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UROLITHIASIS

Is flexible ureterorenoscopy and laser lithotripsy the new gold standard for lower pole renal stones when compared to shock wave lithotripsy: Comparative outcomes from a University hospital over similar time period

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Introduction Renal lower pole stones pose difficulty in management due to anatomical variation, stone size, hardness and patient demographics. Flexible ureterorenoscopy and laser lithotripsy (FURSL) and shock wave lithotripsy (SWL) are preferred for stones 1-2 cm in size. We wanted to compare the outcomes of FURSL and SWL for lower pole stones during the same time period.

Material and methods All patients who were treated for lower pole stones with FURSL and SWL during a 19-month period were included. The stone free rate (SFR) was defined as ≤3 mm fragments on follow-up imaging or stone free endoscopically. Data was recorded in an excel spreadsheet with SPSS version 21 used for statistical analysis.

Results A total of 161 lower pole procedures were done (93 SWL and 63 FURSL). The mean stone size for SWL (7.4 mm; range: 4-16 mm) was significantly smaller than for FURSL (13.4 mm; 4-53 mm). The mean operating time and hospital stay for FURSL was 65 minutes (range: 30-160 minutes) and 0.5 days (range: 0-7 days) respectively.
The SFR was significantly better ($p < 0.001$) for FURSL (n = 63, 93%) compared to SWL (n = 23, 25%). There were 4 (6%) complications (3 Clavien II and 1 Clavien I) in the FURSL group (2 urosepsis, 1 UTI and 1 stent pain). Three patients in the SWL group (Clavien I) were readmitted with renal colic but there were no other complications.

Conclusions FURSL for lower pole stones seems to be a much better alternative than SWL with a high SFR even for larger stones and seems to be the new gold standard for lower pole stone management.

Key Words: calculi ‹› laser ‹› lithotripsy ‹› lower pole ‹› stone ‹› ureteroscopy

INTRODUCTION

Lower pole (LP) renal stones provide a unique challenge when considering their management. The issues are mostly around the presence of one or more lower pole anatomical variations, an increased infundibular (IF) length and a decreased IF width and angle [1]. Due to these factors combined with the stone size, choosing appropriate treatment modality can be debateable [1-5].

Currently, shockwave lithotripsy (SWL) and flexible ureteroscopy and lasertripsy (FURSL) are well-accepted methods for stones less than 2cm in size [2], with percutaneous stone treatment (PCNL) reserved for larger stones [6-10].

SWL is a relatively non-invasive, low-morbidity procedure using external shockwaves to fragment the stone [11]. It has a variable SFR (25-80%) dependent on the stone size, location, density and definition of SFR. However, as it relatively non-invasive with

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a low morbidity, it is favoured by many physicians when initiating stone treatment [10]. In the current European Association of Urology guidelines for urolithiasis, SWL is equivalent to FURSL for stones 1-2 cm, however the SFRs of SWL are inversely proportional to stone-size [3].

Ureteroscopy is an increasing alternative for treating lower pole stones. It is a minimally invasive procedure, involving the use of a flexible endoscope for the retrograde visualisation and fragmentation of renal calculi. It has now become the first-line treatment in many situations [9], such as: failure of SWL, obesity, large stones and when patient factors, such as pregnancy or coagulopathy, are present [11]. FURSL has high SFRs (76-100%) [9], especially for lower pole stones of <1 cm in size [12], and its morbidity rates are far lower than PCNL and comparable to those of SWL [2].

The aim of this study was to compare the outcomes of FURSL and SWL treatments for lower pole stones, during the same time period in our University teaching hospital.

MATERIAL AND METHODS

This was a comparative study using data from a renal stone patient database. All patients included had lower pole stones and were treated by either SWL or FURSL. The same stone team carried out the procedures, during the 19-month period (Jan 2012 – Aug 2013).

CT KUB (non-contrast CT) was performed for the initial diagnosis of renal calculi in all cases, with other diagnostic modalities to aid follow-up (plain XR KUB and/or ultrasound scanning). In addition, all patients had pre-operative haemoglobin and serum creatinine levels along with urine culture. The choice of SWL and FURSL was down to patient preference, although SWL was provided as the first-line treatment in most patients, with FURSL for SWL failure or if the latter was contraindicated.

SWL procedures were carried out as day case procedures by a mobile lithotripter (Wolf Piezolith 3000) under intra muscular analgesia. Pre-operatively, patients were given a combination of diclofenac 100mg per rectum, intramuscular pethidine (100 mg/2 ml) and intramuscular metoclopromide (10 mg/2 ml). An average of 3100 shocks were delivered at an average energy level of 17 kV during each session. If inadequate fragmentation occurred, retreatment with further SWL was undertaken but if further failure occurred the patient was advised to follow another treatment option.

FURSL was carried out as a day case procedure, under general anaesthesia, for the majority of patients, using Storz Flex X2 ureteroscopes, nitinol baskets and a Holmium laser for fragmentation, with the use of an access sheath where possible. A pre-operative/anaesthetic protocol was used where paracetamol (1 gm) was taken along with ibuprofen (400 mg) orally. General anaesthetic using a spontaneous breathing technique and laryngeal mask airway was used. Intraoperative analgesia was provided with intravenous fentanyl and morphine. Antibiotic prophylaxis and 500-1000 ml of intravenous crystalloid along with a single dose of ondansetron was also given.

The follow-up imaging, when the stone was radio opaque, was KUB X-ray (ultra-sound scan in other cases) taken 6-12 weeks after the patient's last FURSL or SWL treatment. There is still a lack of consensus in the definition of SFR, with new classifications being proposed to standardise it [8]. In this study we defined stone free as endoscopically stone free immediately post-FURSL procedure or having ≤3 mm residual fragments on follow-up imaging.

Data was recorded in an excel spreadsheet and SPSS version 21 (SPSS, Chicago, IL, USA) was used for statistical analysis; with Chi-Square testing undertaken and a P value of <0.05 considered statistically significant.

RESULTS

A total of 161 procedures on lower pole renal calculi were undertaken in this period (Table 1). Of these, 93 (58%) underwent SWL and 68 (42%) underwent FURSL. The male:female ratio for SWL was 60:33 with a mean ages of 54 years (range: 24-86) and the male:female ratio for FURSL was 39:29 with a mean age of 54 years (range: 16-85).

29 (46%) patients with lower pole stones treated with FURSL also had stones in multiple locations (11 in multiple renal locations and 18 in ureter). Of those patients who received FURSL, 20 (30%) had a pre-operative stent and an access sheath was used in 44 (65%) patients. The mean stone size for SWL (7.4 mm; range 4-16 mm) was significantly smaller than for FURSL (13.4 mm; range 4-53 mm), although the stone fragmentation rate for SWL was 61% the SFR was 24.7%. When comparing the results for the treatment of lower pole stones, the SFR was statistically significantly better (p <0.001) for FURSL (63/68; 92.6%) compared to SWL (23/93; 24.7%). The mean operating time for FURSL was 65 minutes (range: 30-160 min) with a mean hospital stay of 0.5 days (range: 0-7 days). SWL procedures were done in the outpatient clinics, at an average of about 45 minutes.

The complication rate for FURSL was 5.8% (4 patients); 2 patients developed urosepsis, 1 patient developed a post-operative UTI and 1 patient was readmitted due to stent pain (3 Clavien II and 1 Cla-

Table 1. *Comparison of shock wave lithotripsy (SWL) and flexible ureteroscopy and laser stone fragmentation (FURSL)*

Variable	SWL	FURSL	P-value
Gender, N(%)			
Male	60 (65%)	39 (57%)	
Female	33 (35%)	29 (43%)	
Age (Years)			
Mean Age (SD)	54 (14.6)	54 (16.6)	
Range	24-86	16-85	
Side of stone, N(%)			
Right	41 (44%)	47 (69%)	
Left	51 (55%)	19 (28%)	
Both	1 (1%)	2 (3%)	
Stone size (mm)			
Mean stone size (SD)	7.4 (3.0)	13.4 (10.8)	
Range	4-16	4-53	
Operation time (mins)			
Mean op. time	45	65	
Range		30-160	
Stone free rate (%)	24.7	92.6	p<0.001
Complications, N (%)	3 (3.2%) Clavien I	4 (5.8%)	P=0.414
Hospital stay (days)			
Mean stay	0 (0)	0.5	
Range		0-7	

vien I). All 3 patients who developed infective complications had positive pre-operative urine cultures and had received appropriate antibiotic prophylaxis pre-operatively. The complication rate for SWL was 3.2% (Clavien I), which represents three patients who were readmitted with renal colic with no other complications noted in this group.

DISCUSSION

The optimal management of lower pole renal calculi is still widely debated. Although the stone fragmentation rate for SWL was 61%, the SFR was 24.7%. SWL has a perceived advantage of being less invasive [10, 13] with no need for a general anaesthetic, but the disadvantages include relatively low SFRs and high retreatment rates [2] especially for lower pole stones [4]. Ureteroscopy is an increasingly viable alternative to SWL, with better stone free rates [2] and, with constant technological advancements being made, morbidity rates to rival that of SWL procedures [5].

Our study aimed to compare the outcomes of SWL and FURSL procedures during the same 19-month time period. We found a stark difference between the SFRs of the two procedures with 93% of FURSL procedures resulting in a stone free outcome compared to only 25% of SWL procedures resulting in the same outcome (P ≤0.001). Our results also showed that there was no significant difference (P = 0.414) in complication rates between the two procedures.

In line with other studies in the literature, the results of FURSL compared favourably to SWL. A randomized trial by Sener et al. [9] comparing SWL and FURSL for LP stones <1cm showed a SFR of 100% and 91.5% for FURSL and SWL respectively. They also noted that although both procedures had similar complication rates, FURSL required fewer re-treatments. In a different study undertaken by El-Nahas and colleagues [2] comparing SWL and FURSL in the treatment of LP stones between 1-2 cm in size showed that SFR was notably better after FURSL (86.5% *vs.* 67.7%), with complication rates slightly but not significantly higher for FURSL (13.5% and 4.8% respectively, P = 0.146) and retreatment rates considerably higher for SWL (60% *vs.* 8%). It was these results that led both studies to conclude that FURSL should now be considered as a serious alternative to SWL for the treatment of LP stones.

Stone free rate with SWL is influenced by variables such as obesity (increased skin to stone distance) and stone density and composition [6]; all factors which do not necessarily affect FURSL. Although the complexity of lower pole calyx can affect accessibility of the ureteroscope for FURSL, the stone clearance is much more commonly affected during SWL. Sampaio et al. suggested that the position of the lower calyx, along with other anatomical features, affect gravity-dependent drainage of stone fragments [1]. The other advantage of FURSL is the ability to treat larger sized stones (>2 cm) as shown in a study by Aboumarzouk et al. [14]. With our definition of stone free rate being heavily influenced by residual fragments, this anatomical problem may have influenced overall SWL outcomes. FURSL is not limited by anatomical variation and, due to the basket retrieval of any residual fragments, anatomical dependent drainage was not an issue for these procedures.

In our study, complication rates between FURSL and SWL were comparable (5.8% *vs.* 3.2% respectively). There were 3 Clavien II complications in the FURSL group (two patients developed urosepsis and one patient a UTI) compared to the three Clavien I complications in the SWL group, which were hospital readmission due to mild renal colic. This may be due to the relatively more invasive nature of the FURSL procedure. Similar to our study, previous studies have shown no difference in the complication rates between FURSL and SWL [2, 9].

A 2010 study by Koo et al. found that FURSL required a significantly higher 'actual' cost (£2602 *vs.* £426 for SWL) [7] per procedure to result in treatment success. It is important to note that the higher costs were often attributed to the infective complications after FURSL procedures causing a prolonged hospital stay. However, it is imperative to observe that this cost analysis study did not include the price of initial purchase and maintenance of the FURSL or SWL equipment. FURSL initial equipment costs are far lower than that of SWL [7] and, therefore, the overall expenditure may actually be lower for FURSL treatments. In another study by Somani et al., based on their business model the cost of URS for stones was found to be between £296-£429 and for diagnostic URS was found to be £131 [15].

One limitation of our study was the lack of randomisation. Due to the variety of renal stone treatments available and the non-acute nature of the condition, treatment modalities are heavily influenced by patient preference. Because of this, and the retrospective nature of the study, patients were not randomly allocated to a treatment group, and therefore factors such as age, weight, sex etc. could not be controlled. Further randomised control studies should therefore be undertaken to reinforce the results that we have observed. Another limitation is that the SFR of our SWL procedures was far lower than the normal expected range, which might be due to the use of a mobile lithotripter and our definition of SFR. In our study we did not look specifically at the reasons for failure of SWL including the stone density, infundibular length, width and infundibulopelvic angle. As most of the failed SWL patients then underwent FURSL with successful outcome, these factors seem to be less important for FURSL in the management of lower pole stones.

CONCLUSIONS

FURSL for the treatment of lower pole stones seems to be a better alternative than SWL. With a superior stone free rate, lower retreatment rates, and the ability to treat larger stones, it can therefore be seen as the valuable alternative for the management of lower pole renal calculi.

CONFLICTS OF INTEREST

The authors declare no conflicts of interest.

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