

Office-based ureteric stent removal is achievable, improves clinical flexibility and quality of care, whilst also keeping surgeons close to their patients

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Introduction Diagnostic pressure on endoscopy suites can result in stent removal not receiving the required priority and unnecessary morbidity for patients. As well as using stents with extraction strings, the introduction of a portable single-use flexible cystoscope for ureteric stent removal (Isiris™), offered an opportunity to negotiate these issues by relocating stent removal to the office/clinic. This study aimed to determine whether such flexibility reduced stent dwell time with the assumption this would improve patient experience and decrease associated complications.

Materials and methods A retrospective review of ureteric stents placed during stone procedures was undertaken. Data collection included; patient demographics; stent dwell times; the number of emergency department (ED) attendances and hospital readmissions; procedure cancellation rates and the number of urinary tract infections.

Results In total, 162 stents were removed (113 Standard, 34 Isiris™, 15 via strings). Excess dwell time was reduced in both Isiris™ (median 1 day, mean 1.37 days, $p = 0.0009$) and Strings Groups (median 0.96 days, mean 0.96 days, $p = 0.022$) compared with the Standard Group (median 8 days, mean 15.34 days).

ED attendances and readmissions were reduced by 33.5% and 22% respectively in the Isiris™ Group compared with the Standard Group. There were no ED attendances in the Strings Group. Reductions in length of stay, urine infections and cancellation on the day of procedures were also observed.

Conclusions The clinical flexibility provided by Isiris™ and 'stents on strings' has objectively improved patient experience and is associated with a reduction in complications as well as increasing diagnostic capacity and cost efficacy.

Key Words: kidney stones ◊ ureteral stones ◊ ureteral stents ◊ quality improvement ◊ technology

INTRODUCTION

Ureteric stenting following the ureteroscopic or percutaneous operative management of urolithiasis is common place, since being first introduced in the late 1970s [1]. Approximately 80% of such patients receive a stent [2]. Some groups have claimed that stents may not be necessary

for 'routine' ureteroscopy [2–5], and, whilst these comments imply over usage, such placement may be inevitable whilst the definition of an 'uncomplicated' procedure remains elusive [5, 6]. Similarly, due to the lack of a clear consensus from the endourology community, the clinical heterogeneity of such cases and the multifactorial influences on prosthesis removal, broad variation exists

in clinical practice with regards the time that stents currently remain in situ [7].

Potential complications of indwelling stents include infection, encrustation, the risk of the 'forgotten' stent and the well-recognised stent related symptoms of pain, strangury and haematuria. Stent associated morbidity has been extensively reported [4, 8, 9] with as many as 80% of patients experiencing stent pain that affects their daily activities. Consequently, patients often seek further contact with primary care, the emergency department (ED) and may need readmission. Recent evidence from Nevo et al. [10], has further highlighted the need to minimise stent dwell time. Patients that were stented prior to ureteroscopy had higher sepsis rates than unstented patients and furthermore, the sepsis rate increased the longer the dwell time was prior to such definitive surgery [11].

Given the aforementioned complexity to the decision-making processes surrounding stent placement and removal, addressing the logistics of stent removal seems an appropriate target thus ensuring that stent dwell time is never deemed excessive. The introduction of novel technology in the form of a fully portable single-use, digital flexible cystoscope with an integrated light source and grasper for ureteric stent removal (Isiris™) afforded the opportunity to re-examine the process of stent removal and, along with stent removal via extraction strings, potentially offers the necessary flexibility to negotiate the contemporary clinical pressures which are often weighted towards diagnostics. More specifically, to ensure that stents are removed when they are supposed to be, rather than their removal being deferred in favour of diagnostic cases in the endoscopy suites. The aim of this study was to determine whether our department's adoption of Isiris™ and stent removal via extraction strings, had shortened the dwell time of stents and whether this subsequently improved the rates of post-procedure related events observed.

MATERIAL AND METHODS

All patients undergoing stone surgery performed by a single surgeon in a UK University teaching hospital were prospectively entered into a national audit database (www.baus.org.uk) and procedural logbook (www.elogbook.org). These databases were reviewed retrospectively and all patients that had undergone a rigid and/or flexible ureterorenoscopy or percutaneous nephrolithotomy between August 2013 and December 2016 and received a stent, were identified. Standard practice had been to add patients requiring stent removal to the thrice weekly diagnostic endoscopy lists, performed in an endoscopy suite. List

availability was heavily dependent on the diagnostic pressures faced by the department at any given time. In October 2015, stent removal using extraction strings was employed for the first time and has been used in selected cases ever since. In April 2016, in an attempt to standardise the procedure of stent removal, the process of cystoscopic stent removal was also moved to the office/clinic environment, utilising Isiris™.

Blinded to the method of stent removal employed, the operating surgeon retrospectively reviewed the operation note and recorded an ideal dwell time for that particular patient's stent. The ideal dwell time was defined as being 7 days for uncomplicated surgery, 14 days for minor ureteric or pelvi-ureteric junction trauma such as urothelial abrasion and 28 or 42 days (documented at the time of operation) for those cases with evidence of a significant stricture or who were deemed high risk of subsequent stricture development.

A retrospective review of the electronic patient record for these patients was then undertaken by four co-investigators. Demographic data was collected on patient age, sex, American Society of Anesthesiologists (ASA) grade and urgency of surgery. Stent insertion and removal dates were recorded thereby defining the actual stent dwell time. Subsequently, excess stent dwell time (actual dwell time minus ideal dwell time) was calculated.

With regards to post-procedure-related events, ED attendances and inpatient admissions were recorded, as well as those with documented positive urine cultures with or without symptomatic urinary tract infection. Statistical analysis was performed using a paired T-test, as well as the Fisher's exact and Mann-Whitney tests.

RESULTS

In total, 162 patients were identified with 113 (69.8%) patients having a stent that was ultimately removed with a reusable flexible cystoscope as part of a diagnostic list in an endoscopy suite (Standard Group), 34 (21.0%) using the Isiris™ system (Isiris™ Group) and 15 (9.2%) using extraction strings (Strings Group). The latter two groups being situated in the office/clinic environment. Patient demographics for the stents removed cystoscopically are reported in Table 1A. There was a female preponderance in the Isiris™ group ($p = 0.049$), otherwise the patient cohorts were comparable.

Compared with the Standard Group patients, the demographic data for the Strings Group revealed a younger cohort (mean age 49.7 years vs. 36.7 years, $p = 0.036$) with a greater proportion of males (Stan-

Standard Group 58% male vs. Strings Group 73% male, $p = 0.40$) (Table 1B). The entire cohort included both stent-naive and pre-stented patients. Patients were pre-stented in 9.7% of the Standard Group, 26.7% of the Strings Group and 8.8% of the Isiris™ Group. The median planned Dwell time was 7 days in all groups, this implies that the complexity of cases was comparable, albeit that all cases in the Strings Group were elective. The excess dwell time was significantly reduced in the Isiris™ Group (median 1 day, mean 1.37 days, $p = 0.0009$) and Strings Group (median 0.96 days, mean 0.96 days, $p = 0.022$) compared with the Standard Group (median 8 days, mean 15.34 days). The rate of ED attendance whilst the stent was in situ was reduced by 33.5% in the Isiris™ group (equating to approximately £1,110 cost saving per 100 stent removals) compared with the Standard Group (14.7% vs. 22.1%, $p = 0.47$). There were no ED attendances in the Strings group (0% vs. 22.1%, $p = 0.041$) (equating to approximately £3,315 cost saving per 100 stent removals). Fewer patients from the Isiris™ group (11% vs. 14%) were readmitted to hospital, a reduction of 22% ($p = 0.78$) (equating to approximately £750 cost saving per 100 stent removals). The length of stay for those admitted from the Isiris™ Group was a median of 2 days, (range was 1-3, rate of 0.24/case), compared with a median of 3 days (range 1-7, rate of 0.48/case) in the Standard Group, a reduction of 51% ($p = 0.023$). No patients from the Strings Group required re-admission to hospital (equating to approximately £3,500 cost saving per 100 stent removals). Furthermore, all patients that reattended the healthcare facility in the Strings or Isiris™ Groups did so before the ideal dwell time had been breached. In the Standard Group, 48% of reattending patients, did so after the ideal dwell time had lapsed, perhaps supporting the notion that timely removal prevents morbidity. No patients from the Strings Group had evidence of bacteriuria or symptomatic infection. The rate of bacteriuria and infection (symptomatic with microbiological evidence) whilst the stent was in situ was reduced by 9.1% and 11.3% respectively in the Isiris™ group compared with the Standard Group. Given the change in service provision associated with the relocation of stent removal, further comparative analysis was undertaken of those stents removed in endoscopy (Standard Group) and those in the clinic/office settings (Isiris™ and String Groups combined) (Table 2). The Standard Group were significantly older (49.7 years vs. 42.69 years, $p = 0.0054$). The excess dwell time was again significantly reduced in the Combined Group (median 0.96 days vs. 8 days, $p \leq 0.0001$), compared with the Standard Group. As a consequence of providing alternate methods

Table 1A. Comparative demographic data for study groups with stents removed cystoscopically (Standard Group and Isiris™ Group)

	Standard Group	Isiris™ Group	Statistics
No. of patients (%)	113 (69.8)	34 (21.0)	
Gender (%)			
Male	58	38	
Female	42	62	$p = 0.049$
Mean age (years)	49.7	43.6	$p = 0.282$
Elective cases (%)	98.2	97.1	
Median planned dwell (days)	7	7	$P = 0.873$

Table 1B. Comparative demographic data for the Standard and Strings groups

	Standard Group	Strings Group	Statistics
No. of patients (%)	113 (69.8)	15 (9.2)	
Gender (%)			
Male	58	73	
Female	42	27	$p = 0.40$
Mean age (years)	49.7	36.7	$p = 0.036$
Elective cases (%)	98.2	100	
Median planned dwell (days)	7	7	$P = 0.873$

Table 2. Outcome data comparing those patients who had stents removed in endoscopy (Standard Group) and in the clinic/office environment (Combined Group)

	Standard Group	Combined Group	Statistics
No. of patients (%)	113 (69.8)	15 (9.2)	
Gender (%)			
Male	58	49	
Female	42	51	$p = 0.304$
Mean age (years)	49.7	42.7	$p = 0.005$
Elective cases (%)	98.2	98	
Median planned dwell (days)	7	7	
Median Excess dwell time (days)	8	0.96	$p < 0.0001$
Mean Excess dwell time (days)	15.34	1	$p = 0.0001$
ED attendances (% of cohort)	22.1 (n = 25)	10.2 (n = 5)	$p = 0.081$
Readmission rate (% of cohort)	14.1% (n = 16)	10.2 (n = 5)	$p = 0.614$
Length of stay (inpatient days/case)	54 days (0.47)	8 days (0.16)	$p < 0.0001$

of stent removal in the clinic/office environment, 49 diagnostic endoscopy appointments were released, this enhanced capacity equated to £38,600 per 100 stents potential additional income, if diagnostic appointments were backfilled. Though not statistically significant, the rate of stent removal pro-

cedures cancelled on the appointed day was lower in both the Isiris™ Group (2.9%) ($p = 0.68$) and Strings Group (0%) ($p = 0.59$) compared with the Standard Group (7.1%), realising a 59.2% improvement in the rates of cancellations attracting a further £1,620 per 100 cases of efficiency savings.

DISCUSSION

Essentially, this study has demonstrated that, in our early experience with Isiris™ and stent extraction by strings, stents are removed in a timelier manner. Thus, as a result of this improved efficiency, patients have experienced fewer complications and a potential cost benefit to the department of approximately £40,000 per 100 cases, has been realised. Albeit that direct measurement of patient experience with patient reported outcome measures (PROMs) was not undertaken in this study, we believe that indirect measurement is implicit. Further study, with the aid of a stent-related PROM would be helpful however, the quality improvement findings of this study are presumed to act as a surrogate for an improved patient experience.

Animal studies have shown that ureteric oedema and radiologically determined upper tract obstruction persist for at least 96 hours after instrumentation of the ureter however, there is no comparable conclusive evidence in human studies [12]. When the process of stent removal was moved to the clinic, stents were routinely placed on a Thursday during the weekly operating session and removed during the weekly clinic on a Friday, eight days later. This explains the median excess dwell time of 1 day for the Isiris™ and Strings Groups. The decision about whether to leave a post-procedural stent is primarily determined by the operative surgeon. However, due to paucity of clear guidance and with the clinical heterogeneity observed with such procedures, the proportion of patients being stented can vary. Hughes et al. [13] reported that 74% of patients undergoing ureteroscopy in the UK National Health Service (NHS) setting had some form of ureteric drainage after an uncomplicated procedure. Other groups have claimed that stents may not be necessary for 'routine' ureteroscopy [2–5].

Over 80% of patients with stents experience bothersome symptoms, 58% report a decrease in their ability to work and approximately a third suffer from sexual dysfunction [4]. This study demonstrates that prolonged stent dwell time increases the risk of post-procedural events including hospital readmission. Furthermore, it reinforces the findings from Nevo et al. [10], regarding preoperative stent dwell time and the risk of post ureteroscopy sepsis and provides

evidence that stents should also be removed as soon as possible post procedure with complications being associated with delay. In the UK NHS, readmission within 30 days attracts no further reimbursement for the cost of that admission or any additional treatment. There is a lack of reliable evidence as to how best to manage ureteric stent-related symptoms with no internationally recognised treatment protocols or guidelines available to try and alleviate symptoms and thus minimise readmission. Current practice includes the use of analgesia, alpha blockers, anticholinergics or a combination [14, 15, 16]. Nevertheless, the stent-related morbidity remains high.

Given the persistent indication for ureteric stent insertion yet the uncertainty surrounding the optimal dwell time and the difficulties in managing the high rates of stent-associated side effects, we aimed to reduce dwell time and remove the stents within a reliable and reproducible timeframe. By reducing the duration of stenting we hoped to improve quality of life. In the absence of a defined algorithm that can be applied across the endourology population, stent pathways should be prescribed bespoke to individual patients, with the express aim for stent removal as soon as possible. In the UK, as well as many other healthcare systems, contemporary barriers to such quality improvement include the significant pressure to provide rapid access to diagnostic cystoscopy, particularly with government cancer targets [17, 18] and, in our experience; such cases were prioritised in favour of the stent removals. Isiris™ and the use of stent extraction strings facilitate a process change that increases clinical flexibility and thereby directly addresses the sole aspect of a stone patient's journey with a stent, which, can actually be manipulated. These methods prevent healthcare providers having to duplicate expensive capital equipment (reusable flexible cystoscope in association with a separate stent retrieval device and a laparoscopic stack system) as well as staffing expensive areas of the hospital such as the endoscopy suite. Of course, the expense of capital equipment will be offset to a degree by an increase in consumable costs associated with Isiris™, however, albeit a detailed cost analysis is beyond the scope of this study, we anticipate that no additional staffing or reprocessing requirements to undertake the stent removals in parallel to the diagnostic service. Increased diagnostic capacity in endoscopy, fewer cancellations on the day and less service provision requirements from the ED and in-patients attracts further cost relief. Cost effectiveness of disposable items can be very difficult to determine, given the complexity of calculating the costs involved in the acquisition and servicing of reusable equipment.

It is likely that further study will demonstrate this to correlate with the volume of procedures undertaken, similar to the argument for reusable versus disposable ureterorenoscopy [19].

The use of extraction strings on stents has gained popularity in recent years [3, 6, 20, 21] due to the perceived benefit of being less invasive and inexpensive to remove. Notwithstanding this, the majority (>60%) of stents are still removed by a urologist or appropriately trained urology specialist nurse using a reusable flexible cystoscope with a separate stent retrieval device and a laparoscopic stack system [20], often in an endoscopy suite. A recent meta-analysis examining the practice of stent removal via extraction strings reported the main complication was stent dislodgement [21]. This appeared higher in females and the authors suggested the reason related to both anatomical and behavioural factors. The study authors advised that, although premature dislodgement of stent was low, they would not advocate the use of stents on strings in patients whose care would be significantly compromised by the stent being dislodged, for example those patients that require prolonged stenting due to ureteric perforation or with a high risk of stricture. Certainly, our contemporary practice has been to consider leaving stents on strings in young male patients who require short term stents only and who, albeit a personal view of the study authors, tolerate cystoscopy less well.

The study is limited by its retrospective nature and the fact that surgeon preference for stent removal via extraction strings in younger male patients skewed the demographic data, such that the groups were not entirely comparable. This prompted the decision to pool the data from the Isiris™ and Strings Groups, given that the study was most interested in examining the effects of the change in location rather than the specific technique employed to remove the stent. The measure of bacteriuria and symptomatic urinary tract infection (UTI) may lack reliability

as many may have treated themselves conservatively or have seen a primary care clinician. The department's electronic patient record did not have access to these primary care records, merely microbiology cultures taken within the hospital. We were careful to ensure the diagnoses of bacteriuria and symptomatic infection were differentiated and that the latter did have supportive microbiology thus differentiating it from those patients with cystitis secondary to the direct stent irritation, in turn, ensuring that the latter were not mislabelled as having a UTI. The meaningfulness of post stent removal complications is minimal given the small numbers and is worthy of study in a larger prospective series. The cost savings reported provide evidence of benefit though we are aware of the need for a further, more detailed, examination of the costs associated with the process of stent removal as part of future study and we are also cogniscent of the fact that cost of stent removal will vary between institutions.

CONCLUSIONS

This study has shown that the introduction of Isiris™ offers a cystoscopic solution for use in the clinic/office environment which complements stent removal via extraction strings. Using these two methods, removal of stents in an office environment is both feasible and safe and appears to be associated with a significant potential cost saving. Patient experience has been enhanced as evidenced by the more timely removal of stents and reduction in complications.

Further evaluation of stent removal using Isiris™ in a prospective manner including the assessment of patient reported outcome measures, will help to further establish the role of Isiris™ in a variety of healthcare settings.

CONFLICTS OF INTEREST

Mr. B.R. Grey is a key opinion leader for Coloplast.

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