage symptoms and incontinence, to haematuria. However, this small (n=48), single-centre study relied on smaller subanalysis and was likely underpowered; most differences in urinary symptoms before and 6 weeks after stent removal did not reach statistical significance, despite improved quality of life.

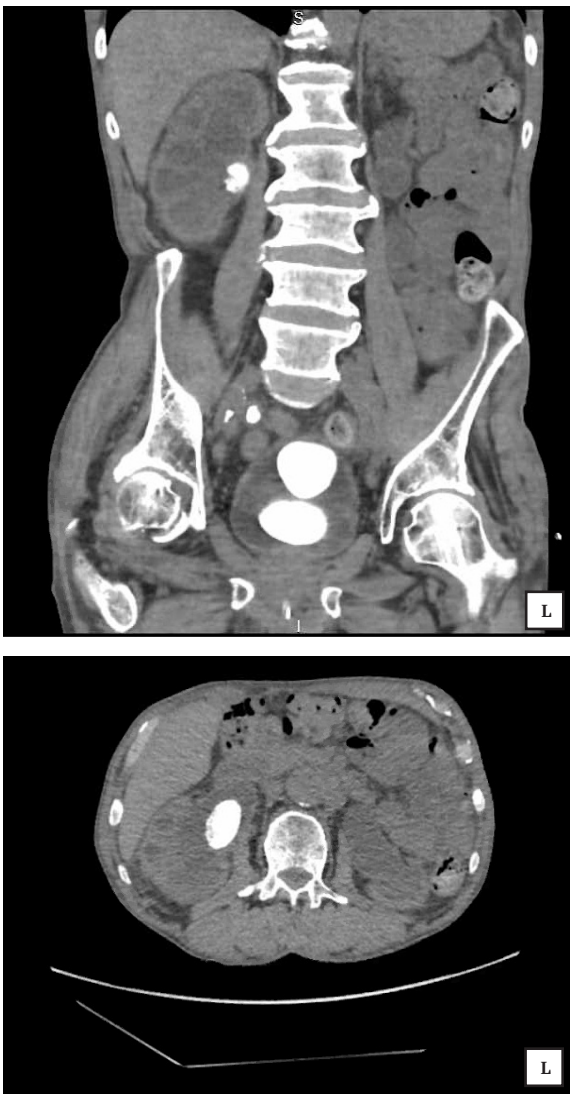

Figure 1: (A) coronal and (B) axial uCT-KUB showing large calculi in the (A) bladder, distal right ureter and (B) right kidney

Nonetheless, the implications are particularly important in patients like Mr X who, due to his sensory deficit and long-term catheterisation, may not experience bladder pain or storage symptoms. Just as those with the most significant stent-related symptoms will find it hard to forget their stent and may count down the days to its scheduled removal, the converse logic applies[10]. It follows that Mr X would be less likely to seek medical attention for his forgotten stent, or to even remember its presence. This, coupled with his preference to focus on the present rather than the future, may have contributed to his delayed presentation and resultant crash landing into the emergency department.

Mr X's age (68 at the time of stent placement) may have also been relevant to his presentation: a large retrospective observational cohort study recently identified patients older than 60 as being 3.6 times more likely to have a forgotten stent[11]. Reasons for this age association were not fully explored, though memory decline was suggested as a contributor.

2. The forgotten ureteral stent requires complex extraction.

Every ureteral stent that is placed must eventually be retrieved or replaced. However, despite best efforts, the stent may be retained and 'forgotten' by both patient and clinician- for as long as 25 years, in one case[12]. The forgotten stent is considered a 'Never Event': one which is entirely preventable and carries the potential to cause serious harm or death[13]. Singh et al. (2005), in their retrospective series of 19 forgotten ureteral stents, reported two patient deaths, one from hydroureteronephrosis and advanced renal failure as a direct stent-related consequence, and the other from complications related to operative intervention[14]. Given this serious risk of iatrogenic morbidity and mortality, it is perhaps unsurprising that forgotten ureteral stents accounted for the largest number (n=23) of successful postoperative negligence claims in the UK between 1995 to 2009[15].

Strikingly, 13 per 100 ureteral stents placed will be forgotten, ten of which will become encrusted[16]. Encrustation and calcification significantly complicate or prevent ureteral stent removal in the standard transurethral way. While the exact mechanism of stent encrustation is yet to be elucidated, it is thought to begin with a urinary conditioning film. This film, often colonised with E.coli, is present on almost all ureteral stents which have been in situ for prolonged periods. Its formation begins with adsorption of urinary proteins and bacterial products onto the stent biomaterial, typically via electrostatic interactions[8]. This draws calcium and oxalate to the film surface, where crystals precipitate then self-propagate. Here, patient factors important for urolithiasis (e.g. hyperoxaluria, hypercalciuria, hypocitraturia) are once again relevant risk factors. Indeed, there is evidence, albeit from one study, that in patients who underwent ureteral stent placement for stone-related obstruction, the material encrusting the stent has the same composition as the concurrent stone[17]. In the case of Mr X, his history of stone disease, long stent dwell-time, and long-term (invariably colonised) indwelling catheter placed him at high risk of encrustation. This may explain his relatively rapid progression to extensive disease.

In the absence of consensus guidelines for removing encrusted stents, the problem has been approached with a myriad of endourological techniques. These include extracorporeal shock wave lithotripsy (ESWL) for mild-to-moderate proximal encrustations; percutaneous nephrolithotomy (PCNL) to fragment the largest proximal encrustations; ureteroscopic lithotripsy along intraureteral portions; cystolitholapaxy of distal encrustations; and rarely, open and/or laparoscopic cystolithotomy, nephroureterectomy or even complex reconstructive surgery such as ileal ureteral substitution[12,18,19,20].

Clearly the degree of stent encrustation affects its management. Being encrusted at both proximal and distal pigtails, Mr X's stent scores grade IV on the FECal system for forgotten, encrusted and calcified stents, a standardisation devised by Acosta-Miranda et al. (2009)[18]. Their proposed classification system assigns forgotten stents a grade based on the size, location and extent of encrustation, and recommends corresponding management that reflects the increasing technical difficulty of stent removal (table 2).

Though helpful as a potentially unifying resource which recognises that surgical management is ultimately determined by the location of the encrustation, the FECal

FECal Classification	**Description**	**Proposed Management**
Grade I	Minimal encrustations of either pigtail	Proximal: <1.5cm ESWL or PNCL. >1.5cm PCNL
		Distal: cystolitholapaxy
Grade II	Complete encrustation of either pigtail	Proximal: PCNL
		Distal: cystolitholapaxy
Grade III	Complete encrustation of either pigtail and along the ureteral component	Proximal: PCNL & antegrade ureteroscopy with holmium laser lithotripsy
		Distal: cystolitholapaxy & flexible ureteroscopy with holmium laser lithotripsy
Grade IV	Complete encrustation of both pigtails	PCNL & cystolitholapaxy
Grade V	Complete encrustation of the entire stent	PCNL & cystolitholapaxy & flexible ureteroscopy with holmium laser lithotripsy

Table 2: FECal treatment algorithm

treatment algorithm is dated and subject to significant limitations. It is worth considering that descriptions are based on KUB radiograph, which may underestimate the stone burden, particularly in radiolucent stones (cysteine, urate). uCT-KUB is therefore the preferred imaging modality and should be used when planning surgical intervention. Furthermore, findings are based on a very small number of patients (n=9), only one of whom had grade IV encrustation similar to Mr X. It is unclear whether any patients had anatomical abnormalities of the urinary tract that may have affected their management and could easily skew the algorithm in such a small study population. The study also did not include any patients with stent-associated renal impairment, as is relevant to this case.

Mr X was offered PCNL at the same time as cystolitholapaxy and open cystolithotomy for the bladder stones, which were deemed too large to safely remove endoscopically. This skilful, combined approach is supported by evidence from Pais et al. (2014)[19], whose 36-patient series revealed that few (n=8, 21%) stents with bulky proximal encrustation could be removed by PCNL alone. Most patients with encrustations on the bladder coil or ureteral segment required cystolitholapaxy or antegrade ureteroscopic laser lithotripsy, respectively. Given that Mr X's stent does have ureteral encrustation, it is reasonable to anticipate the need for auxiliary ureteroscopic assessment and lithotripsy.

Of note, it is also reasonable to anticipate residual stone disease. The same case series[19], which was the first to publish stone-free rates after PCNL for encrusted stents, reported that 37% patients had residual stone fragments on postoperative imaging. Importantly, imaging modalities as disparate as KUB radiograph, CT-KUB, ultrasound, and nephrostogram were used so this figure may well be an underestimation. Perhaps the high frequency of residual fragments is due to the ease with which they fracture off the encrusted stent and escape removal. If so, it is worth considering that the average maximal stone burden on participants' proximal stent curl was 2.9cm whereas Mr X's renal calculus is significantly larger (41mm x 21mm), which may have implications for the success of PCNL or the need for second-stage PCNL. Indeed, heavily encrusted grade IV and V stents typically require multiple procedures (1.94-2.70) for complete removal[21]. Although these, like the other retrospective studies mentioned, may be subject to recall and selection biases.

3. Preventing forgotten stents will require a collaborative effort.

Looking to the future, a final question raised by Mr X's case is of what can be done to avoid forgotten stents. Ultimately, responsibility for any forgotten stent must be shared between the surgeon, health organisation, and patient. Accordingly, proposed solutions must target every level.

Having identified non-compliance as an important reason for the forgotten stent, Singh et al.[14] advocate for adequate pre-stenting counselling to avoid any communication gap between doctor and patient about the need for timely stent removal. Returning to the argument that a bothersome stent provides an imperative for its removal, patient education on stent-associated symptoms is essential for them to be able to attribute those symptoms to the stent[10]. The need for a proactive approach from the clinician is especially relevant to the case of Mr X, given his history of non-engagement and the probable absence of mental prompts from stent-related symptoms.

To this end, physical reminders such as stent cards given on discharge[22], or wristbands scanned and placed before the patient even leaves the operating theatre[10] may be useful. The process of consenting the patient for a wristband, for example, may necessitate the surgeon spend extra time explaining the stent and need for its removal, thereby providing additional patient education. This strict process may additionally encourage a change in practice away from routinely placing stents following uncomplicated ureteroscopy for stone removal, in keeping with recent NICE guidelines[23].

Alternatively, a popular suggestion is to establish computerized electronic stent registration systems that allow medical caretakers to better trace those requiring management[12]. However, there remains an element of human error: even after moving from manual data entry to an elegant barcode system, Lynch et al. (2007) found that 13% of stents were still missed from their register[24]. Plus, this approach lacks the backup of a helpful visual reminder for patients, if all else fails.

Finally, biodegradable stents may be an exciting, novel approach. Here, the most promising is a radio-opaque glycolic-lactic acid (Uriprene) stent that neatly degrades in the distal to proximal direction to prevent ureteral obstruction due to degrading stent fragments[8]. In porcine models, Chew et al. (2010)[25] demonstrated third generation Uriprene stents that were insertable over a guidewire like traditional polymer stents, considerably decreased hydronephrosis (though not to statistical significance) and degraded by 4 weeks. However, first-in-man trials revealed inconsistencies with the time taken to degrade that have slowed further clinical development[8]. Moreover, stent biodegradability simultaneously presents limitations to their clinical application. The 4-week stent lifespan is inadequate for relieving malignant obstruction, and is precariously at odds with the real-world context of longer waiting times between stent placement and definitive management.

Conclusion

In conclusion, Mr X is an extremely insightful case that highlights numerous factors that may lead to a ureteral stent being forgotten; the complexity of managing an encrusted, calcified stent once forgotten; and the need for a proactive approach from clinicians in the context of non-engaged patients, to avoid the considerable consequences of one being lost to follow-up.

Of note, the case additionally raises pertinent ethical, medicolegal and psychosocial questions that are beyond the scope of this report, but that will be essential to explore if we are to fully understand how to avoid history repeating itself in similar patients, and to ensure Mr X is adequately supported in the interim.

Conflicts of interest

None.

Funding

None.

Consent

The patient has consented to the publication of this case study.

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