Repeat Surgery After Ureteroscopic Laser Lithotripsy With Attempted Complete Extraction of Fragments: Long-term Follow-up

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OBJECTIVE To explore repeat surgery as a primary outcome measure in long-term follow-up after ureteroscopic laser lithotripsy (URS) with attempted complete extraction of fragments.

METHODS Retrospective review of the medical records of consecutive patients undergoing URS performed by a single surgeon. Repeat surgery was defined as any return to the operating room for management of stone or complications. For our survival analysis, we used the Kaplan-Meier method.

RESULTS From April 2003 through May 2005 at our institution, URS was performed in 226 renal units in 216 patients. At a median follow-up of 4.1 years, 19 patients required repeat surgery. At 1 year, the cumulative repeat surgery rate (CRR) was 5.8% (95% confidence interval, 3.4%-9.8%), rising to 8.6% (5.6%-13.1%) at 5 years. CRR was strongly related to evidence of residual stone on postoperative computed tomography (P <.001). At 5 years, CRR was 3.5% (1.1%-10.3%) in patients with renal units with no detectable fragments, 8.2% (3.5%-18.6%) with fragments ≤4 mm, and 46.2% (24.0%-75.2%) with fragments >4 mm. The Cox proportional hazards ratio was 9.08 (2.11-38.00; P = .003) with fragments that were >2 mm; the ratio was 22.14 (5.15-95.14; P <.001) with fragments >4 mm.

CONCLUSION Repeat surgery after URS is proportional to the size of residual fragments. Repeat surgery is a discrete objective metric that is consistent with, but does not require, rigorous postoperative radiologic assessment. UROLOGY 85: 1272–1278, 2015.

The prevalence of stone disease is increasing; the intensity and costs of care are accelerating even faster.[1-3] Increasingly, stone disease management is drawing attention for opportunities to improve the patient's experience, the metrics of use, and the costs of care.[4] Studies of claims data have reported an alarming rate of repeat surgery: 21% to 27% within 120 days.[5-7]

Traditionally, the efficacy of stone surgery has been assessed by early postoperative radiologic evaluation. Unfortunately, the urologic literature struggles with consistently defining the objective outcomes that are central to any improvement effort.[8,9] The optimistic term "clinically insignificant residual fragments" (CIRFs) was introduced almost 30 years ago to describe the debris after "successful" shock wave lithotripsy (SWL).[10] However, CIRFs were soon reported to be associated with symptoms and with repeat surgery.[11]

Today, the CIRF issue persists as an obstacle to urolithiasis management, as demonstrated by a recent 85-member expert panel evaluating outcomes after percutaneous nephrolithotomy (PCNL). The panel eventually settled on 2 separate definitions: 82% agreed that "treatment success" could include residual CIRFs that are 2-4 mm and 76% agreed that "stone free" was the complete absence of any stone by computed tomography (CT) imaging.[12] The experts cited an inadequacy of supporting literature to guide their deliberations.

If consensus regarding radiologic definitions of stone clearance success cannot be achieved, considering repeat surgery as a primary outcome measure seems reasonable. Repeat surgery is a discrete event that can be objectively measured and is clearly undesirable from the patient's perspective.[13] In this study, we examined our long-term follow-up results after attempted complete extraction of all ipsilateral stones, including fragments, after ureteroscopic laser lithotripsy; our primary outcome measure was repeat surgery.

METHODS

Under a protocol approved by our institutional review board, we identified consecutive patients who underwent ureteroscopic laser lithotripsy performed by a single surgeon, from April 2003 through May 2005. The inclusion criterion was primary

Financial Disclosure: *The authors declare that they have no relevant financial interests.*
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Submitted: February 25, 2015, accepted (with revisions): March 24, 2015

  http://dx.doi.org/10.1016/j.urology.2015.03.019
0090-4295/15

ureteroscopic laser lithotripsy for ureteral or renal calculi. Exclusion criteria included previous attempts to treat the same stones, a preoperative ureteral stent, an individual stone >15 mm, cystinuria, age <18 years, pregnancy, a transplanted kidney, or congenital anomalies (such as horseshoe kidney). Patients with multiple stones in multiple locations were included, but those with fixed stone burdens (such as diffuse papillary tip calcifications or nephrocalcinosis) were excluded.

In all patients, a standardized technique was used to attempt complete detection and clearance of fragments. Rigid ureteroscopy was performed below the iliac vessels; for stones in the upper tract, flexible ureteroscopy with a ureteral access sheath was routinely used. A 200-μm laser fiber was used in all patients; the initial energy setting was 0.6 J at 6 Hz, adjusted to the desired effect. Stones were generally fragmented to be just small enough to allow extraction. Impacted stones were fragmented in situ. With the patient in the Trendelenburg position, mobile stones were translocated to a dependent upper pole calyx from other regions of the kidney or from the proximal ureter for laser lithotripsy. An attempt was made to clear all generated fragments by basket extraction. The procedure was considered complete when no evidence of residual stone remained after inspection of all calyces on 2 occasions or when no further fragments could be retrieved. A ureteral stent was routinely inserted and removed within 1-2 weeks postoperatively.

Preoperatively, all patients underwent noncontrast CT, and each stone's location and the greatest single dimension were recorded. Postoperative imaging was exclusively performed by CT and those patients with fragmented upper tract stones were routinely requested to undergo imaging about 1 month after stent extraction. During our study period, 4-slice CT was used with a standard diagnostic dosing protocol with data acquired at 5-mm collimation thickness at 5-mm interval width with 2.5-mm reconstruction in transverse and coronal planes. Studies were reviewed initially at soft-tissue settings (window 400, level 350) for initial fragment detection and surveillance for postoperative renal and ureteral effects. Studies were then examined at 4× zoom and bone settings (window 2000, level 350) to measure stone fragments. Uric acid stones and subsequent fragments were measured on soft-tissue settings. Residual fragments were categorized as follows: none detected; ≤2 mm; >2 to ≤4 mm; and >4 mm.

We reviewed the clinic and hospital records of all patients, treating the renal units as discrete entities. Data abstraction included preoperative, intraoperative, and postoperative demographic and clinical information. Original CT images were available for re-review to resolve inconsistencies in the clinical record. Repeat surgery was defined as any ipsilateral operative procedure after the initial ureteroscopic laser lithotripsy.

Using free online Social Security Death Index data (on such sites as www.geneology.com), we conducted a rigorous search for any patient deaths during the follow-up period; we used the social security number or, if it was not available, the last name and date of birth.

To perform our statistical analysis, we used Stata 13.1 (StataCorp, College Station, TX). Univariate and multivariate measures, where appropriate, included the Pearson chi-square test, Fisher exact test, Student *t* test, Kaplan-Meier method, and Cox proportional hazards model.

RESULTS

For the total of 226 consecutive procedures, performed in 218 patients, the median follow-up time was 4.1 years (interquartile range, 3.5-4.8 years). Death was recorded in 17 patients (2 had repeat surgery) after a mean of 2.2 years, and no deaths were directly related to stone disease. Bilateral procedures were synchronous in 2 patients and asynchronous or staged in 6 patients. After shared decision making, repeat surgery was needed in 19 patients (8.7%): 14 underwent ureteroscopy and 5 underwent PCNL. Indications for repeat surgery included symptomatic ureteral stone in 14 and single patients with stone growth, persistent urinary tract infection, or occupational requirement for stone-free state. Symptomatic hydronephrosis without obstructing stone occurred in 2 patients and both responded to ureteral dilation and temporary stent insertion. Average stone size at repeat surgery was 8.2 ± 4.9 mm, and postoperative CT was performed in 13 patients, of which 8 had no residual fragments detected.

Age, sex, laterality, and stone location had no apparent effect on the need for repeat surgery (Table 1). Of the preoperative stone characteristics, the sum of stone lengths—but not the largest single dimension or the number of stones—was associated with repeat surgery. Stone composition was not associated with repeat surgery.

Postoperative CT scans were performed in 160 renal units (71%). We found no significant difference in the need for repeat surgery between patients who did and did not undergo postoperative CT. We found residual fragments in 76 renal units (47%): in the renal lower pole (63%), in the kidney outside the lower pole (34%), and on 2 occasions, in the ureter, neither of which required surgical intervention. The presence of larger residual fragments was strongly associated with the need for repeat surgery ($P < .001$). Patients with fragments ≤2 mm were very unlikely to require repeat surgery (2.4%); however, those with fragments that were >2 to ≤ 4 mm (19%) and > 4 mm (46%) had a proportionally increased need for repeat surgery.

Analysis of factors associated with the presence of fragments >2 mm are summarized in Table 2. Stone laterality, stone location, operative technique, and stone composition had no effect on presence of postoperative fragments. The number of stones ($P = .025$), the single largest dimension ($P = .001$), and the sum of stone lengths ($P < .001$) were all associated with the presence of fragments >2 mm.

At 1 year, the cumulative repeat surgery rate (CRR) was 5.8% (95% confidence interval, 3.4%-9.8%), rising to 8.6% (5.6%-13.1%) at 5 years (Fig. 1A). Significant differences in CRR were revealed after stratification by size of fragments (log-rank $P < .001$; Fig. 1B). At 1 year, the CRR was 2.3% (0.6%-9%) in patients with no detectable fragments, rising to 3.5% (1.1%-10.3%) at 5 years. No repeat surgery was needed in patients with fragments ≤2 mm.

The CRR in patients with fragments that were >2 to ≤ 4 mm was 20.8% (9.3%-43.0%) at 1 year, but no subsequent repeat surgery was needed throughout the remaining follow-up period. In patients with fragments