Multi-session retrograde endoscopic lithotripsy of large renal calculi in obese patients

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Objectives: *To establish the safety and efficacy of planned multi-session retrograde endoscopic lithotripsy (REL) for the treatment of large renal calculi in the morbidly obese.*
Methods: *We retrospectively reviewed charts of patients who underwent multi-session REL procedures from 2003 to 2008. Inclusion criteria included body mass index > 35, total linear stone diameter > 2.0 cm, and patients with a preoperative plan to perform multi-session ureteroscopy. A total of nine patients (six with staghorn calculi) underwent 21 separate procedures. Stone size was measured on preoperative imaging and was defined as length in greatest diameter. Stone free was defined as the complete absence of residual stone on postoperative imaging.*
Results: *Mean body mass index of the patients was 47.8 kg/m^2. Mean total linear stone diameter was 3.8 cm. Three of nine patients (33%) were stone free after their final treatment. Mean decrease in stone size from preoperative imaging was 3.3 cm (83%). There were no intraoperative complications. Mean length of follow up was 0.88 years.*
Conclusions: *Multi-session REL is a safe alternative to percutaneous nephrolithotomy (PCNL) in obese patients with very large stones, including staghorn calculi. We recognize that the stone free rate in this series is lower than would be expected with REL for smaller stone burdens or with PCNL. Due to the limitations imposed by both the patient's general medical conditions as well as technical considerations, these patients are left with few options for treatment. Our experience is that management with staged ureteroscopy offers a reduction in stone burden and in some patients a stone free status that provides an acceptable patient outcome.*

Key Words: ureteroscopy, obese, staghorn, renal calculi

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Introduction

Obese individuals with large renal calculi present a difficult treatment dilemma because many of the treatment modalities commonly used to treat these stones such as extracorporeal shock wave lithotripsy (SWL) or percutaneous nephrolithotomy (PCNL) are either less effective or expose the patient to high risk of morbidity. In addition to technical considerations, obese patients are more likely to present with comorbid conditions such as diabetes, respiratory and cardiovascular disease increasing the risk of anesthetic complications. Obese patients also have an increased rate of postoperative complications, including wound infections, venous thromboembolism and cardiovascular events.[1] Clearly, minimally invasive procedures are preferred in these patients due to their increased risk of both intra and postoperative complications, but the treatment delivered also must have an acceptable success rate.

The introduction of small caliber ureteroscopes has allowed for less invasive treatment of large renal calculi. Previously, stones deemed too large for SWL monotherapy required more invasive procedures such as PCNL or open surgery. Several groups have reported excellent success rates of 67%-87% for large stones > 2cm in diameter managed with retrograde endoscopic lithotripsy (REL) exclusively.[2-5] Similarly, morbidly obese patients with small symptomatic stones treated with REL have stone free rates of 70%-80%.[6-9] While these results are encouraging, patients who are both obese and have large stone burden present a substantial treatment challenge and are unlikely to be rendered stone free with a single treatment. In the current study we present our experience using planned multi-session REL in obese patients with very large renal calculi.

Patients and methods

We performed a retrospective review of nine patients undergoing multi-session REL between January 2003 and January 2008. Inclusion criteria included patients with a preoperative plan to perform > 1 REL procedure to treat their stone burden, body mass index (BMI) greater than 35 kg/m^2 and stone size greater than 2.0 cm in total linear diameter. All patients were counseled regarding their treatment options including medical management, SWL, and PCNL and chose to pursue multi-session REL.

Preoperative imaging included either plain radiograph or non contrast thin slice CT scan. Maximal calculus length was measured on preoperative imaging and was defined as the maximal linear diameter on either transverse or cranial caudal section. In patients with multiple calculi in one kidney, stone size was defined as the sum of the maximal linear diameter of each stone.

Retrograde endoscopy was performed with an Olympus URF-P3 flexible ureteroscope (Olympus America, Center Valley, PA, USA). An 11/13F Navigator Ureteral Access Sheath (Boston Scientific, Natick, MA, USA) was used in all cases to aid in stone manipulation and extraction. Samples of stone fragments were sent for chemical analysis and recorded after the first treatment. A 200 micron holmium laser fiber was used to fragment the stones. The use of a ureteral access sheath and 200 micron laser fiber improved visualization, which we found to be the limiting factor in these patients. When possible, stone fragments were removed using a 1.9F Nitinol basket (Boston Scientific).

Postoperative imaging was performed within 12 months of the final endoscopic treatment. Patients were determined to be stone free if there were no residual stone fragments visualized on postoperative imaging. In all cases, the same modality that identified stone on preoperative imaging was used to evaluate residual stone burden postoperatively. Data analysis was performed using Microsoft Excel (Microsoft Corporation, Redmond, WA). Data are presented as mean $\pm$ standard deviation.

Results

The medical records of nine patients (67% male, mean age 58 $\pm$ 7.2 years) who met the inclusion criteria were reviewed retrospectively. Of the 9 patients, 6 presented with a single large calculus with a mean linear diameter of 3.8 cm $\pm$ 2.2 cm. One patient had two calculi measuring 1.8 cm and 0.5 cm in diameter. Another patient had a total of four separate calculi with the largest measuring 1.4 cm in diameter and a combined linear diameter of 4.1 cm. Mean total linear diameter for all patients was 3.4 cm $\pm$1.9 cm. The stone composition was predominantly uric acid in 3 patients, calcium oxalate monohydrate in 3, calcium phosphate in 2 and cystine in 1. Of the patients, 4 had prior failed SWL and 1 had prior failed REL. A total of 21 REL procedures were performed on these 9 patients. Significant comorbidities were present in 8 of the 9 patients including coronary artery disease with previous myocardial infarction in 2 (22%), hypertension in 6 (67%), chronic renal insufficiency requiring dialysis in 1 (11%), chronic obstructive pulmonary disease in 2 (22%), type 2 diabetes mellitus in 4 (44%) and history of deep venous thrombosis in 1 (11%). At the time of treatment, one patient was on antiplatelet therapy for a history of previous myocardial infarction. All of the patients were obese with a mean BMI of 47.8 kg/m^2 $\pm$ 7.3 kg/m^2 (range 35-58).

The 9 patients each underwent a mean of 2.3 $\pm$ 0.5 REL procedures (range 2-3). Mean total operative time for the first, second and third procedure was 91 $\pm$ 19, 99 $\pm$ 31, and 112 $\pm$ 66 minutes, respectively. The mean duration of time from first REL procedure to last was 41 $\pm$ 51 days. Postoperative imaging was performed

TABLE 1. **Patient and stone characteristics**

Age/ Sex	BMI	# of REL	# stones	Linear diameter (cm)	Residual stone (cm)	Size reduction	Preop symptoms (cm)	Postop symptoms
45 F	47.9	2	1	3.2	1.4	1.8	pyelonephritis	No
60 M	37.3	3	1	3.4	1.4	2	asymptomatic	No
62 F	57.5	2	1	7.2	0.5	6.7	pyelonephritis	Yes
50 M	48.8	3	1	3.5	0	3.5	pyelonephritis	No
57 F	51.6	2	1	2	0	2	pain	No
55 M	50.2	2	4	4.1	0.8	3.3	asymptomatic	No
65 M	51	2	2	2.3	0.7	1.6	pain	No
61 M	35	3	1	5.7	0.6	5.1	hematuria	No
67 M	51.6	2	1	2.8	0	2.8	pain	No

BMI = body mass index; REL = retrograde endoscopic lithotripsy

with plain radiograph in 3 patients and non contrast CT scan in 6 patients, and was performed an average of 79 $\pm$ 82 days (range 11-245 days) following their last REL procedure. Outcomes following treatment are shown in Table 1. A total of 3 of the 9 patients (33%) were rendered stone free after their final procedure based on the absence of any stone fragments seen on postoperative imaging. In those patients not rendered stone free, the mean residual total linear diameter had decreased to 0.9 cm $\pm$ 0.4 cm (mean decrease in linear diameter = 3.4 cm). For all patients (including those rendered stone free), the mean reduction in total linear diameter was 3.2 cm. This represents an 83% reduction in linear stone burden for the entire cohort. Seven of the 9 patients were symptomatic from their stone burden preoperatively. Symptoms included pyelonephritis and pain in 3 patients each and hematuria in 1 patient. Postoperatively, all patients except one had complete resolution of their symptoms. One patient with preoperative pyelonephritis cleared her infection immediately postoperatively but had another episode associated with a residual stone fragment 6 months later.

The patients were then stratified based on stone location, stone size, postoperative imaging modality, and stone composition, Table 2. The stone free rate was 40% in patients with lower pole stones (2 of 5) and 25% in patients with midcalyceal or renal pelvic stones (1 of 4). One patient with both an upper pole and lower pole stone had complete removal of the upper pole stone but a small fragment left in the lower pole. In patients with a total linear diameter greater than 4.0 cm, none was rendered stone free (0 of 3) compared with 50% (3 of 6) in patients with diameter less than 4.0 cm. The type of postoperative imaging (KUB versus CT) did not appear to influence the stone free rates (33% in both groups) indicating that the use of plain film radiography in some patients did not artificially increase the stone free rate through decreased sensitivity. In patients with uric acid stones, the stone free rate was 67% (2 of 3). One patient with uric acid calculi was treated preoperatively with urinary alkalinization for 1.4 years with no effect and this was not continued postoperatively. Another patient

TABLE 2. **Stone free rates stratified by location, size, postoperative imaging modality and stone composition**

Stone parameter	N	# stone free (%)
Location		
Upper pole	1	1 (100)*
Mid pole/pelvis	4	1 (25)
Lower pole	3	2 (40)
Total linear diameter		
< 4.0 cm	4	(2) 50
> 4.0 cm	3	(1) 33
Postoperative imaging modality		
CT	6	2 (33)
KUB	3	1 (33)
Composition		
Uric acid	3	2 (67)
Non uric acid	4	1 (25)

*Patient also had a lower pole stone that was not removed completely was started on urinary alkalinization postoperatively, but continues to develop recurrent calculi. The final patient is hemodialysis dependent and therefore was never started on urinary alkalinization. In contrast, the stone free rate for patients with non-uric acid stoned was 16% (1 of 6). There were no intraoperative complications associated with the treatments. Two patients required unplanned admission within one week of treatment for fever and were treated with oral antibiotics. One other patient required unplanned admission for pain control. Following the completion of treatment, 1 patient required REL for persistent stone burden 6 months following the completion of their treatment. None of the patients required more invasive procedures such as PCNL or open surgery.

Discussion

Over the past century as economic conditions have improved, obesity has become a major health problem worldwide. The prevalence of obesity has increased dramatically in the United States in the last 2 decades from approximately 15% in 1980 to 30% in 2000.[10] Furthermore, it has been shown that obesity increases the risk of renal calculi due to increased urinary excretion of calcium, oxalate and uric acid.[11] Therefore, it is not surprising when obese individuals present with large renal calculi. These patients make surgical procedures more technical challenging and increase the risk to the patient. For example, obese individuals wishing to undergo SWL may exceed the weight limitations of the lithotriptor. In patients who are obese but do not exceed the specified weight limit, treatment efficacy may be further compromised by the damping effect of the fat at the F2 focal point.[12] A skin to stone distance of greater than 10 cm has been shown to decrease SWL success due to the increased distance between the F1 and F2 focal points.[13] In contrast, PCNL for large calculi in obese patient has been shown to have a > 80% rate of stone clearance.[14-17] However, data on morbidity for PCNL in obese patients has been conflicting. Koo et al[15] showed no difference in complications between obese patients and normal weight controls, whereas Faerber et al[16] found a greater complication rate (37% versus 17%) in obese patients compared to normal weight controls. Pearle et al[14] found a marked increase in the rate of transfusion among the most obese patients. Tefekli et al reported an increased risk of postoperative complications and need for additional procedures in patients with metabolic syndrome (obesity, hyperlipidemia, hypertension, and diabetes).[17] Of our 9 patients, 7 were morbidly obese (BMI > 40), which presents an even more challenging situation. Several small series have reported modifications to the PCNL technique for obese patients, such as the use of 30F gynecologic laparoscopes and flank positioning.[18,19] These modifications, however, have not been readily incorporated into common practice.

In addition to the technical limitations imposed by obesity, there are also numerous medical considerations. Obese patients are more likely to present with multiple comorbid conditions such as cardiovascular disease, diabetes mellitus, chronic obstructive pulmonary disease, and chronic renal insufficiency, among others. These problems place patients at higher risk throughout each stage of surgical intervention. Anesthesia difficulties include the risk of aspiration, difficulty with intubation, increased cardiac and respiratory demands, and pharmacologic considerations of anesthetic medications. From a surgical standpoint, access to the organ of interest and increased operative time pose significant problems. Postoperatively, obese patients are at high risk for cardiovascular events, atelectasis, wound complications, and venous thromboembolism.[1] With appropriate perioperative precautions, these risks can be minimized but not completely eliminated.

Several groups have evaluated the use of REL in obese patients and/or large renal calculi. Dash et al[7] reported no significant difference in stone free rates between obese and normal weight patients. Similarly, Andreoni et al[8] reported a 70% stone free rate in morbidly obese individuals with small (< 1.5 cm), symptomatic calculi. Bultitude et al[9] were able to achieve a 100% success rate (defined as no residual stone on postoperative imaging or asymptomatic residual particles < 2mm in diameter) in morbidly obese patients (BMI > 40) treated endoscopically, but did note that those patients with stones > 15 mm were more likely to require multiple treatments. These studies emphasize the utility of minimally invasive techniques such as REL in obese patients. Endoscopic treatment of large renal calculi has become increasingly refined over the past decade and has been able to achieve stone free rates similar to those of PCNL in stones greater than 2 cm in diameter.[2-5] Ricchiuti et al[4] reported a series of 23 patients that underwent staged REL as an alternative to PCNL. In their series, the mean total linear length of stone burden was 30.91 mm. Their overall stone free rate was 73.9% with 43% progressing to require a second endoscopic procedure. They identified total linear diameter < 30 mm and calculus volume < 15000 mm^3 to be predictive of successful treatment. While this study raised the issue of multi-session REL, not all the patients required a second procedure. Furthermore, only 30% of their patients were obese and success was not stratified by BMI. Mariani[20] reported an 88% mobile stone free rate using flexible ureteroscopy with a combination of Holmium: YAG laser and electrohydraulic lithotripsy. In their cohort of 16 patients, 81% were obese with a BMI greater than 30 and all had stones greater than 4 cm in diameter. While their success rate is significantly higher than ours they defined stone free as the absence of mobile calculi, regardless of size. While this may be consistent with favorable short term clinical outcomes, we believe that these patients with residual calcifications are at especially high risk of recurrence and we felt that categorizing their treatment as successful would overestimate our actual success rate.

Due to the size of the stones being treated, we recognized that rendering patients stone free in a single procedure would either be technically impossible or extremely time consuming thus placing the patient at high risk of anesthetic complications. For this reason, we planned to perform multi-session REL in all of the patients. The goal of the initial procedure was not to eradicate the stone completely, but rather to decrease the overall burden while placing the patient at minimum risk of anesthetic or surgical complications and optimizing the chance for successful treatment in subsequent procedures. In our experience, after approximately 100 minutes of endoscopic lithotripsy, visualization became extremely limited making further treatment unproductive. Based on this previous experience, we felt that REL with a plan to end the procedure when visualization became poor and return at a later date would serve to minimize complications and increase stone eradication. Optimally, we plan to perform sequential procedures 2 weeks apart, but in this challenging patient population that goal often is not attained.

In the current study, we demonstrated the safety of performing multi-session REL. There were no intraoperative or major postoperative complications. Two patients were admitted postoperatively for fever but both were effectively treated with oral antibiotics and none progressed to urosepsis.

In terms of treatment efficacy, we were able to achieve an 83% reduction in the total linear diameter of stone burden. However, we recognize that our stone free rate of 33% is much lower than would be expected with REL for smaller renal stones or with PCNL. The reason for this discrepancy is multifactorial. First, we applied a very strict definition of successful treatment. Radiologic imaging demonstrating any residual calculi, even if considered small enough to pass spontaneously, was considered a treatment failure. Other studies have employed less stringent definitions of success with residual burden of up to 4 mm in diameter considered successful.[21] Following treatment, the majority of the patients included were asymptomatic from their stone burden. Because of this, several declined to pursue further treatment of residual stone unless they became symptomatic or showed increase in stone size on follow up imaging. In terms of clinical efficacy, 6 of the 7 patients who presented with preoperative symptoms had complete resolution. The one patient experienced recurrent pyelonephritis did so 6 months later after being lost to follow up. Finally, all of the patients included have two recognized risk factors (obesity and large stone burden) for treatment failure.

The major limitation of the current study is the small sample size. Over the past decade, surgical treatment for renal calculi has advanced to a point where few patients are unable to receive conventional treatment. This study examines a small subset of patients where conventional treatment (in this case PCNL) was not performed because of the limitations imposed by both the patient's general medical conditions as well as technical considerations. Because of the highly selected nature of the patients included in this study, it was not possible to perform a direct comparison between multi-session REL and conventional treatments with PCNL. The patients included in this study either refused PCNL or were not candidates for standard treatment with PCNL due to significant comorbidities or weight restrictions. Therefore, inclusion of a control group would necessarily include more favorable patients introducing bias.

Our experience is that management with multi-session REL offers a reduction in stone burden and in some patients a stone-free status with minimal morbidity; however patients should be aggressively counseled regarding the high probability that their stone will be incompletely treated. □

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EDITORIAL COMMENT

Flexible ureteroscopy is an important element of current urologic training and is within the skill set of the contemporary urologist. Furthermore, once the bladder is entered, obesity does not limit surgical exposure to renal stones ureteroscopically to the extent it may in open, laparoscopic, or percutaneous surgery. Recognizing this, the authors employed and reported a widely applicable approach to the management of a difficult -- yet increasingly common -- clinical scenario: large burden stone disease in the morbidly obese patient. Staged ureteroscopic lithotripsy is a readily available option for addressing stones in the obese.

Enthusiasm for their technique, however, must be tempered by an honest appraisal of their results. The practical concerns of limiting radiation exposure and realities of clinical practice may prevent routine computerized tomography to assess stone free status. Nevertheless, reliance on KUB to assess for residual stone burden in this obese population introduces an important risk of overestimation of stone clearance for 3 of their 9 patients.

Most importantly, even in the setting of planned staged procedures, the authors were only able to achieve a stone free state in 1/3 of their subjects, a sobering statistic that is difficult to accept as successful. Such findings should prompt a more rigorous, prospective evaluation of this technique. In the meantime, these results should remind us to carefully counsel this select group of patients of the limited ability to clear their stone burdens utilizing even multi-staged ureteroscopy.

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