Part of the Solution and Part of the Problem-Report on the Ureteric Stent Use in a Tertiary Referral Center in Australia

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Abstract

Background: The aim of the study is to comprehensively report on a single tertiary referral centre experience with the use of ureteric stents, assess complication burden and determine risk factors to further inform institutional practice.

Materials and methods: The retrospectively analysed cohorts include 529 patients treated over a 12 months period. Data regarding details of the index pathology, stent characteristics and complications were collected retrospectively.

Results: Most stents (58.9%) were used in the context of stone surgery. Stent encrustation occurred in 14.5% of patients and sepsis in 4.3%. There was a statistically significant difference be-tween the complications of the stents removed after 90 days (76.3% of encrustations, 26.8% positive urine cultures) and the rest of the cohort. Overall, 7.6% of patients re-presented to the emergency department due to stent related complications (pain, haematuria, sepsis) and 2.4% required early stent removal. At our institution, we managed to avoid forgotten stents and catastrophic complications.

Conclusions: Stent complications are the complex outcome of interplay between the foreign body and the collecting system environment, influenced by the nature and timing of surgery. Longer stent dwelling times are associated with increased complications rates. Planning definitive management and stent extraction needs to take into account the statistically significant differences between the subgroups with significant co-morbidities.

Introduction

The aim of our retrospective study was to characterise the use of ureteric stents in a busy tertiary centre and to analyse any potential inferences regarding common complications. The ultimate goal was to inform practice regarding the indications and risk profiling in ureteric stenting. We also analysed the data pertaining to the period to stent removal, with implications for usage of operating time. Certainly, the individual complications of stent us-age were detailed before. We, however, focused on a comprehensive analysis that would include data pertaining to individual complications, patient subgroups separated by statistically significant differences and stent management planning in the operating theatre.

The history of the search for methods of draining the obstructed renal tract parallels the history of urology. The stents are hollow tubes that drain fluids through their lumen and in a laminar fashion around their outer surface. The name is an eponym for three English dentists who developed a substance for dental impression; Goodwin, in 1972, refined the meaning to a mould for internal fixation [1].

The first reported successful use of a ureteric drainage technique belongs to Gustav Simon during an open cystotomy procedure, followed closely by Joaquin Albarran and credited with the development of the first ureteric stent. Gibbons introduced the first commercially available rubber stent and finally Finney solved the common problem of stent migration by describing the double J stent and this design is used in the majority of modern stents [2,3].

The indications for stent placement fall broadly into three categories:

- Stent placement to promote ureteric healing and prevent complications (as, for example, after pyeloplasty or after ureteric repair/replant). The stent allows alignment of the ureteric wall decreases the inflammation and the urine extravasation and directs epithelial growth. A success rate of 85% has been reported in the conservative management of ureteral fistulae using stents [4]. As a safety device, the stent allows for the easy identification of the ureter in difficult pelvic surgery procedures.

- Stent placement as an adjunct to stone treatment. The stent is a method of drainage in the acute presentation, allowing for stabilisation of the patient or a safety device following endourological procedures.

- Finally, the stent is an optimal device for maintaining long term patency of the collecting system, most often in the malignant obstruction setting.

In spite of the expanding role for the device, the main characteristics of the ideal stent remain the same (Table 1). It has to be said that none of the stents currently in use meet all these demands.

Easily inserted from any access
Resistant to migration
Well tolerated by the patient
Optimal flow characteristics
Biocompatible
Biodurable
Resistant to encrustation
Non-refluxing
Radio-opaque/easily found with ultrasound
Easily exchanged
Affordable

Table 1: Characteristics of the ideal stent.

Materials and Methods

This study was part of an internal surgical audit regarding the rigid and flexible ureteroscopy and the use of ureteric stents in a tertiary referral center. After institutional approval was obtained for a low risk project, the data concerning stent usage was collected retrospectively for the period September 2014 and September 2015. For the inclusion in the study, the patients had a stent inserted retrograde, during the study period. Post-cystectomy ureteric stents and integrate stents inserted by Interventional radiology were excluded.

The method of data collection included the compilation of patient list with the assistance of the coding department and was compared with the data of the ureteroscopy intra-departmental audit, performed concurrently and spanning the same time period. All the complications were recorded, including intra-operative complications related to stent insertion or stent removal. Baseline renal function was compared to the renal function close to the end of the stent dwell time. Information regarding results of the urine cultures was collected were available.

We performed a subgroup analysis depending on the stent dwelling time e.g. less than 30 days, 30 to 90 days and more than 90 days. The intervals were based on published data suggesting minimal morbidity below 90 days but significant complications in stent retained longer than 3 months [5]. All stents in our series were inserted with patient under general anesthesia, in lithotomy position and under image intensifier guidance.

Results

The cohort included 529 patients identified via clinical records. There was a strong male preponderance (346 vs. 183 or 1.9 to 1 ratio), mainly due to higher percentage of male patients in the category of stents inserted for stone disease. A sizeable cohort of patients were diabetics (12.8%) and 11.3% were on therapeutic anticoagulation for cardiac, peripheral vascular or cerebrovascular disease. The most commonly used stent was the 4.8F 24 cm double J stent, 80.6% of stents having a dwell time of 30-90 days. Of the total number, 13.1% were tethered and removed in the outpatient clinic via the strings (Table 2).

Total patients	529	
Age	20-91	Median 53
Males	346	65.40%
Females	183	34.60%
Diabetes		
Yes	68	12.80%
No	461	78.20%
Therapeutic anticoagulation	60	11.30%
Stent size		
4.8F	387	73.10%
6F	115	21.70%
6F	27	5.20%
Stent length		
24 cm	222	42.00%
26 cm	186	35.10%
22-30 cm	121	22.90%
Stent dwell time		Median 51 days
<30 days	159	30.10%
30-90 days	267	50.50%
>90 days	103	19.40%
Tethered stents (string)	70	19.40%
Longterm stents/stent dependent Patients	32	6.10%

Table 2: Patient demographics and stent characteristics.

The stents were inserted for a variety of reasons (perhaps underlining the nature of our institution, which is a busy university hospital, with a solid presence of all surgical specialties) (Table 3). The most common reason for the stent insertion was as an adjunct in the acute and elective treatment of urolithiasis (58.9%) followed by use in the ureteric reconstruction (28.9%) and in malignant ureteric obstruction (5.2%). With a busy colorectal and gynecological oncology department, in 2% of cases the stents were inserted to help with the intra-operative identification of the ureters.

	Number patients	Percentage
Obstruction/calculus	316	59.9%
Obstruction/malignancy	32	5.2%
Perioperative/identification ureter	11	2%
Ureteric injury	17	3.2%
Ureteric reconstruction	153	28.9%

Table 3: Indications for stent placement.

Overall, 18.8% of patients had one or more complications related to the stent insertion (Table 4). Most commonly, the stents were encrusted (14.5%). Any degree of solid, adherent accretion observed at stent removal was counted as encrustation. The encrustations occurred Predominantly in the stents indwelling for more than 3 months (76.3% of the total encrusted stents) versus 8.5% in the stents retrieved before 30 days. At removal, 5 patients warranted laser ablation of encrustations to allow safe removal, all of them in the group with a dwell time greater than 90 days of the total patients, 8.7% experienced haematuria, while in 5.4% the renal function deteriorated (some in the context of stent migration, which occurred in 6.1%).

	Number	Percentage total
Stent migration	32	6.1%
Stent encrustation	77	14.5%
Haematuria	46	8.7%
Sepsis	23	4.3%
Unplanned ED reviews	40	7.6%
Early removal stent	13	2.4%
Impaired renal function	29	5.4%

Table 4: Stent complications.

The rate of unplanned presentation to the emergency department in relation to the stent insertion was 7.6%, mainly due to pain, haematuria, sepsis (4.3%) or a combination. Overall, 13 stents (2.4%) had to be removed earlier than planned, due to sepsis and pain. There were no instances of forgotten stents in our series. Urine culture results were available in 387 cases pre stent removal. There were significantly less positive urine cultures rate in normal patients (3.3%) than in case with diabetes mellitus or chronic renal failure (33.3% and 39.6% respectively, p=0.001). For stents removed within 30 days of insertion the positive urine culture rates was 6.8%, increasing to 28.6% in stents left longer than 90 days (p=0.01).

Discussion

The literature abounds with reports on stent related complications. Stent morbidity is very common and goes significantly beyond discomfort and urinary symptoms (stenting was dubbed "a friendly procedure with unfriedly complications"). The stents are easy to use and reliable (There were only 6 documented failed attempts at stent insertion during the study period, all in the context of large, obstructed calculi and salvaged by insertion of ipsilateral nephrostomies). There were no issues pertaining to insertion or changes of stents in anti-coagulated patients.

It is, unfortunately, difficult to comment on the real incidence of stent pain, dysuria, frequency and urgency on retrospective data. All the patients who re-presented to the Emergency department post stent insertion described pain (among other symptoms). In contemporary studies, up to 85% to 90% of patients with indwelling ureteral stents reported irrigative voiding symptoms, including frequency, urgency and dysuria, as well as flank pain, suprapubic pain and haematuria; almost half of the patients had to alter their daily activities.

A questionnaire for stent symptoms was developed [6] (addressing pain, voiding symptoms, work performance, sexual health, overall general health and additional problems) [7] and it can form the base for future analysis of our cohort. Alpha blockade is associated with decreased stent related morbidity and smaller studies have shown benefit of anticholinergic medication. Other experimental approach is to decrease bladder urothelium irritation by intravesical submucosal injection of local anaesthetic or by developing stents with a soft distal coil [8].

Clearly the most direct action is to avoid stenting in uncomplicated ureteroscopies. The routine use of alpha blockers not widely adopted and in our institution we used Tamsulosin sporadically as discharge medication [9]. Microscopic and mild gross haematuria are usually related to urothelial irritation and self-limited. Persistent and significant bleeding after prolonged stenting may be due to ureteric arterial fistula, a rare and devastating complication of stenting. In our cohort, the rate of haematuria was 8.7% but the retrospective collection might have under-reported the haematuria in otherwise fit patients awaiting stone treatment. In 3 cases of radiation cystitis and ureteric stricture, haematuria prompted early cystoscopy and stent change.

Stent encrustation is a potentially challenging complications associated with prolonged dwell time, history of urolithiasis, metabolic and congenital abnormalities, chemotherapy, bacteriuria and pregnancy. No stent is inert within the urinary tract. Encrustation is a result of successive interplay of the stent surface and collecting system environment, with protein absorption onto biomaterial and bacterial organic molecules deposits on protein substrate forming a conditioning film. At this point, bacteria approach and attach with subsequent growth and biofilm formation. Cations are then attracted to the extracellular matrix with crystal precipitation and further self-propagation of crystal formation. Polyurethane (PU) is the most common used stent polymer and common uropathogens adhere to PU leading to shelter time to encrustation. Severe encrustation preferentially occurs at the renal and bladder ends of the stent, with the ureteric segment usually involved last secondary to peristaltic wiping. Coating of stent surface can modify these processes. Hyaluronic acid and covalently bound heparin are inhibitors of nucleation, growth and aggregation of salts and its presence leads to delayed encrustation vs. non-coated PU stents [10,11].

Significant encrustation might warrant a multimodal approach for stent management. In or series, there were no instances of forgotten stents, which, in our opinion is the reason we avoided severe complications such as stent fragmentation (reported as high as 30% in retained stents), [12] catastrophic renal impairment or ureteroarterial fistulae. All stents that required ureteroscopy and laser lithotripsy for removal were in the group with >90days dwell time; it is therefore imperative to radiologically assess a patient with longterm stent prior to removal. Our deduction as to the cause of the avoidance of retained stents is that our institution is the only tertiary referral centre for the area and the urology service covers all other local hospitals. The general practitioners have a unique referral direction and the patients return to the centre for their definitive stent management.

To better deal with this major patient safety issue, the use of computerised stent tracking system computer based and barcode acquisition systems significantly increases stent moni-toring [13]. Urinary tract infections (UTI) have been reported to occur in 22-34% of cases, even with prophylactic antibiotics; a negative urine culture does not rule out infection from stent colonisation. In our cohort, 387 patients had urine culture result available; stents removed with a flexible cystoscope had no urine sample analysed. Sepsis occurred exclusively in patients with stents inserted for obstructive calculi.

Also, there was a statistically significant difference depending on dwell time and comorbidi-ties; the diabetics and the patients with dwell time in excess of 90 days had significantly more positive urine cultures (6.8% vs. 28.6%, p value 0.01), as anticipated by previous published data [14] Stents left in situ more than 90 days have more than 9 times the chance of encrustations compared to their counterparts dwelling less than 30 days (76.3% vs. 8.5%).

Dwell time should be minimized to reduce rate of UTI, especially in patients with diabetes mellitus, chronic kidney disease and diabetic nephropathy (globally, these co-factors in-crease the chances of a positive urine 10 fold) [15] Further data collection is needed to charac-terise the infectious complications; a potential future directions is to send stent tip for culture to better capture the stent/ urine/ renal tract interraction. Among the proposed solutions to this common problem is using pharmacologically active agents incorporated into the stents to prevent infection and encrustation, generating activity at the urothelial level with minimal systemic involvement (such as Triclosan loaded stent) [16].

Our study aims for a complete presentation of our experience over 12 months. It identified a number of statistical correlations that might have relevant practical applications (for example, urgent theatre booking for patients with multiple co-morbidities, etc.) It is, however, a retrospective study over a relatively limited time period. The whole magnitude of the infectious complications can only be inferred, since not all patients had formal urine cultures. Also, the real frequency of the stent pain and irritation remains unknown; the only proxy measurement in our cohort is via the frequency of presentation to the emergency department.

Conclusion

Stent insertion is a procedure that brings numerous advantages. It does, however, interfere with patient's lifestyle and, in worst case scenario, can cause catastrophic complications.

Our review of the stent practice in a busy tertiary referral centre shows that major complica-tions can be avoided if the number of forgotten stents is minimised. The situation of our centre is quite idiosyncratic in that it is the unique tertiary centre for the area. Nevertheless, all efforts need to be made in the direction of medical records, tracking software and patient education arrangements to avoid this serious patient safety issue. Serious infectious and encrustation related complications can be minimised by decreasing stent dwell time, especially in patients with concurrent diabetes and renal impairment.

Acknowledgements

Conflict of interest

Dr Victor George Ilie declares that there are no conflicts of interest to disclose. Dr Vlad Ionut Ilie declares that there are no conflicts of interest to disclose.

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