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UROLITHIASIS

Apnoea is not necessary for flexible ureteroscopy and lasertripsy of renal stones: a prospective study over 6 years

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Introduction Temporary apnoea is often practiced during flexible ureteroscopy and lasertripsy (FURSL) for renal stones to reduce the potential movement of kidney secondary to respiratory excursions. While apnoea can help, it can also lead to respiratory complications, longer operative duration and ultimately prolong the length of hospital stay (LOS). The aim of this study was to look at the outcomes of FURSL without the use of apnoea.

Material and methods Over a 6-year period from March 2012–June 2018, consecutive cases of adult FURSL were prospectively evaluated. Patients underwent surgical and anaesthetic counselling, pre-operative assessment and protocol-based general anaesthetic without using apnoea. Data on patient and stone demographics, operative details, LOS, stone-free rate (SFR) and complication rates were collected and analysed.

Results A total of 292 patients underwent FURSL, with a mean age of 57 years and male:female ratio of 1.6:1. Pre and post-operative stents were inserted in 28.8% and 81.2%, a ureteral access sheath (UAS) was used in 61.6%. The mean single and cumulative stone sizes were 10.2 ±5.9 mm and 14.3 ±10.4 mm respectively. For a mean operative time of 48.8 ±25.5 minutes, the SFR was 88.7%.

The median length of stay was 0 days with 216 (74.0%) patients discharged the same day and a further 48 (16.4%) discharged within 24 hours. There were 11 complications, of which 10 were Clavien I/II, and 1 was Clavien IV.

Conclusions Ureteroscopy can be safely performed without respiratory apnoea, using anaesthetic and surgical protocols. It improves day-case rates for FURSL and minimizes complications.

Key Words: ureteroscopy ‹› RIRS ‹› apnoea ‹› complications ‹› urolithiasis ‹› anaesthesia

INTRODUCTION

One in seven people will develop urolithiasis in their lifetime [1, 2]. There are various treatment options available, with ureteroscopy (URS) being a widely used and effective surgical treatment for renal calculi [3–7]. While there is a rising trend of flexible ureteroscopy and lasertripsy (FURSL) for renal stones [3], there is also a broadening of indications for its use with its proven safety in solitary kidneys, pregnancy and patients with bleeding diathesis [4–7].

Although the majority of FURSL is done under general anaesthesia, in some instances it can be done under regional anaesthesia, but this is rare and not practiced widely [4]. FURSL can be made challenging due to potential movement of the kidney secondary to respiratory excursions during mechanical ventilation (MV). For this reason, temporary apnoea during the procedure is suggested and often practiced [8]. A recent study suggests that apnoea is not always mandatory, and the procedure can be safely done with apnoea [9]. While apnoea can help with the procedure, it can also lead

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to respiratory complications, longer operative duration and ultimately prolong the length of hospital stay [10–13].
To achieve apnoea, controlled ventilation with endotracheal (ET) intubation facilitated by propofol and neuromuscular block is often used [8, 9]. In an era of limitations on healthcare resources and pressure on hospital beds, day-case procedures where the patient is discharged the same day would have significant financial reward, efficiency and patient flow benefit and potentially lead to increased patient satisfaction [14, 15, 16]. With rising prevalence of stone disease, this would be a step in the right direction. We do not use apnoea for FURSL procedures and believe that this facilitates same day discharges and decreases the risk of respiratory complications.
The aim of this study was to look at the outcomes of FURSL for patients undergoing the procedure under a general anaesthesia without the use of apnoea.

MATERIAL AND METHODS

All adults with renal stones who underwent flexible ureteroscopy and lasertripsy for stones over a 6-year period from March 2012 to June 2018 were included in this study. It was registered with our hospital 'Clinical Effectiveness (CE) and Audit office'. Outcomes were collated prospectively for consecutive adults (>18 years of age) who underwent FURSL for renal stones, performed or supervised by a single surgeon (BS). Data was analysed by a neutral third party (HH) not involved with the original procedure.
Data collected was focused on patient demographics, stone parameters, use of ureteral access sheath (UAS), pre and post-procedural stent, length of inpatient stay (LOS), operative time, stone-free rate (SFR) and complication rates. Same day discharge was defined by patients discharged on the day of the procedure. LOS was defined from the completion of URS to the day of discharge. Longer LOS that were not same day discharges were further analysed, observing factors for admission and complications associated with the procedure. Complications were categorised using the Clavien-Dindo Classification of Surgical Complications [17]. Data was collected, recorded and analysed on Microsoft Excel and presented as mean ± standard deviation.

Pre-operative assessment

The diagnosis of stone disease was made on a non-contrast computed tomography (CTKUB) and all patients underwent pre-operative counselling for their FURSL procedure in a specialist kidney stone clinic. The patients were seen in a dedicated pre-assessment clinic and underwent a protocol based anaesthetic assessment with routine blood tests including full blood count and renal function along with urine culture. Patients also underwent chest X-ray and other tests (such as echocardiogram) as deemed appropriate. To optimise the patients prior to their procedure, a dedicated uro-anaesthetist reviewed all identified high-risk patients.

Use of an anaesthetic protocol

On the day of surgery, patients were admitted to our dedicated 'Surgical Day Unit'.
The anaesthetic pre-operative medications included oral paracetamol (1 g), oral ibuprofen (400 mg) unless contraindicated, and some form of gastric protection. A laryngeal mask airway (LMA) with spontaneous breathing-inhaled anaesthesia (sevoflurane) and fentanyl titrated to a respiratory rate of 10–15 breaths per minute was used as the default for anaesthetic management. No muscle relaxant was used, unless the patient was deemed to require intubation and positive pressure ventilation for anaesthetic reasons (commonly morbid obesity and gastro-oesophageal reflux), which was discussed pre-operatively.
If the patients did not receive pre-medication, they were given intravenous paracetamol and a non-steroidal anti-inflammatory drug (NSAID) during anaesthesia unless contraindicated. They also received standard protocol-based intravenous antibiotic at induction of anaesthesia, 500 ml of intravenous crystalloid and an anti-emetic intra-operatively.
Additional rescue opioid analgesia was titrated for pain in recovery if required. Unless contraindicated, all patients were discharged with oral paracetamol and ibuprofen, and explicitly advised to take regular analgesia for a minimum of three days post-operatively. They were counselled about expected post-operative pain, with tramadol or dihydrocodeine as rescue analgesia, unless otherwise indicated. Patient expectation was also addressed about stent symptoms and that most FURSL procedures were day-case surgeries and unless any clinical or anaesthetic concerns, they would be expected to go home the same day.

Surgical procedure

Prior to starting the operative list, the World Health Organisation (WHO) checklist was used and any concerns were raised with the theatre multidisciplinary team. All ureteroscopy procedures

followed a standard validated protocol which has been previously described [14, 18]. Under general anaesthesia, all patients were placed in the lithotomy position. The procedure commenced with a cystoscopy-guided safety wire placement followed by rigid ureteroscopy (4.5F or 6F Wolf or Storz) up to the pelvi-ureteric junction (PUJ). A second access guidewire was then advanced to the kidneys and if appropriate, a ureteral access sheath (9.5F/11.5F or 12F/14F Cook Flexor sheath, Cook Medical, USA) was used. A flexible ureteroscopy with laser fragmentation was then performed with all stones managed either with laser fragmentation, basket extraction or both techniques used in conjunction. Fragments were removed with a Cook Ngage stone extractor (Cook Medical, USA). Although respiratory excursions did not affect lasering in most cases, occasionally to counter for respiratory excursions, the laser was only activated when the stone was moving away rather than coming towards the scope, with timing of lasering becoming important in these cases. After the FURSL, a 6F ureteral stent was placed post-URS and this was removed 1–3 weeks post-procedure. Patients did not have a urethral catheter inserted routinely and were planned for same day discharge.

Post-procedural outcomes

Most patients were discharged the day of surgery (day 0). Those procedures which finished after 15:00, and therefore anticipated to stay beyond 20:00 when our day-case ward closed were admitted electively overnight and discharged the following morning. Stone-free rate (SFR) was defined as endoscopically stone-free and clinically insignificant fragments ≤2 mm [19]. The post-operative imaging was undertaken 2–4 months post-procedure, as ultrasound or CTKUB for radiolucent stone and plain KUB XR for radio-opaque stone and patients were seen in dedicated stone clinics by endourologists or stone nurse specialists.

RESULTS

During a 6-year period between March 2012 to June 2018, 292 patients underwent URS for renal calculi (Table 1). Patient demographics and overall outcomes are summarised quantitatively in Table 1. The mean age was 57 ±17.3 (range: 18-89 years). There were 181 males and 111 females with a ratio of 1.6:1. The mean operative time was 48.8 ±25.5 minutes and 20 patients (40 renal units) underwent bilateral FURSL. While the pre and post-operative stent were inserted in 28.8% and 81.2%, a ureteral access sheath (UAS) was used in 61.6%. The mean single and cumulative stone sizes were 10.2 ±5.9 mm and 14.3 ±10.4 mm respectively, and 259 (88.7%) patients were stone-free.

Table 1. *Patient and stone demographics*

N of patients = 292 (number of renal units = 312)	N (%) or mean ±SD
Age	57 ±17.3
Male:female	181:111
Operative time (minutes)	48.8 ±25.5
Bilateral procedures	40 (6.9%)
Pre-operative stent (n)	84 (28.8%)
Post-operative stent placement (n)	237 (81.2%)
Access sheath (n)	180 (61.6%)
Mean number of stones	1.9 ±1.6
Mean single stone size (mm)	10.2 ±5.9
Mean cumulative stone size (mm)	14.3 ±10.4
Stone-free rate (SFR)	88.7 %

Table 2. *Overall length of stay*

N = 292	
Median length of stay (LOS) (days)	0 (0–64)
Same day discharge (day 0)	216/292 (74%)
<24 hours	48/292 (16.4%)
1–3 days	21/292 (7.2%)
>3 days	7/292 (2.4%)

The median length of stay was 0 days (ranging from 0–64 days) (Table 2). While 216 (74%) patients were discharged the same day, 48 (16.4%) were discharged within 24 hours, 21 (7.2%) were discharged between 1–3 days and only 7 (2.4%) stayed more than 3 days (Table 2). The most common reason for not being discharged the same day was that the procedure finished late (n = 21), social reasons (n =1 7), for observations or management of their comorbidities (n = 14) and patients with a history of previous urosepsis (n = 6) (Table 3).

There were 11 complications which led to a delayed discharge (Table 3), of which 10 were Clavien I/II, and 1 was Clavien IV. The Clavien I/II complication included urinary tract infection (UTI), urosepsis, clot retention and pneumonia. The Clavien IV complication was a patient who was admitted to the intensive care unit (ICU) for urosepsis and respiratory failure. The only respiratory complication was due to an exacerbation of chronic obstructive pulmonary disease (COPD) requiring intravenous antibiotics.

DISCUSSION

Prevalence of urolithiasis is increasing in the population [1, 2]. Evidence has shown that FURSL is an effective treatment for renal calculi with high SFR [4–7]. Lasering and retrieving renal calculi has an added challenge due to respiratory excursions and the associated movement of kidney that occurs during spontaneous breathing. Apnoea is used in ureteroscopy for this purpose to manipulate breathing, reducing respiratory induced renal movement and the literature has suggested that it might be beneficial for clinical outcomes [8, 9]. In their paper, Gadzhiev et al. showed that reducing renal movement with manipulation of general anaesthetic provided better conditions for stone dusting, and the surgeons using it had a high degree of satisfaction [9].

In order to generate episodes of apnoea or to reduce renal movement, controlled ventilation frequently with endotracheal intubation is required along with the use of propofol and a high-dose opioid like remifentanil. Occasionally neuromuscular block is required if spontaneous breathing occurs despite the high-dose opioid [8]. Studies have shown that high-dose opioids are associated with an increased risk of respiratory complications and difficult management of post-operative analgesia [20]. Subsequently this can significantly prolong the length of stay and has also shown to increase the readmission rates [10, 11, 12]. This will lead to higher cost of treatment burdening the healthcare resources which is already stretched in most countries. Respiratory complications can include infection, atelectasis, pleural effusion, pneumothoraces, respiratory failure, aspiration pneumonia, pulmonary oedema, pulmonary embolism and exacerbation of known respiratory disease [10]. The POPULAR study, by Kirmeier et al. [10], showed a significant increased risk of postoperative respiratory complications in patients who had neuromuscular block in general anaesthesia.

Using techniques to minimize the movement of the kidney during FURSL can be beneficial from a surgical perspective to allow more precision for stone lasering and retrieval. We do not use apnoea for FURSL procedures at our centre. A standardised anaesthesia protocol is followed, using LMA to facilitate spontaneous breathing. Any renal movement from respiratory excursions are countered by adjusting the timing of the lasertripsy which is activated when the stone is moving away rather than coming towards the scope, thereby avoiding any laser damage or perforation of the pelvicalyceal system. Using an ET intubation is associated with risk of damaging adjacent structures. A Lancet meta-analysis by

Table 3. *Factors leading to admission or failed same day discharge and complications using Clavien-Dindo classification*

	<24 hours (n = 48)	1–3 days (n = 21)	>3 days (n = 7)
Factors for admission/failed same day discharge			
Late completion (n = 21) finished after 15:00 and patient could not be discharged by 20:00	21	0	0
Social reasons (n = 17) (living alone or far away/ awaiting social help at home prior to discharge)	10	6	1
Prolonged stay for further observations or management due to co-morbidities (n = 14)	9	5	0
Acute urinary retention (n = 1)	1	0	0
Prolonged stay due to previous history of urosepsis (n = 6)	3	3	0
Post-operative vomiting (n = 2)	1	1	0
Post-operative pain/ stent discomfort (n = 4)	2	1	1
Secondary to complications (n = 11) (Clavien I/II – 10, Clavien IV – 1)			
Clot retention (that did not require transfusion) (n = 1)	1 (Cl I)	0	0
Urinary tract infection (UTI) (n = 2)	0	2 (Cl II)	0
Urosepsis (n = 2)	0	2 (Cl II)	5 (Cl II-4, Cl IV-1)
Respiratory complications (n = 1)	0	1 (Cl II)	0

Xu et al. demonstrated that LMA intubations were associated with lower incidence of coughing, desaturations in oxygen levels and hoarseness of voice [21]. Caughlin et al. suggested that LMA is preferential in short procedures due to ease of placement, reduced post-operative discomfort and ultimately shortens patient's length of stay [22].

Although FURSL is a safe and effective procedure for renal stones, challenges remain in performing this as a day-case procedure with only a handful of studies supporting this [14, 15, 16]. The use of apnoea reduces respiratory excursions but potentially at the cost of increasing LOS and respiratory complications. Our prospective data for consecutive FURSL shows a day case rate of 74% and SFR of 89% with a low rate of complications. There were only two respiratory complications, both in patients with prior complex medical history and one was secondary to urosepsis. Although our study includes regional referrals and complex patients with relatively large stone burden, it does not have long-term follow-up or repeat sessions. Nevertheless, it shows that thorough pre-operative assessment, anaesthetic protocol without apnoea, procedure carried out by a dedicated endourologist, patient expectation management and

dedicated day-case unit all help in discharging the patients the day of surgery thereby reducing LOS. The goal of ureteroscopy is to achieve a good SFR with minimal morbidity. However, for a robust healthcare system it also becomes important to enhance and expedite hospital discharges and reduce unplanned re-admissions. More studies are needed to look at FURSL without apnoea, and advantages it offers to decrease respiratory complications and decrease LOS. The role of apnoea and the benefit it offers seems to be questionable for ureteroscopic stone surgery although it still plays a significant part in endoscopic management of upper urinary tract urothelial cancers. Perhaps the use of different anaesthetic protocols for FURSL could be studied in the setting of a randomised control trial to suggest the best protocol for different patient and stone demographics.

CONCLUSIONS

Ureteroscopy can be safely performed without respiratory apnoea using anaesthetic and surgical protocols. It seems to improve day-case rates for FURSL, decrease the overall length of stay and respiratory complications. Patient expectation management and counselling, with good anaesthetic and surgical cooperation during pre-assessment, surgery and post-procedure helps to improve the clinical outcomes of flexible ureteroscopy and laser-tripsy of renal stones.

COMPLIANCE WITH ETHICAL STANDARDS

The authors declare that there is no conflict of interest from any of the co-authors.
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ETHICAL APPROVAL

All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

INFORMED CONSENT

Informed consent was obtained from all individual participants/parents included in the study.

AUTHORS CONTRIBUTION

Protocol/project development – A. Pietropaolo, S. Prattley, B. Somani
Data collection or management – H. Ho, T. Hughes, L. Whitehurst
Data analysis – H. Ho, T. Hughes
Manuscript writing/editing – C. Way, B. Somani

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