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Displacement of Lower Pole Stones During Retrograde Intrarenal Surgery Improves Stone-free Status: A Prospective Randomized Controlled Trial

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Study Need and Importance: Retrograde intrarenal surgery (RIRS) is a mainstay in the surgical management of stone disease. Despite a plethora of technological advancements over the last several decades, stones within the lower pole of the kidney continue to present a challenge to urologists. Indeed, lower pole stones are associated with the lowest stone-free status (SFS) of any location in the urinary tract. To avoid laser lithotripsy in the lower pole, many urologists use a basket to displace lower pole stones into a more accessible upper or interpolar calyx. We investigated whether displacing stones out of lower pole calyces would improve SFS for patients during RIRS.

What We Found: A total of 138 patients with lower pole stones were randomized to undergo RIRS with laser lithotripsy in situ or with basket displacement. Ultimately 124 patients (62 in each group) followed up for postoperative imaging. SFS was significantly higher in the basket displacement group (95% vs 74%, $P = .003$). There were no significant differences between groups in operative time, laser energy usage, complications, emergency department visits, or hospital readmissions (see Table). Multivariate analysis showed that only study group allocation was associated with SFS ($P = .024$).

Limitations: Despite lower sensitivity for detecting residual stone fragments compared with computerized tomography, we chose to use abdominal x-ray and renal ultrasound to avoid additional costs to patients. Additionally, there was an element of procedural variability, as patients were enrolled by 2 different surgeons without standardization of certain aspects of the procedure. Despite these limitations, our data suggest that displacement of lower pole stones during RIRS maximizes SFS.

Interpretation for Patient Care: Moving lower pole stones into more accessible parts of the kidney maximizes SFS during RIRS. The technique is simple, safe, and requires no additional equipment costs and little additional operative time. We encourage all urologists to displace lower pole stones during RIRS to improve patient outcomes.

Table. *Primary and Secondary Outcomes*

	Displacement group (n=69)		In situ group (n=69)		Odds ratio	*P* value
Stone-free status, No./total No. (%)[a]	59/62	(95)	46/62	(74)	0.15 (0.03;0.50)	**.003**
Operative time, median (IQR), min	65.0	(51.0;84.0)	55.0	(34.0;82.0)	0.99 (0.98;1.01)	.11
Total laser energy used median (IQR), kJ	2.80	(1.53;6.20)	1.84	(0.64;5.16)	0.94 (0.87;1.01)	.11
Complication (Clavien grade), No. (%)					0.48 (0.12;1.64)	.3
None	61	(88)	65	(94)		
II	7	(10)	3	(4.4)		
IIIb	0	(0)	1	(1.5)		
IVa	1	(1.5)	0	(0)		
30-Day ED visit, No. (%)	8	(12)	4	(5.8)	0.48 (0.12;1.64)	.4
30-Day hospital readmission, No. (%)	3	(4.4)	3	(4.4)	1 (0.17;6.01)	1

Abbreviations: ED, emergency department; IQR, interquartile range.
Bolded *P* values indicate statistical significance.
[a] A total of 14 patients (7 in each group) did not receive follow-up imaging to determine stone-free status.

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Displacement of Lower Pole Stones During Retrograde Intrarenal Surgery Improves Stone-free Status: A Prospective Randomized Controlled Trial

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Data Availability: The data sets generated during and/or analyzed during the current study are available from the corresponding author on reasonable request.

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Purpose: Lower pole renal stones are associated with the lowest stone-free status of any location in the urinary tract during retrograde intrarenal surgery. Prior work has suggested displacing lower pole stones to a more accessible part of the kidney to improve stone-free status. We sought to prospectively compare the efficacy of laser lithotripsy in situ vs after displacement during retrograde intrarenal surgery for lower pole stones.

Materials and Methods: Between July 2017 and May 2022 patients undergoing retrograde intrarenal surgery for lower pole stones were randomized into an in situ or displacement group. Demographics, comorbidities, and operative parameters were documented. Primary outcome was stone-free status, determined by combination of abdominal x-ray and renal ultrasound at 30-day follow-up. Secondary outcomes included operative time, 30-day complications, emergency department visits, and readmissions.

Results: A total of 138 patients (69 per group) were enrolled and analyzed. Baseline characteristics were similar between groups. Stone-free status significantly favored the displacement group over the in situ group (95% vs 74%, $P = .003$, n=62 in each group). Operative time, total laser energy usage, 30-day complications, and 30-day emergency department visits or hospital readmissions were similar between groups. On multivariate analysis only study group allocation was significantly associated with stone-free status ($P = .024$).

Conclusions: Basket displacement of lower pole stones results in a significantly higher stone-free status compared to in situ lithotripsy. The technique is simple, atraumatic, and requires no additional equipment costs and little additional operative time, making it a practical tool in the treatment of lower pole stones.

Key Words: kidney calculi; ureteroscopy; lithotripsy, laser

Retrograde intrarenal surgery (RIRS) is now well established as a first-line treatment in the management of most renal stones ≤2 cm.[1] Over the decades, a plethora of technological improvements have been introduced to the RIRS procedure, ranging from the introduction of flexible, fiberoptic ureteroscopes to state-of-the-art lasers with pulse modulation. Despite these innovations, prior studies have consistently demonstrated that stone location is a key predictor of stone-free status (SFS).[2,3] In particular, due to the natural infundibulopelvic angle, sharp deflection of the flexible ureteroscope is required to access the lower pole (LP). This in turn often leads to impaired ureteroscope maneuverability and stone fragment visibility. Unsurprisingly, LP calyceal stones are associated with the lowest SFS of any location in the urinary tract.[2,3] As such, the optimal management of small- (<1 cm) and medium-sized (1-1.5 cm) LP stones remains open for debate.

Indeed, the American Urological Association guidelines make a special consideration for the surgical management of LP stones, discouraging shock wave lithotripsy and reducing the suggested stone burden for consideration of percutaneous nephrolithotomy from 2 cm to 1 cm.[1] As a means of avoiding the sharp angles often needed to treat LP stones, many urologists will frequently employ a stone retrieval basket to displace LP stones into more favorable locations, such as the upper pole or renal pelvis.[4]

In this study we aimed to compare the effect of LP stone displacement during RIRS on SFS via a prospective, randomized controlled trial. We hypothesized that displacing LP stones to a more favorable location within the collecting system would improve SFS.

MATERIALS AND METHODS

Patient Recruitment and Eligibility

We performed a prospective, randomized controlled trial of patients undergoing RIRS for LP stones from July 2017 to May 2022. Institutional Review Board approval was obtained (IRB No. 16-01539). Inclusion criteria consisted of adult patients undergoing unilateral RIRS for isolated LP renal stone(s) with total stone burden between 6 mm and 15 mm, with no single stone exceeding 11 mm (the maximal size of the stone basket) and at least 1 stone of 6 mm or larger. Exclusion criteria consisted of any upper urinary tract (ie, ureteral or renal) stone burden outside of the LP, presence of preoperative stent, or anatomical anomalies (pelvic kidney, urinary diversion, upper tract reconstruction, horseshoe kidneys). After informed consent was obtained, eligible patients were randomized in a 1:1 ratio into one of 2 groups: a control group in which the LP stone burden was treated with laser lithotripsy in situ (ISU), and an intervention group in which stone burden was first displaced out of the LP via stone retrieval basket into a more ergonomically favorable position prior to lithotripsy (DIS). Block randomization was performed via concealed envelope system and patients were blinded to their study group allocation.

Study Protocol

All procedures were performed by one of 2 high-volume endourologists at a single academic center with patients under general anesthesia and in the standard dorsal lithotomy position. A Storz Flex X2 7.5Fr flexible ureteroscope (Karl Storz, Tuttlingen, Germany) was used exclusively for all procedures and guidewires were employed per surgeon discretion to gain access to the renal pelvis. When used, ureteral access sheaths (UASs) were placed prior to pyeloscopy and were utilized per surgeon discretion based upon a combination of factors including but not limited to tightness of the ureter, degree of hydronephrosis, history of infections, and stone density. Upon access to the renal pelvis, full pyeloscopy was performed to ensure stone burden was limited only to LP calyces. At this point, a nonsurgical member of our research team opened an envelope containing the patient's predetermined study group allocation and disclosed this to the operating surgeon. In the DIS group, a Dakota nitinol stone retrieval basket (Boston Scientific, Marlborough, Massachusetts) was used to displace the stone(s) from the LP. Preference was given to place stones into an upper pole calyx, followed by a middle calyx. If upper and middle calyceal infundibula were too narrow to accommodate the stone, then stones were deposited in the renal pelvis. This process was repeated until all LP stones were displaced. Laser lithotripsy was performed with a 120 W holmium laser with Moses technology (Lumenis Pulse, Boston Scientific) using a 200 μm laser fiber. Starting laser settings were 0.5 J and 5 Hz in both groups but could be adjusted as needed per surgeon discretion up to a maximum power of 16 W. As is our standard practice, gravity irrigation (∼70 cm above patient's abdomen, without additional pressure) was used to initiate all procedures. Pressurized bag irrigation was allowed only when a UAS was employed. In both cohorts, lithotripsy was performed until all stones were fragmented into small particles. Any remaining fragments ≥2 mm were basket extracted regardless of whether a UAS was used. Indications for stent placement included use of UAS, need for ureteral or ureteral orifice dilation, or perceived mucosal or deeper injury to the ureter intraoperatively, and this decision was ultimately left to surgeon discretion. Intraoperative parameters that were recorded included operative time, total laser energy used, intraoperative complications, use of UAS, and stent placement.

Patients who received ureteral stents followed up approximately 10 days postoperatively for stent removal. The primary outcome of the study was SFS at 30-day follow-up. All patients were scheduled to follow-up approximately 30 days postoperatively and received both renal ultrasound (RUS) and abdominal x-ray (KUB) to assess SFS. SFS was defined as the absence of any visible fragments on both imaging modalities. Secondary outcomes included 30-day postoperative complications, 30-day emergency department (ED) visits, 30-day hospital readmissions, operative time, and laser energy usage.

Power Analysis

A statistical power analysis was performed for sample size estimation assuming a normal approximation to the binomial distribution based on SFS determined by the prior retrospective study by Schuster et al[5] (71% and 94% in the ISU and DIS groups, respectively). Setting α at 5%, the sample size needed to achieve 90% power was estimated at 106 subjects. Two adjustments were made to this sample size based on the following assumptions. First, to account for potential failure of stone displacement in the DIS group (due to narrow LP infundibula or a stone too large to fit in the basket) we assumed a 5% crossover from the DIS cohort to the ISU cohort. Second, since our practice is largely referral-based, we anticipated that approximately 15% of post-RIRS patients return to their referring urologist to undergo postoperative imaging or are lost to follow-up altogether. Accounting for these 2

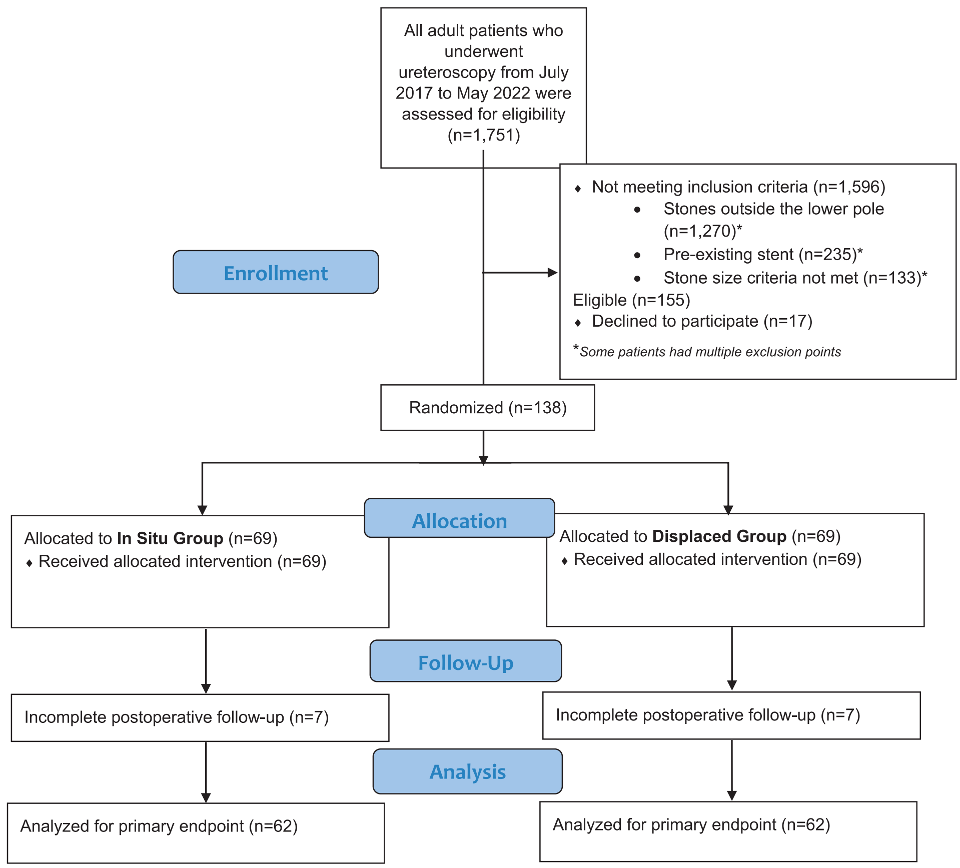

Figure. CONSORT (Consolidated Standards of Reporting Trials) diagram.

assumptions, we estimated the final sample size at approximately 136 subjects.

Statistical Analysis

Categorical data are represented as absolute numbers and relative frequencies. Outcomes including SFS, 30-day complications, 30-day ED visits, and 30-day hospital readmissions were assessed as categorical outcomes (patients were considered to have either none or at least 1 event). Outcomes including operative time and total laser energy used were assessed as continuous outcomes. Non-normally distributed data are summarized as medians and interquartile ranges (IQRs). Normally distributed variables are represented as means±standard deviations. Differences between groups for categorical outcomes were evaluated with the χ^2 test. Differences between groups for continuous outcomes were evaluated using nonparametric Kruskal-Wallis test. Multivariable logistic regression was performed using factors previously associated with SFS or that were different between the 2 groups. These included stone volume,[6] stone density (Hounsfield units),[7] use of UAS, operating surgeon, and study group. Statistical analyses were performed with the R programming language and statistical environment (4.1.0). Significance was set for a *P* value $< .05$.

RESULTS

A total of 138 patients (69 in each group) were enrolled in the study and randomized (see Figure, CONSORT diagram). Baseline patient and stone characteristics, as well as intraoperative parameters of both groups, are described in Table 1.

In all, 14 patients (7 in each group) failed to perform follow-up imaging, resulting in a total of 124 patients (62 in each group) eligible for primary outcome analysis. The overall SFS was significantly higher in the DIS group (95%, 59/62) than in the ISU group (74%, 46/62), $P = .003$ (Table 2). On multivariate analysis only stone displacement was independently associated with SFS (OR 0.18, $P = .024$; Table 3). A subset analysis to determine SFS for patients in the upper and lower 50th percentiles of stone volume revealed that there was no statistically significant difference in SFS based on size. There was a statistically significant difference between cohorts, however, for patients with smaller stones (26/26, 100% vs 26/36, 72%, $P = .003$). This did not reach significance for larger stones (Table 2). A similar analysis was performed to determine SFS for each surgeon. Surgeon MG had a similar result to the overall cohort, with a significantly higher SFS in the DIS group. While surgeon WA also had a higher SFS for patients in the DIS group, the difference did not reach the level of statistical significance (Table 2).

There were no statistically significant differences between groups in any secondary outcomes including operative time, total laser energy used, 30-day

Table 1. *Baseline Patient and Stone Characteristics, Select Intraoperative Parameters*

	Displacement group (n = 69)		In situ group (n = 69)	
Male gender, No. (%)	39	(57)	30	(44)
Age, median (IQR), y	57.0	(51.0;64.0)	58.0	(47.0;68.0)
BMI, median (IQR), kg/m^2	27.5	(24.1;31.7)	28.7	(25.2;33.1)
Diabetes mellitus, No. (%)	12	(17)	16	(23)
ASA, median (IQR)	2.00	(2.00;2.00)	2.00	(2.00;2.00)
Stone volume, median (IQR), mm^3	196	(112;361)	166	(99.8;289)
Stone Hounsfield units, median (IQR)	924	(658;1254)	868	(568;1192)
No. lower pole calyces involved with stone, median (IQR)	1.00	(1.00;2.00)	1.00	(1.00;2.00)
UAS used, No. (%)	24	(35)	13	(19)
Ureteral stent placed, No. (%)	48	(70)	45	(65)
Follow-up imaging performed, No. (%)	62	(90)	62	(90)

Abbreviations: ASA, American Society of Anesthesiologists; BMI, body mass index; IQR, interquartile range; UAS, ureteral access sheath.

complications, 30-day ED visits, or 30-day hospital readmissions (Table 2). There were a total of 12 postoperative complications ranging from Clavien II to Clavien IVa, with 8 complications in the DIS group and 4 in the ISU group. All 12 complications corresponded with ED visits, 6 of which resulted in hospital readmissions. The most common complication was flank pain, with 5 in the DIS group and 2 in the ISU group. Two patients experienced more severe complications, including 1 patient in the DIS group who developed postoperative septic shock requiring intensive care unit admission and 1 patient in the ISU group who presented with an obstructed stent on postoperative day 2 that required replacement in the operating room.

DISCUSSION

We performed a prospective, randomized study assessing whether displacing LP stones into a more favorable position during RIRS would improve outcomes. Our primary outcome, SFS, was significantly higher in the DIS group, indicating a strong benefit to displacing LP stones prior to initiation of laser lithotripsy. RIRS is more difficult for LP stones primarily due to anatomical reasons, and as such, these stones are associated with the lowest SFS of any location in the urinary tract. In this regard, the sharp deflection of the ureteroscope required to reach the LP limits maneuverability and visibility, and fragments and dust in the gravity-dependent LP are less likely to pass postoperatively.[2,3] Narrow infundibulopelvic angle and long LP infundibula have also been associated with a clear reduction in SFS[8-11] and the impact of small residual fragments after RIRS cannot be overlooked, as Rebuck et al demonstrated that up to 20% of these patients will experience a stone-related event within 19 months.[12] One must also consider the effect of LP RIRS on the longevity of flexible ureteroscopes, as prior data suggest that operative time spent in the LP is associated with more rapid deterioration of the ureteroscope, resulting in fewer uses before repairs are needed.[13,14]

Unsurprisingly, avoidance of LP calyces is not a novel concept. Kourambas et al were the first to describe their use of a basket to displace LP stones into middle or upper pole calyces during RIRS and found only a modest improvement in SFS.[4] Following this, Schuster et al retrospectively described their experience with LP stone displacement.[5] They found that displacing LP stones resulted in an increase in SFS from 71% to 94%, although this did not reach statistical significance. Furthermore, a multitude of studies have been published on harnessing the force of

Table 3. *Multivariate Analysis*

	Stone-free at follow-up imaging		
Predictors	Odds ratio	CI	*P* value
UAS used	0.97	0.22-5.17	.9
Stone Hounsfield units	1.00	1.00-1.00	.3
Stone volume (mm^3)	1.00	0.99-1.00	.13
Surgeon	0.66	0.20-2.38	.5
Study group: in situ	0.18	0.03-0.70	**.024**

Abbreviations: CI, confidence interval; UAS, ureteral access sheath.
Bolded *P* values indicate statistical significance.

Table 2. *Primary and Secondary Outcomes*

	Displacement group (n = 69)		In situ group (n = 69)		Odds ratio	*P* value
Stone-free status, No./total No. (%)[a]	59/62	(95)	46/62	(74)	0.15 (0.03;0.50)	**.003**
Upper 50th percentile stone volume	33/36	(92)	20/26	(77)	0.30 (0.07;1.35)	.10
Lower 50th percentile stone volume	26/26	(100)	26/36	(72)	0.72 (0.59;0.88)	**.003**
Surgeon MG	43/45	(96)	35/46	(76)	0.16 (0.02;0.66)	**.019**
Surgeon WA	16/17	(94)	11/16	(69)	0.16 (0.01;1.23)	.085
Operative time, median (IQR), min	65.0	(51.0;84.0)	55.0	(34.0;82.0)	0.99 (0.98;1.01)	.11
Total laser energy used median (IQR), kJ	2.80	(1.53;6.20)	1.84	(0.64;5.16)	0.94 (0.87;1.01)	.11
Complication (Clavien grade), No. (%)					0.48 (0.12;1.64)	.3
None	61	(88)	65	(94)		
II	7	(10)	3	(4.4)		
IIIb	0	(0)	1	(1.5)		
IVa	1	(1.5)	0	(0)		
30-Day ED visit, No. (%)	8	(12)	4	(5.8)	0.48 (0.12;1.64)	.4
30-Day hospital readmission, No. (%)	3	(4.4)	3	(4.4)	1 (0.17;6.01)	1

Abbreviations: ED, emergency department; IQR, interquartile range; MG, Mantu Gupta; WA, William Atallah.
Bolded *P* values indicate statistical significance.
[a] A total of 14 patients (7 in each group) did not receive follow-up imaging to determine stone-free status.

gravity via patient positioning to minimize migration of fragments into LP calyces. Herrell et al first described ureteroscopy in the flank position to preferentially displace stone fragments medially towards the renal pelvis.[15] More recently, our group reported on the improved SFS using the T-tilt position, in which patients are placed in 15 degrees of Trendelenburg and 15 degrees lateral tilt away from the surgical kidney.[16] This position allows stone fragments to migrate towards the renal pelvis and upper pole calyces where treatment is easier. So desperately do urologists wish to avoid stones in the LP that 2 groups even described placing patients with proximal ureteral stones in the Trendelenburg position.[17,18] While this position increased retropulsion of stones into the kidney, it also improved SFS because fragments were less likely to disperse into LP calyces. Although not used in this study, in our routine practice we use patient positioning techniques in addition to basket displacement to maximize our chances of successful LP stone clearance.

While not reaching statistical significance, there was some evidence to suggest longer operative times and more laser energy used in the DIS group. There may be several explanations for this observation. First, median stone volume in the DIS group was slightly larger than in the ISU group. Second, we could more effectively visualize and reach residual fragments in the upper/middle pole calyces and renal pelvis, allowing us to treat them to completion more often than in LP calyces. This may in turn, also explain the lower SFS seen in the ISU group, as small fragments and dust are less likely to pass out of the LP due to their gravity-dependent position. Interestingly, while there was a significant difference in SFS between cohorts for smaller stones, this difference did not reach statistical significance for larger stones. This is likely due to the fact that our study was powered for the overall analysis and not for this subsequent post hoc subset analysis. Thus, we believe that displacing LP stones is warranted for small and large stones alike. Both surgeons demonstrated a higher SFS when displacing stones, however this only reached statistical significance for surgeon MG, likely because of the smaller sample size for surgeon WA.

It should be noted that use of the basket displacement technique did not increase equipment costs in the DIS group as we routinely employ a basket in all procedures to extract at least 1 stone fragment for analysis. For several reasons, we find the Dakota basket to be particularly useful in this regard. First, it has a wide opening that allows for forward-grasping of stones in small spaces. Second, this basket has an additional widening mechanism that allows grasping of very large stones and easier releasing of stones into the desired calyx.

Several limitations of the current study are worth mentioning. First, RUS and KUB were used to assess SFS postoperatively, which both have reduced sensitivity for detecting residual fragments compared to CT. This was decided on as we routinely use RUS and KUB to assess patients postoperatively in our daily practice, and have found that CT scans in the post-RIRS setting often impose additional out-of-pocket costs to patients. Second, although accounted for in sample size, we ultimately did not experience a failure to displace an LP stone in any DIS patient. We acknowledge that narrow infundibula or impacted stones may prevent successful basket displacement, and in such cases in situ lithotripsy would be necessary. Third, there was an element of procedural variability, as the procedures were performed by 2 different surgeons, without standardization of certain aspects of the procedure, such as usage of UAS, guidewires, and stents. Finally, UAS seemed to be used more frequently in the DIS group, however UAS usage was not an independent predictor of SFS on multivariate analysis. Despite these limitations, our data suggest that, when possible, displacement of LP stones during RIRS maximizes SFS.

CONCLUSIONS

Herein we have presented the strongest evidence to date demonstrating that basket displacement of LP stones into more favorable locations can significantly improve SFS during RIRS without compromising other aspects of the procedure. Basket displacement is simple, safe, requires no additional equipment costs, and requires little additional operative time, making it an effective tool in the urology armamentarium.

REFERENCES

1. Assimos D, Krambeck A, Miller NL, et al. Surgical management of stones: American Urological Association/Endourological Society guideline, part II. *J Urol.* 2016;196(4):1161-1169.
2. Xiao Y, Li D, Chen L, et al. The R.I.R.S. scoring system: an innovative scoring system for predicting stone-free rate following retrograde intrarenal surgery. *BMC Urol.* 2017;17(1):105.
3. Ghani KR, Wolf JS Jr. What is the stone-free rate following flexible ureteroscopy for kidney stones?. *Nat Rev Urol.* 2015;12(5):281-288.
4. Kourambas J, Delvecchio FC, Munver R, Preminger GM. Nitinol stone retrieval-assisted ureteroscopic management of lower pole renal calculi. *Urology.* 2000;56(6):935-939.
5. Schuster TG, Hollenbeck BK, Faerber GJ, Wolf JS. Ureteroscopic treatment of lower pole calculi: comparison of lithotripsy in situ and after displacement. *J Urol.* 2002;168(1):43-45.
6. Ito H, Kawahara T, Terao H, et al. The most reliable preoperative assessment of renal stone burden as a

predictor of stone-free status after flexible ureteroscopy with holmium laser lithotripsy: a single-center experience. *Urology.* 2012;80(3):524-528.

7. Aksoy SH, Cakiroglu B, Tas T, Yurdaisik I. The effects of stone density on surgical outcomes of retrograde intrarenal stone surgery. *Br J Radiol.* 2022;95(1135):20220229.

8. Grasso M, Ficazzola M. Retrograde ureteropyeloscopy for lower pole caliceal calculi. *J Urol.* 1999;162(6):1904-1908.

9. Jessen JP, Honeck P, Knoll T, Wendt-Nordahl G. Flexible ureterorenoscopy for lower pole stones: influence of the collecting system's anatomy. *J Endourol.* 2014;28(2):146-151.

10. Dresner SL, Iremashvili V, Best SL, Hedican SP, Nakada SY. Influence of lower pole infundibulopelvic angle on success of retrograde flexible ureteroscopy and laser lithotripsy for the treatment of renal stones. *J Endourol.* 2020;34(6):655-660.

11. Richard F, Marguin J, Frontczak A, et al. Evaluation and comparison of scoring systems for predicting stone-free status after flexible ureteroscopy for renal and ureteral stones. *PLoS One.* 2020;15(8):e0237068.

12. Rebuck DA, Macejko A, Bhalani V, Ramos P, Nadler RB. The natural history of renal stone fragments following ureteroscopy. *Urology.* 2011;77(3):564-568.

13. Knudsen BE, Glickman RD, Stallman KJ, et al. Performance and safety of holmium: YAG laser optical fibers. *J Endourol.* 2005;19(9):1092-1097.

14. Afane JS, Olweny EO, Bercowsky E, et al. Flexible ureteroscopes: a single center evaluation of the durability and function of the new endoscopes smaller than 9Fr. *J Urol.* 2000;164(4):1164-1168.

15. Herrell SD, Buchanan MG. Flank position ureterorenoscopy: new positional approach to aid in retrograde caliceal stone treatment. *J Endourol.* 2002;16(1):15-18.

16. Liaw CW, Khusid JA, Gallante B, Bamberger JN, Atallah WM, Gupta M. The T-tilt position: a novel modified patient position to improve stone-free rates in retrograde intrarenal surgery. *J Urol.* 2021;206(5):1232-1239.

17. Pan J, Xue W, Xia L, et al. Ureteroscopic lithotripsy in Trendelenburg position for proximal ureteral calculi: a prospective, randomized, comparative study. *Int Urol Nephrol.* 2014;46(10):1895-1901.

18. Zhou R, Han C, Hao L, et al. Ureteroscopic lithotripsy in the Trendelenburg position for extracting obstructive upper ureteral obstruction stones: a prospective, randomized, comparative trial. *Scand J Urol.* 2018;52(4):291-295.

EDITORIAL COMMENT

Treatment of lower pole (LP) stones can be challenging and achieving stone-free status depends on infundibulopelvic anatomy.[1] Infundibular length, width, and angle can all influence stone-free rate (SFR). In this randomized trial the authors compare in situ laser lithotripsy vs displacement (DIS) during retrograde intrarenal surgery for LP stones.[2] SFR significantly favored the DIS group over the in situ group, with no difference in complication rates and no impact on cost. While stone displacement may not be possible in all cases, the authors make a strong case of using the DIS technique for LP stones whenever possible. Apart from the LP anatomy, the SFR might also be influenced by stone volume and multiplicity or the use of a ureteral access sheath.[1]

While the authors have used a high-power holmium laser with Moses technology and a plain x-ray or ultrasound for follow-up, this debate might still continue with new thulium fiber laser and the increasing use of CT scan for follow-up.[3] One of the key challenges in the future would be accurate measurement of LP anatomy to help predict the likelihood of successful displacement of stone. Secondly, for difficult LP anatomy, where retrograde intrarenal surgery may not be successful, a percutaneous approach with mini percutaneous nephrolithotomy might be more acceptable, and these metrics will help in informed consent and decision-making by the patient.

While it has always been believed that displacement of LP stones protects the flexible ureteroscope from breakage, this study clearly shows the clinical benefit of doing it in a randomized clinical trial setting. It also shows that the operative time or cost was no different between the groups. Endoscopic stone treatment training and curriculum needs to follow these principles too,[4] where displacement of LP stones to a favorable calyx is taught during their training.

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REFERENCES

1. Karim SS, Hanna L, Geraghty R, Somani BK. Role of pelvicalyceal anatomy in the outcomes of retrograde intrarenal surgery (RIRS) for lower pole stones: outcomes with a systematic review of literature. *Urolithiasis.* 2020;48(3):263-270.

2. Yaghoubian AJ, Anastos H, Khusid JA, et al. Displacement of lower pole stones during retrograde intrarenal surgery improves stone-free status: a prospective randomized controlled trial. *J Urol.* 2023;209(5):963-970.

3. Buell MI, Amasyali AS, Chen N, et al. Thulium versus holmium for in situ lower pole laser lithotripsy. *Can J Urol.* 2022;29(6):11371-11377.

4. Veneziano D, Ploumidis A, Proietti S, et al. Evolution and uptake of the Endoscopic Stone Treatment Step 1 (EST-s1) protocol: establishment, validation, and assessment in a collaboration by the European School of Urology and the Uro-Technology and Urolithiasis Sections. *Eur Urol.* 2018;74(3):401-402.

REPLY BY AUTHORS

We thank the authors for their thoughtful comments. In designing this study,[1] we had a suspicion that with the introduction of high-power "dusting" lasers, displacement of lower pole (LP) stones would fall out of favor. Perhaps the biggest impact of this study is that it shows the continued benefit of LP stone displacement even with an efficient dusting laser. We agree that evaluating the thulium fiber laser (TFL) for LP stones is of utmost importance. TFL may prove more effective at in situ lithotripsy owing to its superior dusting capabilities, but most importantly the ability to reduce fiber sizes to as small as 50 μm, thereby allowing for better deflection and mobility within the LP. However, even small dust particles are not innocent and can potentially serve as a nidus for stone growth and future stone episodes. Therefore, even though outcomes of this study should be corroborated with TFL, it is our belief that displacement can be beneficial even when in situ fine dusting is possible.

We wholeheartedly agree regarding the importance of LP infundibular anatomy. Long infundibula and sharp infundibulopelvic angles make for tremendous difficulty reaching LP stones, and in severe cases, even basket displacement is not possible. In this regard, if we could know ahead of time that displacement will not be possible for a particular patient, a percutaneous approach could be offered. Prospective studies, perhaps with the assistance of artificial intelligence, are needed to predict the best candidates for displacement, in situ lithotripsy, or percutaneous approaches. Until then, we believe stone displacement is the proper technique for all LP stones.

REFERENCE

1. Yaghoubian AJ, Anastos H, Khusid JA, et al. Displacement of lower pole stones during retrograde intrarenal surgery improves stone-free status: a prospective randomized controlled trial. *J Urol.* 2023;209(5):963-970.