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Trans-urethral snare stent removal: a novel, self-constructed innovation for simultaneous ureteral stent removal and safety guidewire insertion

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Abstract

Background: Ureteral stent insertion and subsequent removal remain one of the most common procedures to be performed in endourology. We aimed to evaluate a novel, one-step method, permitting simultaneous stent removal and guidewire passage using a self-constructed suture snare via standard cystoscopy. This method is to be used prior to ureteroscopy, in cases of minimal stent encrustation and peri-ureteral mucosal oedema, where identification and subsequent cannulation of the ureteral orifice may be a challenge.

Methods: A self-constructed suture snare is constructed using an open-ended ureteral catheter to facilitate this novel 'Switch' technique. Operative duration, cost feasibility, and potential complications with this novel method were assessed in patients with an indwelling stent duration above 100 days.

Results: Age inclusion in this study ranged from 21-35 years, with KUB (Kidney Ureter Bladder) scores all under 6, in the 5 patients assessed. Previous ureteral stent indwelling time ranged from 106 to 315 days. Reasons for (pre-stented) ureteroscopy were mostly stone related. The overall recorded procedure time for the 'Switch' technique was successfully performed in under 96 seconds (68-95 seconds range) in all cases within this series. No procedure-related complications were reported.

Conclusion: Utilising the suture Snare, the novel 'Switch' technique was successfully performed in all cases assessed. This method is both time and cost feasible and could be easily utilised in resource-limited areas, regional centres, or in cases where a stent grasper is not available, may have malfunctioned, or cannot adequately approximate due to distal ureteral stent encrustation.

Key words:

Novel Innovation;

Endourology;

TUSnSR;

COVID-19 delays;

stent removal;

Switch technique

Introduction

Ureteric stent placement and removal remains one of the commonest procedures performed in the field of endourology across the last four decades.[1] Various innovations within the ureteric stent design and manufacture, have the potential to assist with complications associated with this common surgical intervention. These advancements include the use of bio-degradable ureteral stents,[2] or the replacement of the distal coil with a magnetic end,[3] suture thread,[4] or a modified silicone end-piece.[5]

Although these various innovative advancements have shown promise, the 'ideal stent' has not yet been discovered. So the '*early as possible'* stent removal strategy is still advised to avoid the potential unwanted effects of ureteral stent placement and subsequent insertion.[1]

As per the recently published current COVID-19 pandemic recommended guidelines, the *'delay most procedures*' approach is advocated for patients who have already been stented, and may be due for subsequent ureteroscopy.[6] This unavoidable deferment will result in longer ureteric stent indwelling times, and thus increase the incidence of subsequent stent encrustation and peri-ureteric oedema.[7]

Stent encrustation and incrustation results from prolonged indwelling time and certain patient as well as stent related factors. Despite optimisation of these factors, encrustation along with other concerns are well described in the literature.[8] This can complicate removal in certain extreme cases, where stents migrate or are even forgotten.[9] An indwelling stent duration of 12 weeks or longer has proven to result in stent encrustation rates of 75.9%.[7]

Resultant peri-ureteric oedema may also pose a potential problem for retrograde ureteric access and subsequent planned retrograde ureteroscopy. This factor has been a hindrance in the catheterisation of the ureteral orifice, and has been reported as early as 1927, where authors described searching for the ureteric access route in a case of a distal ureteric stone, stating that '*the orifice was searched very carefully, but was probably lost between the pockets of the edema'.* [10]

Other complications associated with the removal of the encrusted stent is bleeding and ureteric blood clots, which may pose to be another challenge in subsequent ureteroscopy. This will also make the passage of the guidewire a potential challenge in cases where subsequent ureteroscopy is planned.[11]

Conventional practice prior to (pre-stented) ureteroscopy is to have the ureteric stent removed using the cystoscopic grasper or forceps. As a following step the safety guidewire is inserted into the ureteric orifice to facilitate ureteroscopy.

The use of graspers to remove ureteral stents in cases of stent encrustation, may pose a challenge in removal. Since the jaws may not close adequately, slipping upon retrieval from the bladder. The outer portions of the unopposed jaws may also injure the bladder neck, or urethra during retrieval.

Although stent removal is usually a straightforward step in routine (pre-stented) ureteroscopy, there may be cases where the subsequent retrograde ureteric access may be a challenge, despite having had a ureteric stent within that very same ureter, just moments before. These situations can arise in cases with stent encrustation and the presence of peri-ureteric oedema **(Figure 1).**

To facilitate an easier guidewire placement, some surgeons extract the ureteral catheter up to the level of the urethral meatus and then utilise the ureteric catheter lumen itself to run a guidewire up into the ureter via the stent lumen. However, this may not be possible in cases where stent incrustation is present.

Other authors place the guidewire alongside the stent with a plan to remove the indwelling ureteral stent subsequently. The issue with this is that the encrusted stent may migrate upwards during the guidewire insertion or may be stuck against an encrusted segment of the stent.

In cases where the ureteric orifice is reimplanted or crossed, various access techniques have been described to assist with ureteric access.[12] However, the challenge of ureteric access can also be found in an orthotopic ureteric orifice with a history of prolonged indwelling stent time, stent encrustation and bleeding. This study is focused on describing a novel, time and cost feasible, innovation in this specific cohort of patients.

The use of a snare device has been established in Urology, since the snare prostatectomy by Leopold von Dittel (1895),[13] and we have recently described the use of an endoscopic polypectomy cautery snare, in the Trans-Urethral Snare of Bladder Tumour (TUSnBT) method for the 'En-Bloc' resection of papillary bladder lesions.[14]

Our ophthalmology colleagues have recently illustrated the use of a Gor-Tex suture snare as an extraction device within a fine calibre needle, while operating within the anterior chamber of the eye.[15] Their innovation and concept led to the development of this novel, Trans-Urethral Snare Stent Removal (TUSnSR) method, allowing a one-step, 'Switch' technique to facilitate simultaneous ureteral stent removal and guidewire insertion, prior to ureteroscopy.

Methods

Construction of the Suture Snare

Using an open-ended ureteric catheter and a nylon suture thread, the suture snare is constructed in a sterile fashion (**Figure 2**). Length of the ureteric catheter is shortened (at a length 2 cm longer than sheath). After cutting the ureteric catheter to size, the nylon thread is inserted and tied on both the ends of the ureteric catheter. The distal (grasping loop) should at least encircle three fingers in diameter, while the proximal (handle) loop should be able to encircle the surgeon's wrist in diameter. A standard rigid cystoscope with dual instrumentation ports were used to perform the TUSnSR procedure.

Simulation

The application, passage and TUSnSR technique was successful in a simulated pre-stented model. The distal snare loop size was optimised (at three fingers spacing) to allow adequate control and sufficient circumference to encircle the distal ureteric coil loop while it remains visible endoscopically during cystoscopy. The length of the ureteric catheter is optimal at 2 cm longer (1cm at each end) than the scope length as it allows the suture snare to be manipulated proximally and visualized endoscopically.

Participants

Study participants with indwelling stent duration above 100 days, a combined KUB score below 6 were included,[16] along with features of minimal stent encrustation and/or peri-ureteric oedema at cystoscopy. Patients were not considered for this technique if ‘K’ or ‘U’ scores of 2, or above were visualised on preoperative images, this implies that the actual KUB criteria for the study is a B score of 3 or less ie. no calcification seen in the ureter and kidney, and the distal encrustation up to 'presence of calcification with width >5 mm, apparent at the coil at the vesical end, but not filling the coil'.[16]

For uniformity, all patients were managed by the same surgeon, within the same theatre complex. Tabulated data variables included; sex and age, construction time, stent product, size, side, preoperative KUB score,[16] duration of stent indwelling time, reason for stent insertion, duration of the passage of guidewire and removal of stent (‘Switch’ technique) and the post-operative Clavien Dindo score. [17]

Cost feasibility

The cost factor was also assessed for feasibility in this study. Cost quotation estimates (United States Dollars - USD) were attained for all the other endoscopic instruments which have been routinely utilised for ureteric stent removal.

The procedure

Standard cystoscopy is performed with the patient in the lithotomy position. Antibiotic prophylaxis is given at the time of anaesthetic induction. Snare construction was performed by the attending surgeon, during induction of anaesthesia in the operating room itself. Simultaneously, both channels of the instrument ports within the cystoscope are utilised. The cystoscopy instrument port, on the side ipsilateral to the intended orifice is used to pass the safety guidewire, while the suture snare is passed in the contralateral port. After passing the guidewire parallel to the stent, care is taken not to advance the stent unintentionally up the ureter. In cases where the stent migrates proximally, the suture snare is then deployed to allow for better control and distal traction of the ureteric stent. In the usual instance, the suture snare is deployed, and the distal ureteric stent coil is grasped using the suture snare. Under fluoroscopic screening, the safety guidewire is confirmed to be coiling within the renal pelvis, then the ureteric stent is removed while maintaining the safety guidewire up the ureter. After the removal of the ureteric stent, the guidewire remains in situ, and the ureter is now primed for subsequent ureteroscopy with the safety guidewire already in place **(Figure 3A and 3B).**

Ethics Approval

Local institutional Human Research Ethics Committee (Medical) Certificate (M200382-R14-49-23/03/2020) was attained.

Results

Over a 6-month period of assessment of 64 potential cases, 9 presented with indwelling times above 100 days (4 were excluded as their KUB scores were all above 6). The remainder cases with KUB scores all under 6 (n=5), were included in this prospective case series.

Age inclusion ranged from 21-35 years. Indwelling stent time ranged from 106 to 315 days. Reason for (pre-stented) ureteroscopy was mostly stone related. The recorded snare construction time (37-49 seconds) and procedure time for the 'Switch' technique was successfully performed in under 96 seconds (68-95 seconds) in all cases. No complications were reported **(Table S1).**

Cost feasibility

Quotations (31 March 2020) taken from a global Endourology (Karl Storz SE & Co. KG, Germany) supplier revealed the following costing prices per instrument. Standard Optical Biopsy Forceps Double Action jaws: 1297.00 USD, Standard Optical Grasping Forceps double action jaws: 1297.00 USD, Cystoscopic Port Grasping Forceps 7 Fr. semi-rigid double action jaws: 1465.43 USD, Flexible Ureteric Grasping Forceps 3 Fr. Double action jaws flexible: 1451.47 USD, Rigid Ureteric Grasping Forceps for stone fragments rigid double action jaws 5 Fr: 1346.77 USD.

While the TUSnSR suture snare had a total cost of only 14.31 USD (this included the open-ended Ureteric catheter (6Fr) (Boston Scientific AXXESS Ureteric Catheter) 13.08 USD and the Nylon Suture thread 1.23 USD).

Discussion

The TUSnSR technique is a simple technique that is performed using standard cystoscopy access. The standard extraction equipment upfront cost ranged from 1297.00 USD to 1465.43 USD, compared to the suture snare which only costs 14.31 USD. So, in comparison, the suture snare costs less than 1 percent of the upfront cost of the standard Cystoscopic Port Grasping Forceps (Karl Storz SE & Co. KG, Germany). Thus, the cost burden per case for this technique is minimal, as listed above.

Construction times were well under 50 sec, while the actual TUSnSR procedure itself was performed well under 96 sec in all cases (Table S1.). This time expenditure is minimal and comparative to conventional practice utilizing the conventional grasper. Snare construction was performed at anaesthetic induction, so there was no bearing on the actual theatre operative time. Thus, the time burden per case for this technique is minimal, as listed above.

We have shown this procedure to be successful in cases of minimal stent encrustation. However, in cases of a sustained proximal ureteral stent loop due to more severe encrustation, previous authors utilised a 2-0 Prolene suture knotted to the distal stent to allow a longer control and manipulation on the ‘elongated’ stent.[18] The insertion of the guidewire alongside the stent prior to stone laser or manipulation is still advised.[19]

In cases of unyielding ureteric stents, 11/12 cases were successfully managed using ureteroscopy and holmium laser, deferring only one case for percutaneous stone management. [20] Most management strategies now describe using a multimodality, along with staged procedures to render patients stent and stone free.[21]

Another described option (‘Bailout’ technique) utilised a secondary ureteric stent as a temporary measure, to facilitate for subsequent ureteroscopy and complete clearance at a deferred setting. [22]

The use of a suture lasso has been successfully applied in blind ureteric stent (without encrustation) removal in children. Sundaramurthy et al. utilised the suture attached to a feeding tube (Vellore Catheter Snare).[23] Similar results were observed in the non-cystoscopic attempt of stent removal using a lasso technique with success in boys and girls (97 and 41 respectively),[24] and again on 45/47 children.[25] The advent of blind ureteral stent removal has also been performed using a three-way urethral catheter snare created from a looped guidewire. [26]

Technical Aspects

Placing a guidewire while a stent is already in situ, is beneficial in cases with ureteric oedema and stent encrustation, as there may be bleeding around the ureteric orifice which all contribute to making the subsequent identification of the ureteric orifice challenging.

Since theatre time has an estimated cost of 37 USD per minute,[27] the cost feasibility on shorter operative time is another positive factor in this ‘Switch’ technique, since the stent removal and guidewire insertion is always done in one-step.

If poorly selected severely encrusted stents are snared, the resultant unyielding stent may be easily addressed. In this scenario, the distal suture loop at the handle of the suture snare is cut and the ureteric catheter housing the suture snare can be easily retrieved from the bladder. The remaining proximal knot can then be retrieved while pulling on the external suture thread. This is possible since the distal suture knot is fixed at around 3cm in circumference and is only functional as a lasso once the ureteric catheter is placed over the knot to constrict this diameter. Alternatively, a secondary stent can be placed if needed to facilitate for the ‘bailout’ staged technique. [22]

This TUSnSR method has a role to play in place of **tethered stents (stent with extraction strings)** and conventional **flexible reusable biopsy forceps**, in certain clinical scenarios. Tethered stents are of ‘limited value’ in cases of ureteric perforation, pyelonephritis, ureteral compression and where relook ureteroscopy is planned. [28] Other concerns with tethered ureteral stents include premature stent dislodgement, broken strings and Lower Urinary Tract Symptoms. [28]

When compared to the flexible reusable biopsy forceps, the (trans-cystoscopic port) grasper jaws are at times too small to allow complete closure in cases of a minimally encrusted distal ureteral stent coil. These unclosed, partially open jaws of the instrument may slip or cause significant urethral trauma during the extraction process. This potential problem is less likely, if the TUSnSR technique is performed.

Although force is not advocated in any aspect of endourology, the tensile physical properties are more in favour of snare entrapment than the forceps grasp in cases of ureteral stent removal. The maximum extraction tensile force attained with an enclosed 'snare like' encasement via a stone basket (2,4 Fr) surrounding the stent (1,9 Kg), is far greater, than the maximum extraction force (0,4 Kg) observed with flexible forceps. [29]

Furthermore, a 'tangential angle' of approach between the distal stent and forceps does not allow for a proper compressible grasp of the distal stent. [29] Stent compressibility is also less favourable in cases of stent incrustation and encrustation.

However, the TUSnSR loop diameter allows snare entrapment of the distal ureteral in cases with minimal encrustation.

Ureteral stent fracture has also been demonstrated in instances where a focused cystoscopic grasper is utilized on an encrusted stent. A previously published case was successfully managed by extracting the stent using 'snare' basket encasement retrieval of the fractured stent segment. [29]

The mucosal trauma from inadvertent mucosal injury with closure of the forceps is also a matter of concern. The likelihood of prostatic, urethral, or bladder mucosal injury is far greater when compared to entrapment using a suture snare, as shown **(Video S1).** The iatrogenic trauma factor is also of concern in cases with prostatic hyperplasia and narrow bladder neck or urethral diameters.

The grasping forceps mechanism failure and break off, of the approximating jaws have a far greater danger in causing subsequent morbidity than the TUSnSR technique. In cases of an unyielding stent, the suture ends are easily cut to remove the self-constructed snare device, this cannot be applied in all cases of forceps malfunction.

Once the snare is activated, the stent is retained and traction can be applied passively, whereas the grasping forceps can only provide traction on the ureteral stent if the surgeons hands are actively approximating the jaws of the forceps. This point is more relevant when simultaneous passage of a guidewire is passed up the ipsilateral ureter during the ‘Switch’ technique. Traction on the ureteral stent, using the activated snare can also be applied in cases where guidewire advancement leads to inadvertent migration of the ureteral stent up the ureter.

Another less significant advantage, of the snare above the forceps, include the absence of reflective glare often seen from the shiny shaft of the forceps. This factor may be a hindrance in cases of limited visibility or bleeding.

Limitations

Limitations within this study, include the relatively small patient number. This method could not be applied in cases with significant concurrent ureteral and kidney encrustation, as these cases may require multiple episodes to attain stent and stone clearance.

Another limitation is the fact that the cost calculation is for up front purchase cost, and is not corrected for multiple uses per item, but listed to illustrate the variance across standard grasping instruments. This factor highlights the initial cost feasibility with this self-constructed Snare. Other additional cost implications in utilising a re-usable endoscopic grasper include; the water, steam, repair, electricity and overall maintenance cost.

Conclusion

The TUSnSR allows for a one-step ‘Switch’ technique that can be successfully applied prior to (pre-stented) ureteroscopy in challenging scenarios, which may include cases of minimal stent encrustation, peri-ureteric mucosal oedema or bleeding. This method is both time and cost feasible and could be utilised in resource limited areas, regional centres, or in cases where a stent grasper may have malfunctioned or is not available at all.

Author Contribution Statement

AA

Conceptualization

Data-curation

Analysis

Investigation

Methodology

Administration

Writing-draft

Writing-review & editing

NL

Analysis

Methodology

Supervision

Validation

Visualization

Writing-review & editing

ASB

Supervision

Validation

Visualization

Writing-review & editing

Disclosure Statement

No competing financial interests exist.

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Legends

Figure 1. Cystoscopic images depicting the resultant peri-ureteral orifice oedema and stent encrustation associated with prolonged indwelling time. These scenarios may pose a challenge in locating the ureteral orifice after stent removal

Figure 2 A-H. Construction of the suture snare

A. Materials include; standard cystoscope, mosquito forceps, scissors, ureteric catheter (6 Fr / 70 cm - Axxcess™ Ureteral Catheters, Boston Scientific), nylon suture thread.
B. The ureteric catheter is shortened to allow manipulation of the suture snare just outside the cystoscope.
C. The nylon suture is passed through the distal end of the ureteric catheter.
D. A loop for the snare is created on the distal end (enough to encircle three fingers).

E. This knot is secured.

F. The suture thread is pulled into the ureteric catheter, so the knot is now concealed within the distal ureteric catheter lumen.

G. A larger loop is knotted proximally to allow for a ‘handle’ in the snare.

H. This snare can now be easily inserted into the instrument port via a standard cystoscope. The other unused, parallel cystoscopic access port will facilitate the simultaneous insertion of the safety guidewire **(*cf* Figure 3A-B).**

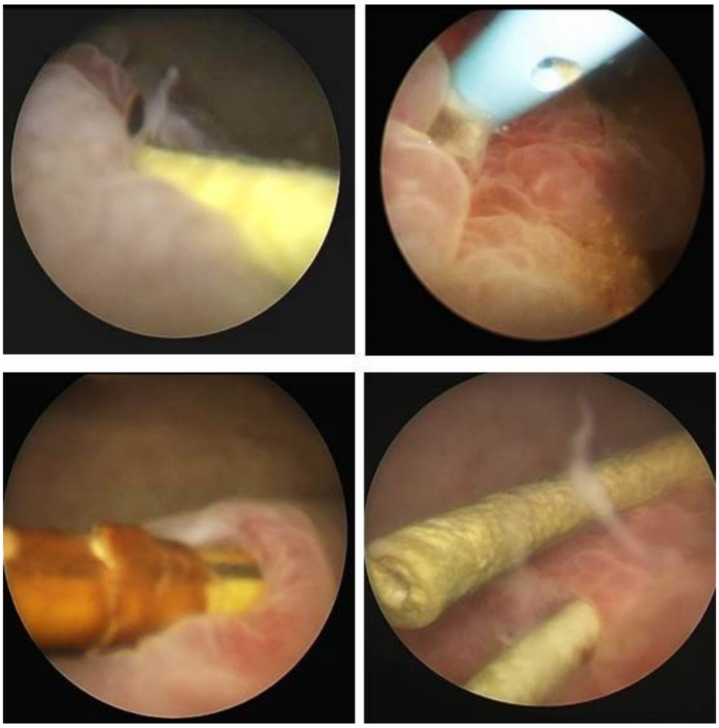
Figure 3. The one step ‘Switch’ Technique depicted with a left ureteric orifice: (3A) A schematic 3D image with the cystoscope inside the bladder (3B) Cystoscopic view. At cystoscopy, the ureteral stent and the orifice is identified. Peri-ureteric oedema and stent encrustation is noted. A guidewire is passed into the ureteric orifice **(green arrow)** and fluoroscopic confirmation is performed. Via the contralateral access channel, the snare is then inserted, and the suture loop is secured around the distal ureteral stent coil in the bladder. Once the suture snare is secured around the distal stent, gentle traction on the snare device **(black arrow)** allows for stent removal **(blue arrow)** and leaves the guidewire in situ. Simultaneous advancement of the guidewire may be required if inadvertent removal occurs while the stent is being removed from the ureter. Since they have been inserted via different access channels, the guidewire remains in situ after stent and cystoscopy removal. Subsequent ureteroscopy or access into the ureteric orifice is now easily attainable, without the need to change instruments.

Video S1. Surgical Video of the technique (attached as a supplemental file).

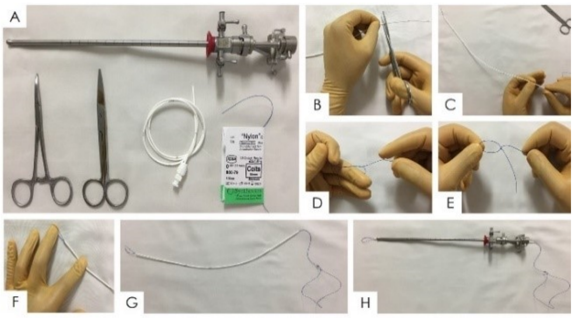
Table S1. Tabulation of the construction times, demographics, and details within this study (KUB: Kidney, Ureter, Bladder)

Table S1.

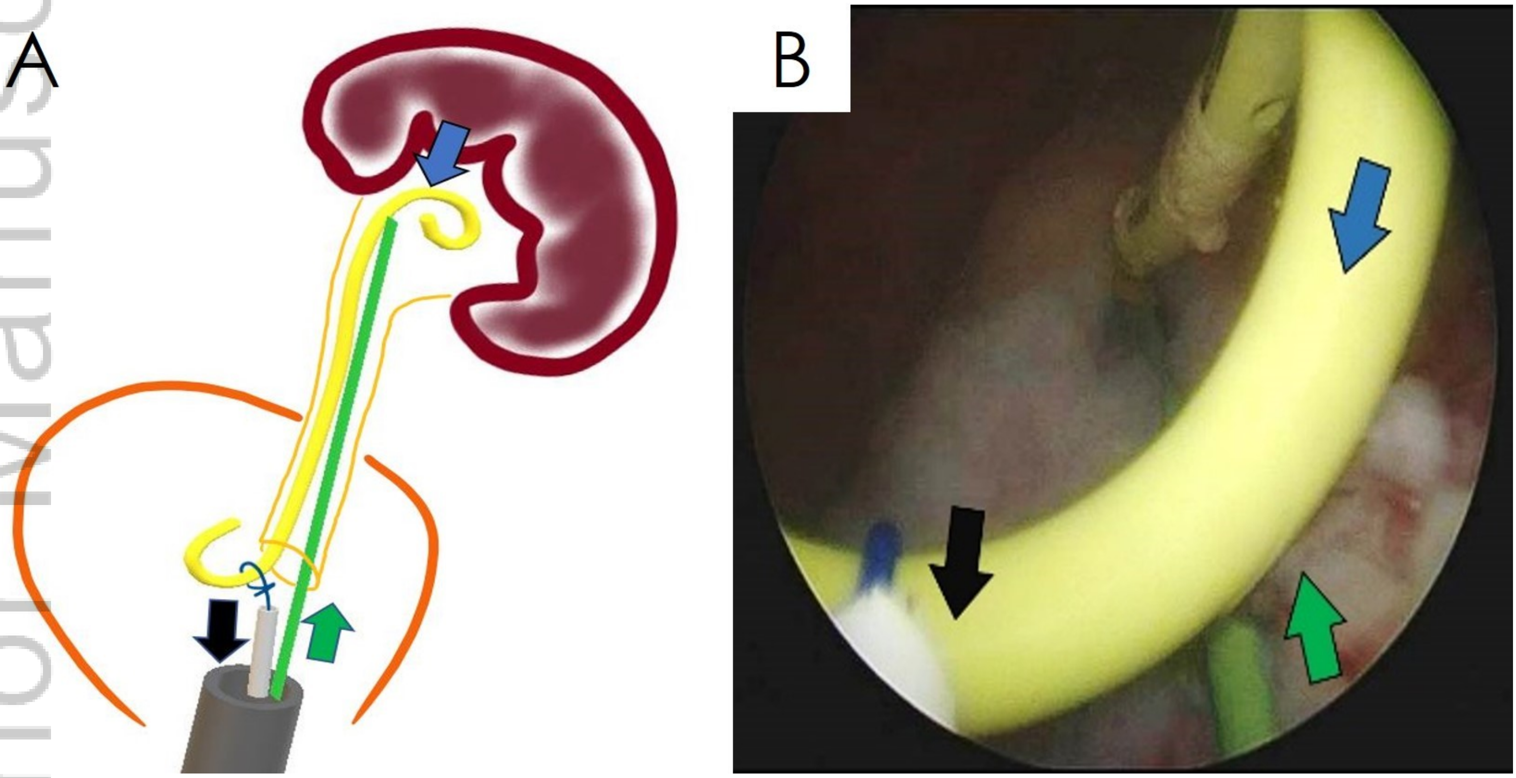
	Sex /Age	Snare construction time (sec)	Stent size/ brand	Left/ right ureter	KUB SCORE [16]	Peri-ureteric Oedema	Stent duration (Days)	Reason for stent insertion	Guidewire insertion to Stent removal time (sec)	Clavien Dindo [17] at 24 hrs (Grade)	Dysuria/ Urgency/ Frequency/ Haematuria
1	F/21	47	26cm / 4,7 Fr BD (Bard) Inlay optima	Right	K1U1B2	Present	121	Ureteric stone 3mm VUJ Stone	89	0	Mild Dysuria
2	M/56	43	26cm / 4,7 Fr BD (Bard) Inlay	Left	K1U1B3	Present	110	Ureteric stone 8mm VUJ Stone	95	0	-
3	M/50	37	26cm / 4,7 Fr BD (Bard) Inlay optima	Right	K1U1B3	Present	307	Ureteric stone 6mm Mid-ureter	68	0	Mild Urgency
4	M/64	49	26cm / 4,7 Fr BD (Bard) Inlay optima	Right	K1U1B2	Present	315	Ureteric stone 9mm right lower pole	70	0	-
5	M/35	39	26cm / 4,7 Fr BD (Bard) Inlay optima	Left	K1U1B2	Present	106	Ureteric Injury previous repair from gunshot injury	68	0	-



ANS_16621_AdamFigure 1..tif



ANS_16621_AdamFigure 2..tif



ANS_16621_AdamFigure 3..tif