Urol Res (2006) 34: 108–111
DOI 10.1007/s00240-005-0020-6

ARTICLE

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Management of lower pole renal calculi: shock wave lithotripsy versus percutaneous nephrolithotomy versus flexible ureteroscopy

Accepted: 2 November 2005 / Published online: 7 February 2006

Abstract Current ureteroscopic intracorporeal lithotripsy devices and stone retrieval technology allow for the treatment of calculi located throughout the intrarenal collecting system. Difficulty accessing lower pole calculi, especially when the holmium laser fiber is utilized, is often encountered. Herein we review our experience where lower pole renal calculi were ureteroscopically managed by holmium laser fragmentation, either in situ, or by first displacing the stone into a less dependent position with the aid of a nitinol stone retrieval device. Lower pole stones less than 20 mm can be primarily treated by ureteroscopic means in patients: that are obese; have a bleeding diathesis; with stones resistant to shockwave lithotripsy (SWL); with complicated intra-renal anatomy; or as a salvage procedure after failed SWL. Lower pole calculi are fragmented with a 200 μm holmium laser fiber via a 7.5 F flexible ureteroscope. For those patients where the laser fiber reduced ureteroscopic deflection, precluding re-entry into the lower pole calyx, a 1.9 F nitinol basket is used to displace the lower pole calculus into a more favorable position, thus allowing for easier fragmentation. A nitinol device passed into the lower pole, through the ureteroscope, for stone displacement cause only a minimal loss of deflection and no significant impact on irrigation. Eighty-five percent of patients were stone free by IVP or CT scan performed at 3 months. Ureteroscopic management of lower pole calculi is a reasonable alternative to SWL or percutaneous nephrolithotomy (PNL) in patients with low volume stone disease. If the stone cannot be fragmented in situ, nitinol basket or grasper retrieval, through a fully deflected ureteroscope, allows for repositioning of the stone into a less dependant position, thus facilitating stone fragmentation.

Keywords Nephrolithiasis · Ureteroscopy · Calculi · Renal · Lower pole ureteroscopy

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Introduction

With recent advances in endoscopic and shock wave lithotripsy (SWL) technology, many alternatives exist today for the management of renal and ureteral calculi. As a consequence, questions have been raised regarding the application of particular modalities for the treatment of various types of stone disease. Although shock wave lithotripsy remains the most common mode of treating the majority of renal calculi, there are a number of factors, which will modify the stone-free rates achieved with lithotripsy monotherapy. In particular, the size of the stone, the stone composition and the stone location and collecting system anatomy will all determine the completeness of stone fragmentation as well as the completeness of fragment elimination.

Now 25 years after the introduction of shock wave lithotripsy technology, debate persists regarding the optimal management of stones located within the lower pole calyx. Retrospective studies have suggested that stone-free rates following shock wave lithotripsy treatment of lower pole calculi are not as good as those achieved with stones located in other locations within the intrarenal collecting system. Because of this concern, a number of randomized, prospective, multicenter trials were initiated. The following monograph reviews the long-term data from these trials.

Descripton of randomized trials

The majority of centers (44%) enrolled between five and ten patients into this randomized, prospective trial. Criteria for inclusion were that the patient must be more than 18 years of age with a stone burden less than or equal to 30 mm in aggregate diameter. Only solitary, lower pole stones were entered into the trial. Moreover, the patient must have agreed to be randomized between shock wave lithotripsy and percutaneous stone removal. Patients were excluded from the study if they had evidence of UPJ obstruction, stones in a caliceal diverticulum or infundibular stenosis. Moreover, if SWL or percutaneous nephrolithotomy (PNL) were contraindicated or not feasible due to body size, patient habitus or coagulopathy, etc., they were not entered into the trial. Other exclusion criteria included renal insufficiency, cystinuria, transplant kidneys, or pregnancy.

As noted above, this is a prospective, multi-institutional trial where separate randomization schemes are applied at each institution depending upon stone size.

Perhaps one of the more important facets of the study is the use of nephrotomograms to document stone-free status in the study patients. Previous studies have demonstrated a significant over-estimation of stone-free status when using KUB alone to assess whether or not a patient is stone free, following their stone removal procedures. Therefore, this current study utilizes nephrotomograms as a more sensitive measure to assess residual stone fragments following either shock wave lithotripsy or percutaneous nephrolithotomy.

Eight lithotriptors were represented in the study including the unmodified Dornier HM3 as well as a number of second and third generation devices.

Results

Results of the 122 patients who were eligible for follow-up, data is available for 112 (92%) of the patients. For stones less than 1 cm in diameter, only 67% of the patients treated with shock wave lithotripsy were rendered stone free, whereas all of the 18 patients treated by percutaneous techniques had complete stone removal. Stone-free rates for calculi between 11 and 20 mm were 21 and 92% for SWL and PNL, respectively. Although only a small number of patients were in the group of stones measuring 21–30 mm in diameter, only 14% of the patients treated by shock wave lithotripsy were rendered stone free, while all of the patients treated with percutaneous techniques had complete stone removal (Table 1).

As noted previously, stone size, stone composition and renal anatomy will all impact on stone-free rates. Yet, the size of the stone in each of the groups, stone composition and renal pre-treatment renal anatomy appeared similar while comparing the patients who underwent shock wave lithotripsy versus those underwent percutaneous nephrolithotomy. Overall, only 35% of the patients with lower pole calculi treated with SWL were rendered stone free, whereas the percutaneous group achieved a 96% success rate.

Hospitalization for the percutaneous group was significantly longer than shock wave lithotripsy-treated patients and the complication rate for the percutaneous approach was also higher than shock wave lithotripsy. However, the pre-treatment rate for auxiliary procedures was significantly reduced in those patients undergoing percutaneous nephrolithotomy as compared to those undergoing shock wave lithotripsy treatment.

Finally, 58 patients were followed for a minimum of 12 months in the study. Of the patients in the shock wave lithotripsy group, 26% had metabolically active stone disease whereas only 14% of the patients undergoing percutaneous stone removal were metabolically active with growth of existing stone material or new stone formation.

Table 1 Stone-free rates

Size (mm)	Shock wave lithotripsy	Percutaneous nephrolithotomy	*P* value
0–10	12/18 (67%)	18/18 (100%)	0.017
11–20	6/29 (21%)	22/24 (92%)	0.0001
21–30	1/7 (14%)	5/5 (100%)	0.033
Overall	19/54 (35%)	45/47 (96%)	< 0.001

Conclusions

The preliminary results of this randomized, prospective, multi-institutional trial suggests that while shock wave lithotripsy is less invasive than percutaneous stone removal, it is also less effective for lower pole calculi, especially for stones greater than 1 cm in diameter. When treating lower pole calculi with shock wave lithotripsy, it appears stone-free rates are dependent upon stone burden and pre-operative renal anatomy. However, stone-free rates achieved by percutaneous nephrolithotomy appeared to be independent of these variables.

The stone-free rates reported in the current study are lower than reported in the medical literature, perhaps due to the fact that nephrotomograms were used as the criteria for determining stone-free status. When recommending appropriate treatment to a patient with a lower pole renal calculus, percutaneous techniques might be considered, especially for stones greater than 1 cm in diameter. Finally, the long-term recurrence rate following treatment of lower stones might be greater in patients undergoing shock wave lithotripsy, due to the fact that residual stone fragments are left behind. Continuation of this long-term clinical trial as well as other randomized, prospective trials will be necessary in order to better define the most appropriate treatment for managing symptomatic renal calculi.

Ureteroscopic management of renal calculi

Certain indications may preclude the use of percutaneous stone removal or shock wave lithotripsy and favor the ureteroscopic management of renal calculi. These factors include the coexistence of ureteral calculi and/or ureteral strictures in addition to the renal calculi.

In addition, patients with bleeding diatheses, renal anomalies, solitary kidneys or morbid obesity may all benefit from ureteroscopic management of renal calculi.

Flexible ureteroscopy

While ureteroscopic instrumentation and intracorporeal stone fragmentation techniques had been available for many years, two recent innovations now allow routine ureteroscopic access and successful stone fragmentation for the management of renal calculi. Currently, 7.5 French flexible ureterorenoscopes are available which allow routine access to the intrarenal collecting system. The small caliber of these ureterorenoscopes often obviates the need for dilation of the distal ureter. We will either pass the ureterorenoscope over a working guide wire or in some cases utilize a ureteroscopic access sheath to access the proximal ureter and intrarenal collecting system.

Holmium laser lithotripsy

The other major factor that now allows for routine ureteroscopic access and management of intrarenal calculi has been the introduction of holmium:YAG laser lithotripsy. The holmium laser is an efficient and relatively safe device, which will fragment stones of all compositions. The major advantage, however, of the holmium laser is that small fibers can be placed through the flexible ureterorenoscope. Both the 200 and 365 μm fibers can be placed through a flexible ureterorenoscope. We prefer using the 200 μm fiber when managing intrarenal calculi, since the smaller fiber diameter allows for greater ureteroscopic deflection.

Our current settings for the Holmium laser are 0.8 J at 8 Hz (6.4 W). Studies have demonstrated that increasing the power to more than 1 J will rapidly damage the small caliber 200 μm fiber. Moreover, the relatively low power required to fragment calculi also allows the use of low power holmium lasers. These low power units provide 25–30 W of power, at a significantly reduced price as compared to the high power 80 W lasers.

Nitinol baskets/graspers

Even though the 200 μm fiber is quite flexible, one can still loose anywhere from 10–45° of tip deflection of a 7.5 French flexible ureteroscope when a 200 μm laser fiber is placed through the working channel. Another recent innovation, in the form of nitinol baskets and graspers, now allow for virtually full deflection of the flexible ureteroscopes with these instruments in place. Indeed, we have found that a 3 French nitinol basket and/or grasper can be passed through a fully deflected endoscope with minimal loss of tip deflection.

One technique that we have found useful is utilizing a nitinol basket or grasper to re-position the stone from the lower pole calyx into a less dependent position such as the renal pelvis or a upper pole calyx, which allows for easier access with the holmium laser fiber.

Technique of stone fragmentation

Complete stone fragmentation can usually be achieved with the holmium laser. One should attempt to vaporize or melt the stone by "painting" the laser fiber over the stone's surface instead of trying to just fragment the stone into multiple small pieces. If one can keep the entire stone together during laser vaporization, it precludes the need for trying to further break up all of the small fragments created if the stone is just cut into multiple pieces. We have found that complete vaporization is possible, obviating the need for extraction of large fragments. However, if one finds that vaporization is not possible or if extraction of fragments is indicated, the use of a ureteroscopic access sheath is highly recommended, which allows for rapid access of the ureteroscope to the intrarenal collecting system.

Conclusions

Ureteroscopic access to the intrarenal collecting system for the management of renal calculi has now become a routine part of our stone practice. We find that use of the holmium YAG laser as well as nitinol baskets and graspers, allows for access to virtually the entire intrarenal collecting system. In patients with small volume calculi who neither underwent shock wave lithotripsy nor percutaneous stone removal, or in patients having concomitant calculi who are already undergoing ureteroscopy, ureteroscopic access to renal calculi offers a rapid, safe and very efficient modality for managing complex stone patients.

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