

Optimizing Stone-free Rates With Ureteroscopy

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Ureteroscopy is being increasingly utilized in the treatment and management of patients with renal and ureteral stones. Improving stone-free rates with ureteroscopy decreases the need for ancillary procedures and improves patient outcomes and satisfaction. This article reviews contemporary literature regarding the efficacy of a wide range of currently available techniques for improving stone-free rates with this procedure.

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KEY WORDS

Ureteroscopy • Upper urinary tract stones • Stone-free rate

Nephrolithiasis is a common ailment affecting approximately 1 in 11 Americans, and its rates are increasing.¹ Many patients have small stones that pass spontaneously; this process can be accelerated with medical expulsive therapy, primarily α -blockade. The majority of patients who are unsuccessful with α -blockade are treated with minimally invasive procedures such as shock wave lithotripsy (SWL) and ureteroscopy (URS).² In recent years, there has been a shift in the utilization of these procedures—URS is now more commonly used. Data from the Urologic Diseases in America project show that rates of URS have risen among Medicare beneficiaries and privately insured

individuals over time.³ A study examining stone management in Australia shows similar findings; the proportion of stones treated with URS has doubled in the past decade.⁴ Additionally, it has been shown that physicians who have recently entered practice or recently completed training are more likely to use URS.^{5,6} With increased utilization of URS and changing physician reimbursement models, patient outcomes and satisfaction with URS are of utmost importance. It is hoped that improving stone-free rates is one way to improve patient outcomes by decreasing future stone episodes and the need for further intervention. To date, there has not been a comprehensive review of modalities suggested to

optimize stone-free rates with URS. We review existing literature on methods of increasing stone-free rates, ranging from methods with supporting level 1 evidence to those that are anecdotal.

Preoperative Predictors

Determining whether a patient is an appropriate candidate for URS should be the first step in maximizing stone-free rates. Multiple preoperative predictors have been suggested as tools to improve decision making and to better counsel patients on expected outcomes. Several published nomograms have been generated to predict stone-free status with URS. A number of different parameters have been used, including stone burden, pres-

results with URS if active fragment removal is not undertaken. In a randomized controlled trial (RCT) in which patients harboring 1- to 2-cm renal or ureteral stones were subjected to flexible ureteroscopic laser lithotripsy without fragment extraction and were either not given or received tamsulosin, CT-measured stone-free rates at 4 weeks were significantly higher in the latter group (86.5% vs 69.4%). In addition, this group had significantly fewer episodes of postoperative colic (5.4% vs 22.2%).¹⁴ In another trial, patients with 5- to 10-mm distal ureteral stones undergoing semirigid URS and pneumatic lithotripsy without fragment retrieval were treated with or without postoperative tamsulosin.

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ence of hydronephrosis, stone location, number of stones, computed tomography (CT) stone attenuation, age, sex, preoperative stenting, and surgeon volume. The most influential parameters are consistently stone burden and location.⁷⁻⁹ Ito and colleagues⁷ have published multiple papers on preoperative assessment of stone burden. On multivariate analysis they found that stone volume, location, operator experience, obstruction, and cumulative stone diameter are independent predictors of stone-free status.^{7,10,11} The impact of pelvicalyceal anatomy on treatment of lower pole stones has been evaluated in multiple series as well. Infundibular length > 3 cm, infundibular stenosis, and infundibulopelvic angle < 30° have been shown to negatively impact outcomes of flexible URS for lower pole calculi.^{12,13}

Tamsulosin

Medical expulsive therapy can be used to improve stone-free

The stone-free rate in the tamsulosin group was higher (93.3% vs 70%), although this did not reach statistical significance. However, there were statistically significant improvements in the parameters of time to expulsion, number of colic episodes, lower urinary tract symptoms, and need for analgesia with administration of tamsulosin.¹⁵

Fragmentation Versus Active Extraction

Laser fragmentation of stones without active extraction has been utilized with the expectation that patients can spontaneously pass small resulting particles. Other rationales for this practice include shorter operating times and reduced potential for trauma with multiple ureteral excursions. In a retrospective analysis of 238 patients with ureteral stones treated with semirigid URS in combination with pneumatic or laser lithotripsy,

Göktaş and associates¹⁶ showed that patients treated with fragmentation alone had a 95% success rate (stone-free or residual fragments < 3 mm). However, 5% required an additional ureteroscopic procedure due to residual fragments and 25% required emergent readmission for pain management.¹⁶ To date, there has only been one RCT that has compared active retrieval versus spontaneous passage of residual fragments. Schatloff and associates¹⁷ randomized 60 patients undergoing semirigid URS with laser lithotripsy to intraoperative fragment retrieval or fragmentation to < 2 mm and observation. Stone-free rates were assessed with plain radiograph kidney-ureter-bladder and renal ultrasound or CT 1 month postoperatively, showing a 100% stone-free rate in those undergoing active extraction versus 87% in those undergoing fragmentation alone, though this difference was not found to be statistically significant. Fragmentation alone resulted in higher rates of postoperative rehospitalization, emergency room visits, and ancillary treatments. Interestingly, there was no significant difference found when comparing operating room times between the two groups.¹⁷

Antiretropulsion

Stone retropulsion can occur during URS for ureteral stones and may lead to longer operative times and treatment failure if a flexible ureteroscope is not available. Antiretropulsion devices have been developed to avert the latter and RCTs have been performed to assess their efficacy. In a prospective RCT of patients undergoing semirigid ureteroscopy with pneumatic lithotripsy, utilization of NTrap® (Cook Urological, Spencer, IN) was shown to have a significantly lower rate of retropulsion (0% vs 12%) and

a higher stone-free rate 1 week and 1 month postoperatively after semirigid URS and pneumatic lithotripsy. However, pain scores, analgesic use, and operative times were higher with utilization of this device.¹⁸ An RCT comparing the NTrap and Stone Cone™ (Boston Scientific Corp., Natick, MA) with control subjects showed that Stone Cone significantly lowered rates of retropulsion during semirigid URS and pneumatic lithotripsy. The Stone Cone, NTrap, and control groups had stone-free rates of 95.24%, 83.05%, and 72.41%, respectively, but only the difference between Stone Cone and the other groups was found to be statistically significant. The rate of auxiliary procedures was inversely related to the stone-free rates and pattern of significance was similar. Operating times in the occlusive device groups were significantly lower than the control group.¹⁹ In a pooled meta-analysis, NTrap was shown to have improved stone-free rates (odds ratio [OR] 3.08), decreased retropulsion (OR 0.23), and decreased need for auxiliary procedures (OR 0.29) when compared with control subjects. Operating room time was

retropulsion devices, costs must be taken into consideration. In a cost-analysis of commercially available antiretropulsive devices, devices were considered cost effective if the retropulsion rate was $\geq 6.3\%$. This estimate was based on retropulsion rates of 1.9% with devices and 16.3% without, average cost of devices to be \$278, and cost of secondary

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procedures of \$5290 for SWL and \$6390 for URS.²⁴ In summary, the utilization of an antiretropulsion technique may be helpful. Stone position and the availability of a flexible ureteroscope are important factors to consider when making a decision on whether to employ such an approach.

Ureteral Access Sheaths

The suggested merits of utilizing ureteral access sheaths (UAS) include simplifying repetitive passage of a ureteroscope into the upper urinary tract, reduced intrarenal pressure, improved vis-

stone-free rates in patients having undergone URS with use of UAS (79% vs 67%). However, in a recent retrospective study of 280 patients undergoing flexible URS for upper urinary tract stones, no differences of stone-free rates or complications were observed when comparing patients in whom UAS were used with those in whom they

were not.²⁸ A larger, randomized prospective study evaluating cost, complications, and stone-free rates is needed to define the merits of using an access sheath.

Stone Displacement

Modern flexible ureteroscopes have facilitated treatment of lower pole stones via their increased capability of deflection and improved visualization.^{29,30} The treatment of lower pole stones in situ may be hampered by the decreased flexion of ureteroscopes that occurs when a laser fiber, stone basket, or grasping device is in place (7%-16% reduction). This may result in reduced clearance of stones as well as scope damage.³¹ Displacement of lower pole stones to interpolar or upper pole calyces with graspers or baskets was first described in 2000 by Kourambas and coworkers.³² In a high-risk population with lower pole stones < 2 cm, it was demonstrated that displacement of lower pole stones into a more favorable position resulted in higher stone-free rates (90% vs 83%). Improvement in stone-free status with lower pole stone displacement was also reported by Schuster and associates.³³ For lower pole stones < 1 cm, they reported a stone-free rate of 89% with displacement and 77% without it. The differential

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not found to be significantly different.²⁰ Other approaches have been utilized in an effort to prevent retropulsion, including the Accordion® (PercSys, Palo Alto, CA) and BackStop® devices (Boston Scientific), and the injection of 2% lidocaine jelly proximal to the stone. Utilization of the Accordion device and the lidocaine technique was associated with significantly higher stone-free rates.²¹⁻²³ When contemplating the use of

ibility, decreased operative time, reduced cost, and higher stone-free rates.^{25,26} However, there are limited prospective RCTs assessing this technology. In a randomized prospective study, Kourambas and colleagues²⁵ showed no significant difference in stone-free rates if an access sheath was used, but operating time was significantly shorter. L'esperance and associates,²⁷ in a retrospective study, found a statistically significant increase in

was more prominent for stones > 2 cm—it was 100% with stone displacement versus 29% without it.³³ The aforementioned findings certainly support the displacement of lower pole stone prior to lithotripsy as this augments stone-free rates, especially for larger stones.

Patient Position

Patient position may be changed to facilitate fragment passage during ureteroscopic laser lithotripsy of renal stones. Placing the patient in a flank position with the targeted stone side up may augment migration of stones into the renal pelvis and facilitate passage through an access sheath or into a more favorable position for instrument entrapment. Herrell and Buchanan³⁴ reported using this maneuver in 11 patients with relatively large renal stones (1.5-5 cm). Stone displacement was not used in this series. Seven patients were stone free based on plain film imaging at follow-up, whereas the other four had an approximately 80% reduction in stone burden. The latter patients had stones

> 3 cm.³⁴ Bercowsky and associates³⁵ examined the effects of prone, supine, Trendelenburg, and reverse Trendelenburg positions on the infundibulopelvic angle of the lower pole with use of intravenous urography. They showed that the broadest angle of entry into the lower pole was with patient prone, 20° head down. This position was observed to increase the right lower pole infundibulopelvic angle by 16° and the left side by 25°. RCTs are needed to confirm the utility of the aforementioned maneuvers.

Autologous Blood Clot

Injecting an aliquot of autologous blood into the renal collecting system can entrap small stone fragments generated with lithotripsy or small stones naturally residing in the collecting system. The resultant clot can then be extracted with the fragments and theoretically improve stone-free rates.³⁶ We have found that, even after clot removal, small fragments continue to coalesce, most likely due to residual coagulation

factors within the collecting system. Others have used autologous blood as a barrier to prevent stone migration into the lower pole area during ureteroscopic stone removal.³⁷

Conclusions

Ureteroscopy is now the most commonly performed stone removing procedure. Efforts should be made to render patients stone free, as this will reduce the requirements for future secondary interventions. Utilization of some of the techniques and measures profiled in this article should facilitate this goal. There is a need to develop other novel approaches and technology to accomplish this objective. ■

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MAIN POINTS

- Utilization of ureteroscopy for the treatment of renal and ureteral stones is rising.
- Several nomograms based on patient and stone characteristics are available to clinicians to predict stone-free rates. Stone burden and location are repeatedly shown to be the strongest independent predictors of outcome.
- Administration of adjunctive tamsulosin and active extraction of stone fragments have been shown to result in higher stone-free rates and decreased postoperative complications.
- There are many antiretroulsive devices available for treatment of ureteral stones and their utilization may increase stone-free rates.
- There is insufficient evidence to determine if ureteral access sheaths have significant impact on stone-free rates; further studies are needed to evaluate their utility.
- Displacement of lower pole renal stone into more favorable calyces may improve stone-free rates, especially with treatment of larger stones. However, level 1 evidence in this area is lacking.
- Performance of ureteroscopy in the flank position or prone with the head 20° down can theoretically modulate renal anatomy into favorable positions, promoting fragment drainage and increased stone-free rates.

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