Flexible Ureteroscopy and Laser Lithotripsy for Single Intrarenal Stones 2 cm or Greater—Is This the New Frontier?

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Purpose: Percutaneous nephrolithotomy has been the standard of care for intrarenal calculi greater than 2 cm. Flexible ureteroscopy with holmium laser lithotripsy is a minimally invasive treatment modality that is able to treat large intrarenal calculi with the potential to decrease morbidity, while maintaining a high level of efficacy.

Materials and Methods: A total of 15 patients with a single intrarenal calculus 2 cm or greater were treated with retrograde ureteroscopic nephrolithotripsy. Lithotripsy was performed with a 7.2Fr flexible ureteroscope and 200 μ laser fiber. The stone-free rate was defined as the absence of any stones in the kidney or residual stone fragments less than 1 mm, which is too small to be extracted with a basket or a grasper. All patients underwent followup ureteroscopy within 15 days after the last procedure and renal ultrasound 30 days after the last treatment.

Results: There were a total of 15 intrarenal calculi 20 to 25 mm (mean 22) in diameter. The mean number of procedures was 2.3 (range 2 to 4). The overall stone-free rate was 93.3%. One patient (6.6%) had a residual 5 mm stone fragment in the lower pole of the kidney, which was followed expectantly for 2 years with no change in size. There were no major complications. There were 3 minor complications (20%), including 1 emergency room visit for fever and pain, and 2 cases of gross hematuria. All cases were performed on an outpatient basis.

Conclusions: In select patients with a single intrarenal calculus 2 cm or greater small diameter flexible ureteroscopy with holmium laser lithotripsy may represent an alternative therapy to standard percutaneous nephrolithotomy with acceptable efficacy and low morbidity.

Key Words: kidney, kidney calculi, ureteroscopy, lasers, lithotripsy

Large intrarenal calculi have traditionally been treated with PNL.[1,2] The 2005 AUA guidelines on the management of staghorn calculi indicate PNL as first line treatment for calculi greater than 500 mm^2.[3] While the stone-free rate following PNL is between 78% and 95%,[2,3] there are significant complications associated with the procedure, including urinary extravasation in 7.2% of cases, transfusion in 11.2% to 17.5% and fever in 21.0% to 32.1%.[2] Major complications, such as sepsis in 0.3% to 4.7% of cases, colonic injury in 0.2% to 0.8% and pleural injury in 0.0% to 3.1%, are rarer but still a source for concern.[2]

These potential complications have driven interest in the ability of other treatment modalities, most notably ESWL®,[4] ureteroscopy[5,6] and the 2 methods combined,[7] to treat large renal calculi. ESWL monotherapy is associated with only a 54% stone-free rate[3] and, therefore, it is indicated for single intrarenal calculi less than 2 cm.[4] The use of ESWL in combination with ureteroscopy has shown some promising results with a stone-free rate of 76.9% after 2 sessions.[7] In the recent literature there are increasing reports of endoscopic ureteroscopy as a viable treatment for large renal calculi. Stone-free rates of 77% to 91% have been cited,[5,6,8] which are comparable to PNL rates. Furthermore, with the technological advancement of modern flexible ureteroscopes and holmium lasers the complication rates of ureteroscopic procedures are decreasing.

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We evaluated the efficacy of small diameter flexible ureteroscopy with laser lithotripsy, as evidenced by the stone-free rate and morbidity, as an outpatient, minimally invasive treatment for intrarenal calculi 2 cm or greater.

MATERIALS AND METHODS

Patients with a single intrarenal stone 2 cm or greater in maximum diameter who underwent flexible ureteroscopy and laser lithotripsy were recruited from July 2003 to April 2006.

Technique

Patients were given intravenous preoperative antibiotics, typically ampicillin and gentamicin. Before the start of the procedure while under general anesthesia, the patient was placed in the dorsal lithotomy or low lithotomy position and prepared and draped in sterile fashion. The bladder was entered with a 22Fr cystoscope, allowing visualization of the ureteral orifice. This was cannulated with an open ended 5Fr catheter and a 0.038-inch guidewire. A second 0.038-inch guidewire was placed under fluoroscopic guidance with a Dual Lumen Flexi-Tip® ureteral access catheter or a Desilets-Hoffman introducer set. These tools enable dilation of the ureteral orifice without necessitating balloon dilation of the ureteral orifice. A ureteral access sheath was placed to allow optimal visualization, maintain low intrarenal pressure and facilitate stone fragments extraction. A 7.2Fr flexible ureteroscope and a 200 μ laser fiber were used for

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treatment. We use a holmium laser machine set at an energy of 0.8 J and a rate of 15 Hz. Following successful identification and lithotripsy of intrarenal stones and stone fragments a Double-J® stent was placed. Basketing of the fragments was only deemed necessary in cases with residual fragments more than 2 mm after multiple procedures.

All patients were evaluated after the first treatment with a second look ureteroscopic procedure. This was to allow time for spontaneous passage of stone fragments and visually inspect the kidney for a residual stone burden. Furthermore, all patients underwent renal ultrasound after 30 days after the second look procedure to ensure the absence of hydronephrosis and document the final stone burden. If the patients were stone-free with no hydronephrosis on kidney ultrasound, they continued the remaining followup with the primary care physician.

We defined the stone-free rate as the absence of any stones in the kidney or stone fragments less than 1 mm, which are too small to be extracted.

RESULTS

A retrospective review identified 15 patients, including 10 males and 5 females. Patient age was 39 to 70 years (mean 56.4). Table 1 lists patient demographics, and stone location and size. There were a total of 15 intrarenal calculi 20 to 25 mm (mean 22) in diameter. The mean number of procedures was 2.3 (range 2 to 4) with the followup procedure included in the total number. All cases were performed on an outpatient basis and required no hospital stay.

Number of Procedures

Ten of 15 patients (66.6%) required only 1 procedure for complete fragmentation of intrarenal calculi, 4 (26.6%) required 2 treatments and 1 (6.6%) required 3 treatments for complete stone fragmentation. At the end of each therapeutic procedure a Double-J ureteral stent was placed. Each patient then underwent final diagnostic ureteroscopy, at which time the stent was removed. According to the 2005 AUA guidelines for the treatment of staghorn calculi this equates to 21 primary and 15 adjuvant procedures for a total of 2.3 procedures per patient.

Operative Time

Mean operative time was 83.3 minutes (range 45 to 140) for a total of 21 treatments. Operative time was calculated from the time of cystoscope insertion to the completion of stent placement. These 21 procedures encompass all procedures in which stone fragmenting or significant basketing was performed.

Stone Retrieval

Five patients (33%) required the extraction of stone fragments more than 2 mm with a 2.2Fr nitinol tipless basket following the first ureteroscopic lithotripsy. In these patients only the larger fragments were extracted, leaving fragments less than 1 mm in situ to allow spontaneous passage.

Stone-Free Rate

The overall stone-free rate was 93.3%. After 1 to 3 procedures 60%, 86.6% and 93.3% of the patients were stone-free, as confirmed by followup ureteroscopy and renal ultrasound. One patient (6.6%) still had a 5 mm lower pole fragment after the third treatment, as evidenced by followup ureteroscopy and computerized tomography urogram. This patient was asymptomatic and had been followed expectantly for more than 2 years with annual kidney ultrasound, during which time the kidney stone did not change in size.

Stone Composition

Of the patients 73% had CaOx (monohydrate and dihydrate) stones. Two patients (13%) had mixed stones of uric acid and CaOx. Two patients (13%) had matrix stones.

Complications

There were no major intraoperative or postoperative complications in any of the cases. There were 3 minor complications (20%), including 1 case of fever and pain postoperatively, and 2 cases of hematuria, of which neither required transfusion. Only 1 patient was readmitted to the emergency room for fever and pain. Of our patients 40% had moderate or severe stent pain.

TABLE 1. *Results*

Pt No.—Age	Location	Stone Size (mm)	Basket	No. Treatments	Stone-Free	Stone Type	Minor Complication
1—45	Rt upper	22	No	2	Yes	CaOx	None
2—50	Lt mid	20	Yes	3	Yes	CaOx	None
3—67	Lt upper	23	Yes	1	Yes	CaOx	None
4—55	Lt upper	21	Yes	4	5 mm Lower pole	Uric acid + CaOx	Fever/pain (emergency room visit)
5—60	Rt mid	23	No	2	Yes	Matrix	None
6—61	Lt lower/lt mid	25	Yes	2	Yes	CaOx	None
7—55	Rt mid	22	No	3	Yes	CaOx	None
8—39	Rt renal pelvis	20	No	2	Yes	CaOx	None
9—67	Lt renal pelvis	23	No	2	Yes	CaOx	Hematuria for 2 days
10—45	Rt upper/rt mid	22	Yes	3	Yes	CaOx	None
11—60	Rt renal pelvis	20	Yes	2	Yes	CaOx	None
12—70	Lt mid	22	Yes	2	Yes	Matrix	None
13—66	Lt renal pelvis	24	No	2	Yes	CaOx	None
14—55	Rt renal pelvis	23	No	2	Yes	CaOx	Hematuria for 1 day
15—51	Rt renal pelvis/rt upper	21	Yes	3	Yes	Uric acid + CaOx	None