ORIGINAL RESEARCH

Safety and efficacy of ultrasound-assisted bedside ureteric stent placement

A prospective, single-institution study

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ABSTRACT

INTRODUCTION: Previous studies have demonstrated the feasibility of bedside placement of ureteric stents; however, they have traditionally required two skilled operators and were associated with some stent malposition especially for proximal ureteric obstruction. We sought to investigate the efficacy and safety of a modified technique for ultrasound-assisted bedside ureteric stent insertion without the presence of a skilled assist.

METHODS: A single institution prospective study was performed from April-August 2023. Indications for stenting included infection, renal insufficiency, or intractable colic. Exclusion criteria included age <18 years, hemodynamic instability, and patients with history of chronic pain. Point-of-care ultrasound (POCUS) was used to confirm wire placement in the kidney and presence of a hydronephrotic drip from a 5 French ureteric catheter was used to confirm placement beyond the level of obstruction.

RESULTS: Of 28 patients, all patients underwent successful bedside ureteric stent placement. Mean age was 64.9 years and mean body mass index (BMI) was 33.2. Proximal ureter obstruction was present in 52% of patients and mid/distal obstruction in 48%. In cases with obstructing stones, the mean stone size was 8.1 mm with a range of 4–15 mm. Infection was the indication for stent placement in most patients (71%), followed by pain (4%) and acute kidney injury (AKI) (4%). All patients who underwent successful stent placement had presence of hydronephrotic drip from the ureteric catheter.

CONCLUSIONS: Ultrasound-assisted bedside ureteric stent insertion without a skilled assist is a safe and feasible option for management of acute ureteral obstruction. Presence of hydronephrotic drip can indicate successful access beyond the level of obstruction as an alternative to POCUS.

INTRODUCTION

Retrograde placement of a ureteral stent is both a common and potentially life-saving skill in a urologist's repertoire for management of acute ureteral obstruction. Indications for urgent ureteral stent placement in the setting of acute ureteral obstruction can include refractory pain, obstructive acute kidney injury (AKI), bilateral obstructing stones, and obstructive pyelonephritis. The most common setting for urgent ureteric stent placement is in the operating room with the aid of fluoroscopy and general anaesthesia, spinal anesthesia, or sedation; however, access to an operating room can be associated with long wait times and higher cost. Delayed upper tract drainage (>48 hours) in cases of acute obstructing stones (obstructive pyelonephritis, urinary tract infection [UTI], renal insufficiency) has been associated with worse patient morbidity and mortality, highlighting a need for timely methods to achieve renal decompression.[1]

Ureteral stent placement in both outpatient centers and emergency departments, with and without use of fluoroscopy, has previously been explored. In a retrospective study of 119 cases, Sivalingam et al showed good patient tolerability and success rates of 71% with ureteric stent placement under local anesthetic with aid of fluoroscopy.[2] In a retrospective study of 42 patients undergoing bedside ureteric stent placement without the aid of fluoroscopy, Nourparvar et al showed a success rate of 71%.[3] In both studies,

there was significant cost savings of $15,000–$19,000 per case by avoiding the operating room. The use of ultrasound for ureteric stent placement was first described in 1993 by Jerrarrd et al in an effort to minimize radiation exposure to pregnant patients.[4] More recently, Yang et al described their experience utilizing live ultrasonography for bedside ureteral stent placement with an improved success rate of 88%.[5]

Despite the successful results in previous studies, many of the stent placements occurred with a combination of two skilled providers (resident/resident, resident/fellow, resident/staff). In each study, the most common reason for failure was presence of proximal ureteric obstruction. When considering the potential application of bedside ureteral stent placement in many healthcare systems, it may not be feasible for urologists to have easy access to a second skilled assistant. At our center, we have been performing bedside ureteric stent placement with use of live ultrasonography, incorporating techniques to facilitate stent placement without need of a second skilled assistant. The objective of this study was to investigate the efficacy and safety of our technique with ultrasound-assisted bedside ureteric stent placement.

METHODS

We performed a prospective case series of all patients that underwent bedside ureteric insertion at one of two tertiary care institutions in Winnipeg, Manitoba between April 2023 and August 2023. Institutional ethics approval was obtained (HS25920). Patients presenting with acute ureteric obstruction were considered for bedside ureteric stent insertion. Indications included infection, renal insufficiency, and intractable colic. Exclusion criteria included age <18 years, hemodynamic instability, and history of chronic pain. After an initial training period of three cases with one attending staff, all cases were performed by one of two urology residents ranging from PGY2 to PGY4 upon review of clinical scenario with the attending on call. Verbal consent was obtained prior to the procedure. This study received institutional ethics board approval.

Patients were given oral or intravenous (IV) antibiotics prior to the start of the procedure. Patients were positioned appropriately (male patients supine, female patients frog-legged) in a sterile fashion. Lidocaine jelly was placed into the urethra. Patients were given analgesia/anxiolytic if felt necessary by the clinician. Typical analgesia medications used were either hydromorphone 1–2 mg orally or fentanyl 25–50 mcg IV. Typical anxiolytic medications used were either lorazepam 0.5–1 mg or midazolam 1–2 mg IV. Additional sterile drapes were used to cover the entire foot of the bed to allow for greater sterile working space. Ultrasound was positioned on the side of interest, with the cystoscopy monitor positioned opposite the operator. A working bench was used for sterile and easy access to equipment (Figure 1).

Cystoscopy was performed with either Olympus reusable cystoscope or Innovex disposable cystoscope. The ureteric orifice of interest was visualized and cannulated with a guide wire. A Sensor wire was tried first. If it was felt that the wire was not passing easily beyond the point of obstruction, a combination of a 5 French ureteric catheter and angled glide wire were used to get beyond the point of obstruction. Once felt to be coiling in renal pelvis, 5 French Flexi-Tip ureteric catheter was inserted over wire to 1) check for hydronephrotic drip; and 2) obtain urine culture if indicated. Guidewire (either Sensor

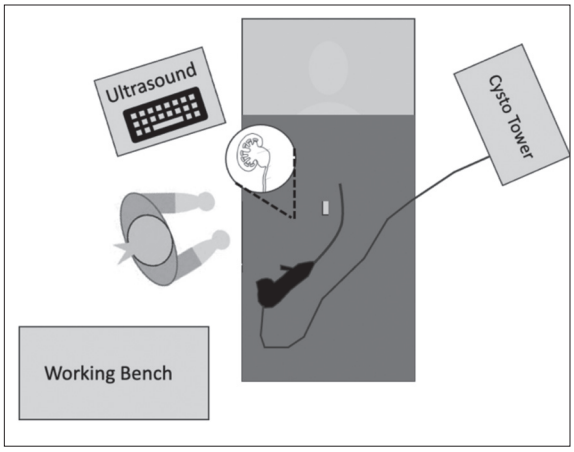

Figure 1. Bedside ureteric stent insertion setup.

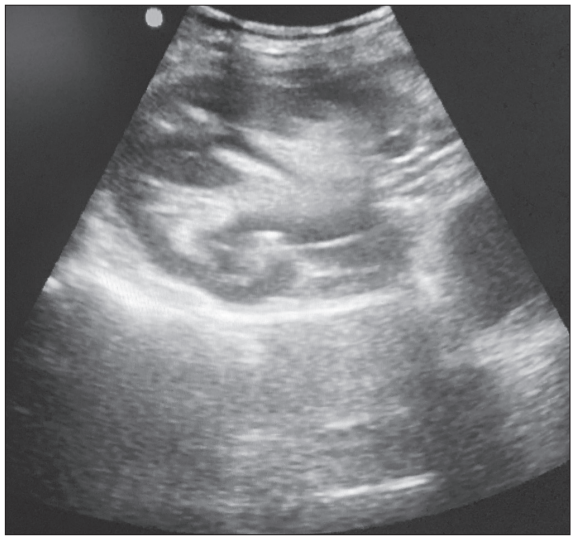

Figure 2. Renal point-of-care ultrasound with wire visualization.

Table 1. Patient characteristics and outcomes

	Number (%), N=28
Gender	
Male	8 (29%)
Female	20 (71%)
Mean patient age (years)	65
Mean BMI	33.2
Cause of obstruction	
Stone	24 (86%)
Malignancy	2 (7%)
UPJO	2 (7%)
Main indication for stenting	
Infection	20 (71%)
Pain	4 (14%)
AKI	4 (14%)
Mean stone size (mm)	8 (range 4–15)
Obstruction location	
Distal ureter	12 (44%)
Mid ureter	1 (4%)
Proximal ureter	15 (52%)
Laterality	
Right	13 (46%)
Left	12 (43%)
Bilateral	3 (11%)
Location of procedure	
ER	19 (68%)
Ward	7 (25%)
ICU	2 (7%)
Analgesia used	
Local anesthetic only	17 (61%)
Oral analgesics/anxiolytics	5 (18%)
IV fentanyl	2 (7%)
IV fentanyl/midazolam	4 (14%)
Stent placement successful	28 (100%)
Performed without skilled assist	26 (93%)
Hydronephrotic drip seen	28 (100%)
Wire visualized on POCUS	22 (79%)

AKI: acute kidney injury; BMI: body mass index; ER: emergency room; ICU: intensive care unit; IV: intravenous; POCUS: point-of-care ultrasound; UPJO: ureteropelvic junction obstruction.

or stiff wire) was replaced, and point-of-care ultrasound (POCUS) was performed to visualize wire in collecting system (Figure 2). Wire was manipulated (bouncing the wire) in a sterile fashion to aid in visualization.

Following this, a 4.8 French ureteric stent was inserted under direct visualization through the flexible cystoscope. For a pusher, a 5 French ureteric catheter was used with 5 cm cutoff to allow for optimal size through the flexible cystoscope. To provide tension on the wire during placement of the stent, one of two methods was used: 1) a nurse was asked to provide tension on the wire briefly during stent placement; or 2) the flexible cystoscope was placed low on the sterile field and the wire snapped in place on the sterile field, allowing the surgeon to operate the cystoscope with one hand and advance the stent/pusher with the other hand.

Following stent placement, a portable kidney, ureter, and bladder (KUB) X-ray was performed to confirm stent placement. Descriptive statistics were used for baseline characteristics using SPSS software.

RESULTS

A total of 28 patients from April to August 2023 underwent attempted bedside stent insertion with ultrasound guidance. Patient demographics are shown in Table 1. Average patient age was 64.9 years and mean BMI was 33.2. Causes of obstruction were stones (86%), malignancy (7%), and ureteropelvic junction obstruction UPJO (7%). Fourteen patients (50%) had proximal ureteric obstruction, while 12 patients (42%) had distal ureteric obstruction. In cases with obstructing stones, the mean stone size was 8.1 mm with a range of 4–15 mm. Infection was the indication for stent placement in the majority of patients (71%), followed by pain (4%) and AKI (4%). Procedures were performed in the emergency department (68%), ward (25%) or intensive care unit (ICU) (7%).

A total of 28 patients underwent successful ureteral stent placement (100% success rate). Two of 28 cases required a skilled assist due to anatomic challenges. In both cases, stent placement was successful. Topical lidocaine jelly alone was used in 61%, while a combination of lidocaine jelly and oral analgesia was used in 18% and a combination of topical lidocaine jelly and IV analgesic/anxiolytic was used in 21% of cases. Presence of a hydronephrotic drip from the 5 French ureteric catheter was seen in all cases. Wire was visualized in the kidney on POCUS in 79% of cases. One complication was encountered during bedside stent placement (patient #20). The stent was advanced too far into the ureter causing the distal end to coil in the distal ureter/ureterovesicular junction. This was identified cystoscopically at the time. After discussion with the attending and consent from the patient, a disposable flexible ureteroscope was used to cannulate the ureteric orifice, visualize the distal coil of the stent, and drag it down into the bladder without need for further intervention. Plain film X-ray of the kidneys, ureters, and bladder demonstrated appropriate stent placement afterwards in all cases. No cases were terminated early due to patient discomfort or technical difficulties.

DISCUSSION

Timely retrograde placement of a ureteric stent in the setting of acute ureteral obstruction is a common and potentially lifesaving skill in a urologist's toolbox. Although ureteric stent placement is often considered an emergent/urgent surgical procedure, the operating room can be a scarce resource, potentially delaying time to renal decompression. One Canadian retrospective study found that approximately 20% of emergency surgical cases experienced delays.[6] Delayed upper tract drainage (>48 hours) in cases of septic stones has been associated with a 29% increased mortality.[8]

In this large, prospective case series, we describe our technique for ultrasound-assisted bedside ureteric stent placement. We found that the majority of the time, this procedure can be performed safely and effectively without the need of a skilled assistant. The ability to perform bedside ultrasound-assisted ureteric stent placement without a skilled assistant may provide a feasible option for urologists to provide timely care in carefully selected patients with acute ureteral obstruction.

Safety and efficacy of bedside ureteric stenting has been previously demonstrated in multiple studies. Sivalingam et al reported their experience in 119 patients undergoing ureteric stent placement under local anesthetic only with the aid of fluoroscopy and showed a success rate of 71% and average cost savings of $19 000 per case compared to stent placement in the operating room.[3] Similarly, Nourpavar et al reported a success rate of 71% and average cost savings of $15 000 in patients undergoing bedside stenting without aid of fluoroscopy.[4] With use of live ultrasonography, Yang et al were able to increase their success rate to 87.5%.[5]

In each study, the most common reason for failure was presence of a proximal ureteric obstruction. In our experience, this is because when deploying the stent under direct vision it can visually appear that the wire/stent has passed sufficiently far beyond the ureterovesical junction (UVJ) to be in the kidney, while in fact not passing beyond the point of proximal obstruction. To limit this, we used POCUS and also checked for presence of hydronephrotic drip from the ureteric catheter. Overall combination of hydronephrotic drip and POCUS in bedside ureteric stent placement appears to improve rates of successful placement, with our series demonstrating an improvement on previously reported rates in the literature.

Urologists/urology residents may not be comfortable with POCUS, which may be a potential barrier to utilizing this technique; however, renal POCUS is associated with a short learning curve overall and may be a skill that can be easily attained.[7] Non-hydrophilic wires are very echogenic on ultrasound and we found a low learning curve in use of POCUS to confirm wire placement. Other techniques such as optimizing positioning with bolsters under the affected side can also help with visualization. An important finding was that presence of hydronephrotic drip from the ureteric catheter was seen in all successful cases. This can be an alternative for practitioners who are not comfortable with ultrasound or in cases where anatomic challenges make it difficult to visualize the kidney on imaging. Overall combination of hydronephrotic drip and POCUS in bedside ureteric stent placement appears to improve rates of successful placement. Use of these methods may be particularly useful in avoiding cases of premature stent deployment for proximal ureteric obstruction.

When starting this technique, we recommend a stepwise approach. First, we recommend gaining comfort with placing a stent under direct vision in the operating room and limiting fluoroscopy to a single shot at the end to confirm stent placement. Once comfort has been gained with this technique, bedside stent placement with a skilled assistant can be attempted without aid of fluoroscopy in carefully selected patients. Finally, once comfort has been obtained with bedside stent placement with aid of a skilled assistant, bedside stent placement can be attempted without aid of a skilled assistant.

Patient selection is key early on. Similarly to our exclusion criteria, we recommend avoiding this technique in patients who are hemodynamically unstable and patients with chronic pain. Patients with larger proximal ureteric obstruction can add a degree of difficulty and should also be avoided early on when starting this technique. Although we did not specifically evaluate patient tolerability, anecdotally we found that older patients (>50 years of age) generally tolerated the procedure better. Overall, we found patient tolerability for bedside ureteric stent placement was similar to stent removal with a flexible cystoscope.

We have identified a number of practical tips to aid in bedside stent placement without a skilled assistant, and in all but two cases, successful bedside stent placement was achieved without a skilled assistant. In some cases, the cystoscope was able to be positioned low down on the drape to allow for snapping the wire to the drape to provide tension, freeing the operators to control the cystoscope with one hand and advance the stent over the taut wire with the other hand. If this is not possible, a nurse can be asked to assist by holding tension on the wire and allowing the operator to view the ureteric orifice and advance the stent over the wire.

For female patients, 6 French ureteric stents can be inserted easily without an assist by advancing the stent and pusher over the taut wire with one hand, while performing cystoscopy alongside the wire with the other hand to visualize stent deployment. In two patients, skilled assist was required due to large, impacted stones with significantly tortuous ureters requiring use of 5 French catheter and an angled glide wire.

Limitations

There are several limitations to this study. Since this was a single-institution descriptive study, it is possible there was selection bias and we did not capture data on patients who were deemed not appropriate for bedside stent placement; however, we did try to use fairly broad inclusion criteria including larger obstructing stones, bilateral stones, and patients with elevated BMI. Our exclusion criteria included patients with hemodynamic instability because of the concern that a failed procedure could delay care; however, given the high success rate and our ability to rapidly mobilize personnel and equipment, it could be argued that bedside stent placement may have advantages in this patient population, allowing for more timely decompression; though future studies would be needed to explore this further.

Another limitation is that no objective measures of patient-reported pain/tolerability were carried out. Subjectively, patients tolerated the procedure reasonably well and no procedures had to be terminated due to patient discomfort. Future studies evaluating patient tolerability would be worthwhile.

CONCLUSIONS

In this prospective, single-institution study, we describe our technique for ultrasound-assisted bedside ureteric stent placement. We found that the majority of the time this can be performed safely and effectively without the need of a skilled assistant. Presence of hydronephrotic drip can indicate successful access beyond the level of obstruction for providers that are unfamiliar with POCUS. The ability to perform bedside ultrasound-assisted ureteric stent placement without a skilled assistant may provide a feasible option for urologists to provide timely care outside of the operating room in carefully selected patients with acute ureteral obstruction.

COMPETING INTERESTS: The authors do not report any competing personal or financial interests related to this work.

This paper was reviewed by the CUA 2024 Scientific Program Committee Co-Chairs and was selected as one of two winning essays. As such, it was presented at the 2024 CUA 2024 Annual Meeting in Victoria, BC.

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