Single Session Bilateral Vs Staged Bilateral Ureteroscopy for Nephrolithiasis: An Assessment of Safety and Efficacy

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OBJECTIVE To compare outcomes of patients undergoing single session bilateral ureteroscopy (SSBU) to those undergoing planned staged ureteroscopy (URS) for bilateral nephrolithiasis. While SSBU has the advantage of 1 anesthetic procedure, some may pursue a staged approach due to the potential higher risk of complications and patient discomfort with 2 ureteral stents.

METHODS We retrospectively identified patients undergoing SSBU and planned staged URS for nephrolithiasis between December 2007 and December 2014. Preoperative characteristics, intraoperative techniques, and postoperative outcomes were compared. Stone burden was calculated as cumulative stone diameter. Residual stone fragments were defined as any stone visible on postoperative imaging.

RESULTS Sixty-three patients underwent SSBU and 37 underwent planned staged URS. Both cohorts had a relatively large cumulative stone burden (30.9 mm vs 32.4 mm, $P = .71$). Total operative time was significantly longer for planned staged URS (139 vs 86 minutes, $P < .0001$). There were no significant differences in complications or emergency room visits between the 2 cohorts despite bilateral ureteral stents being placed in the majority of the SSBU cohort (73%). There were no differences in stone-free rates or the need for additional procedures.

CONCLUSION SSBU is safe and effective with overall shorter operative times and similar stone-free rates compared to planned staged URS. Bilateral ureteral stent placement did not increase the rate of unplanned emergency visits. For patients with bilateral nephrolithiasis, urologists should strongly consider SSBU to limit anesthetic exposure, overall operative time, and health care costs. UROLOGY 123: 64–69, 2019. © 2018 Elsevier Inc.

Roughly 1 in 10 people in the United States will be affected by kidney stones during their lifetime.[1] The National Health and Nutrition Examination Survey data show a linear increase in the prevalence of kidney stones for U.S. adults over the last several decades from 3.8% in 1980 to 8.8% (10.6% among men compared with 7.1% among women) for the period of 2007-2010.[1] This increase in the rate of stone disease is at least partly attributed to obesity and associated metabolic syndrome, which have reached epidemic proportions in the United States.[1] Currently, the utilization of retrograde intrarenal surgery for the treatment of ureteral and renal calculi has increased due to advancements in flexible ureteroscope technology and instrumentation including holmium lasers, intracorporeal lithotrites, ureteral access sheaths, and extraction baskets, making this approach both effective and safe.[2]

Patients with bilateral nephrolithiasis present an interesting dilemma to today's urologist. Depending on the size, location, and stone composition, options for management include observation, shock wave lithotripsy, ureteroscopy (URS), and percutaneous nephrolithotomy (PCNL), completed in either planned staged procedures or a single session bilateral approach. Single session bilateral ureteroscopy (SSBU) has the potential to treat all stones in 1 setting, sparing the patient from 2 anesthetics and likely decreasing cost. However, SSBU also has the potential for increased complications secondary to prolonged time under anesthesia, lower stone-free rates (SFR), potential for renal injury, more postoperative pain secondary to the presence of 2 ureteral stents and a subsequent increase in emergency room (ER) visits and readmissions. The aim of this series is to compare the outcomes of patients with bilateral nephrolithiasis undergoing SSBU vs planned staged bilateral URS.

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METHODS

A retrospective chart review was conducted for all patients who underwent URS at our institution between December 2007 and December 2014. All patients were treated by 1 of 2 fellowship-trained endourologists (NLM and SDH). Indications for URS included obstructing ureteral stones, enlarging nonobstructing stones, recurrent infections, flank pain, and patient choice. All patients who underwent SSBU and planned staged URS within the study period were identified and included in this study. Patients were excluded if concomitant PCNL or shock wave lithotripsy was performed. The decision to undergo SSBU or planned staged URS was based on surgeon preference and shared decision making with the patient. SSBU was defined as planned bilateral URS under the same anesthetic. Staged URS was defined as planned bilateral URS where stones in only 1 kidney were treated per stage. The separate stages were performed within a 6-month time period. Patients were only stented on the operative side during each respective stage and stents were not left indwelling during the period between stages. Surgeon preference determined whether a stent was left on a string or not. Subsequent removal via office cystoscopy was not deemed another procedure. Given that these were planned bilateral simultaneous or planned bilateral staged URS procedures within the time frame reference, the study population by definition does not represent all consecutive ureteroscopic procedures performed by the respective surgeons as patients undergoing URS for unilateral stone burden were excluded.

Demographics, stone location, stone size, intraoperative data, and postoperative data were collected. Stone size was measured as the cumulative maximal stone diameter on computerized tomography (CT) axial imaging. If multiple stones were present, the maximal diameter of each stone was added together to get a sum of each renal unit's (RU) stone burden. Intraoperative complications were obtained from the operative report. URS was completed with a Karl-Storz semirigid ureteroscope measuring 9.5F at the tip and/or a Karl-Storz flexible X2 ureteroscope measuring 7.5F at the tip. Postoperative complications were categorized based on the Clavien-Dindo classification system. Complications captured via chart review including occurrence of urinary tract infection, ER visit, unplanned office visits, surgical interventions, and/or hospitalization with re-intervention that occurred within 3 months of surgery. Follow-up was determined by surgeon preference but usually within 3 months. SFR was based on follow-up imaging. Renal ultrasound (RUS) was used in the majority; however, CT scan was increasingly utilized in the staged group for future surgical planning. Stone free was defined as no stone fragments seen on postoperative imaging. Statistical analysis was performed using a Microsoft Office Excel 2013 Analysis ToolPak 2-tail *t* test for continuous variables and a chi-squared online calculator Social Science Statistics (http://www.socscistatistics.com/tests/chisquare2/Default2.aspx) for categorical variables.

RESULTS

A total of 63 patients (126 RU) underwent SSBU and 37 patients (74 RU) underwent a planned staged URS procedure. Preoperative characteristics are presented in Table 1. There was no significant difference in patient demographics. The average age of patients undergoing SSBU was 48.6 years vs 48.3 years of age for the planned staged URS group ($P = .87$). Gender and body mass index were also similar in both groups. There was a trend for more American Society of Anesthesiologists (ASA) 4

Table 1. Preoperative characteristics

	SSBU (n = 63)	Staged (n = 37)	*P* value
Age, years old (mean ± STD)	48.6 ± 14.0	48.3 ± 11.1	.87
Female gender, no. (%)	31 (49%)	15 (40%)	.40
Body mass index, kg/m^2 (mean ± STD)	31.5 ± 8.2	29.6 ± 5.6	.20
ASA, no. (%)			
1	1 (2%)	2 (5%)	.28
2	28 (44%)	22 (60%)	.15
3	29 (46%)	13 (35%)	.29
4	5 (7.9)	0 (0)	.08
Creatinine, mg/dL (mean ± STD)	0.98 ± 0.29	0.95 ± 0.34	.67
Prior stone history, no. (%)	50 (79%)	27 (78%)	.46
Positive preoperative urine culture, no. (%)	2 (3%)	3 (8%)	.27
Total no. of stones per patient (mean ± STD)	6.2 ± 4.3	6.8 ± 3.9	.53
Absolute difference in no. of stones per RU (mean ± STD)	1.7 ± 2.1	2.2 ± 1.9	.26
Stone burden, mm (mean ± STD)	30.9 ± 20.4	32.4 ± 14.2	.71
Absolute difference in stone burden per RU, mm (mean ± STD)	10.5 ± 11.0	9.0 ± 9.3	.46
Stone location			
Upper pole, no. (%)	80 (23%)	67 (28%)	.40
Middle pole, no. (%)	108 (28%)	39 (16%)	.0008
Lower pole, no. (%)	133 (34%)	95 (39%)	.20
Renal pelvis, no. (%)	18 (5%)	4 (2%)	.048
UPJ, no. (%)	8 (2%)	4 (2%)	.72
Proximal ureter, no. (%)	12 (3%)	2 (1%)	.06
Mid ureter, no. (%)	6 (2%)	5 (2%)	.63
Distal ureter, no. (%)	17 (4%)	12 (5%)	.85
Unknown stone location*	1 (0.2%)	16 (7%)	.0001

dL, deciliter; kg, kilogram; m, meter; mg, milligram; no., number; STD, standard deviation; UPJ, ureteropelvic junction.
Statistical analysis: Continuous variables were analyzed using a *t* test (2-tail), categorical variables were analyzed with chi-squared online calculator at http://www.socscistatistics.com/tests/chisquare2/Default2.aspx.
* Stone location unknown secondary to no preoperative CT scan available for review.

Table 2. Perioperative outcomes

	Intraoperative		
	SSBU (n = 126 RU)	Staged (n = 74 RU)	*P* value
Operative time*, min (mean ± STD)	86 ± 44	139 ± 54	< .0001
Prestented, no. (%)	28 (22%)	20 (27%)	.44
Access sheath, no. (%)	102 (81%)	59 (80%)	.83
Ureteroscope, no. (%)			
Flexible	117 (93%)	71 (96%)	.37
Semirigid	24 (19%)	20 (27%)	.19
Laser lithotripsy, no. (%)	89 (71%)	73 (99%)	.0001
Postoperative ureteral stent, no. (%)	102 (81%)	71 (96%)	.003
Intraoperative complications, no. (%)	0 (0%)	1 (1%)	.19
Patients admitted overnight, no. (%)	2 (2%)	3 (4%)	.28

RU, renal unit; SSBU, simultaneous bilateral ureteroscopy.
Statistical analysis: Continuous variables were analyzed using a *t* test (2-tail), categorical variables were analyzed with chi-squared online calculator at http://www.socscistatistics.com/tests/chisquare2/Default2.aspx.
* Operative time for staged procedures was calculated as the summation of both procedures.

patients in the SSBU group compared to the planned staged URS (5 vs 0, *P* = .08), though this difference was not statistically significant. The majority of patients in both groups had prior stone episodes (SSBU 79.4% vs staged URS 78.4%) and prior stone surgeries (SSBU 63% vs staged 59%). There was no difference between average stone size per side (Table 1) or total average cumulative stone size (SSBU 30.9 mm vs staged 32.4 mm, *P* = .71). Stone location did not differ significantly other than that the SSBU cohort had more interpolar stones (27.6% vs 16.0%, *P* = .0008) and renal pelvic stones (5% vs 2%, *P* = .048). The most common stone composition was calcium oxalate monohydrate and there were significantly more of this stone type seen in the SSBU vs the planned staged group (39% vs 14%, *P* = .006). There was no significant difference with any other stone composition.

Intraoperative characteristics are presented in Table 2. Total cumulative operative time was significantly shorter for the SSBU compared to the planned staged group (86.3 min vs 138.8 min, *P* = .0001). Laser lithotripsy and ureteral stent placement were less common in the SSBU group compared to the planned staged URS group (70.6% vs 98.6%, *P* = .0001, 81.0% vs 95.9%, *P* = .003, respectively). Of the 63 patients who underwent SSBU, 46 had bilateral stents placed and 7 had no stents placed. The dusting technique was used in 9.5% of patients for both groups. Ureteral access sheaths were used for roughly 80% of cases in both groups (Table 2). The average time between planned staged procedures was 60 days. The vast majority of patients in this study were discharged the same day of the procedure (Table 2). The duration of postoperative stenting varied from 3 to 10 days postoperatively. It is surgeon preference to leave stents tethered to a string for subsequent removal at home or office.

Postoperative outcomes are listed in Table 3. There was no significant difference observed in postoperative complications, ER visits, or need for additional procedures. All complications in both groups were Clavien-Dindo grade 1 and 2. There were no major complications. The most common postoperative complication was stent pain. The majority of postoperative imaging was done with RUS (SSBU 76.2% vs staged URS 62.2%, *P* = .29). Follow-up imaging was unavailable for review for 7 patients (4 in the SSBU cohort and 3 who underwent planned staged surgery). SFR based on postoperative imaging showed a trend toward higher SFR in the SSBU. However, this did not reach statistical significance (SSBU 62% vs staged URS 43.2%, *P* = .07).

DISCUSSION

SSBU has several theoretical advantages compared to planned staged URS including one anesthetic, lower overall operative time, patient convenience, and decreased health care costs. Historically, many urologists have been hesitant to manipulate both kidneys in the same setting given the concern for increased risk of complications and potential for renal injury. However, with the increased utilization of flexible URS, SSBU becomes an intriguing option for a patient with bilateral nephrolithiasis.[2]

Many early studies on SSBU used large caliber (10.5-12 Fr) semirigid ureteroscopes to treat mostly distal ureteral stones (Table 4). These studies report relatively high rates of intraoperative complications (7%-26%) and an average hospital stay of greater than 2 days.[4–10] In the current study, we only had 1 intraoperative complication (1%) that was on a planned staged procedure. The patient had extravasation seen on retrograde pyelogram which was thought to be secondary to a forniceal rupture from a wire false passage. The patient required no additional treatments other than leaving the ureteral stent in for a longer duration (10 days). Furthermore, the vast majority of patients in this study were discharged the same day as the procedure. Only 2% of patients in the SSBU and 3% in the planned staged group were admitted overnight. This trend of decreasing intraoperative complications and hospital stay is likely secondary to the advent of smaller flexible ureteroscopes with better visualization, ureteral access sheaths, and improvement in endourologic training.

In order to produce optimal outcomes, it is important to determine which patients are most appropriate for SSBU. Undergoing SSBU not only saves a patient from multiple anesthetics, but also decreases their overall time under anesthesia, which theoretically may lead to a decrease in complications. The total operative time was significantly less in the SSBU group compared to the planned staged group (86.3 minutes vs 138.8 minutes, *P* < .001). There was a trend for more ASA 4 patients in the SSBU group compared to the staged URS (5 vs 0, *P* = .08). This trend

Table 3. Postoperative outcomes

	SSBU (n = 63)	Staged (n = 37)	*P* value
Need for additional procedures, no. (%)	2 (3%)	1 (3%)	.89
Clavien-Dindo Grade 1 and 2 complications, no. (%)	11 (17%)	8 (22%)	.60
Stent pain (pre/post removal)	6 (9.5%)	5 (14%)	.54
Urinary tract infection	2 (3%)	0 (0%)	.27
Pneumonia	1 (1.6%)	0 (0%)	.44
Urinary retention	1 (1.6%)	3 (8%)	.11
Hematuria	1 (1.6%)	0 (0%)	.44
Emergency department visits, no. (%)	12 (19%)	9 (24%)	.53
Postoperative imaging, no. (%)			
RUS only	43 (68%)	22 (60%)	.37
RUS + KUB	5 (8%)	1 (3%)	.29
KUB only	3 (5%)	3 (8%)	.29
CT only	8 (13%)	8 (22%)	.24
None	4 (6.3%)	3 (8%)	.74
Stone free, no. (%)	39 (62%)	16 (43%)	.07
Creatinine, mg/dL (mean ± STD)	0.97 ± 0.28	0.94 ± 0.31	.67
Short-term follow up, mo, mean (range)	3.5 (0-51)	3.1 (0-19)	.68

CT, computerized tomography; KUB, kidney ureter bladder x-ray; RUS, renal ultrasound.
Statistical analysis: Continuous variables were analyzed using a *t* test (2-tail), categorical variables were analyzed with chi-squared online calculator at http://www.socscistatistics.com/tests/chisquare2/Default2.aspx.

Table 4. Prior studies of SSBU

Study	n = Number of Patients	% Flexible URS	Scope Caliber	Complications	SFR
Current series	SSBU = 63	93%	9.5F semirigid	16%	62%
	Staged = 37	96%	7.5F flexible	22%	43%
Peng 2015[3]	SSBU = 59	100%	7.5F flexible	11.9%	89%
	Unilateral URS = 59	100%		8.5%	92%
Alkan 2014[4]	SSBU = 44	100%	5.3F flexible	9.1% intra-op	89%
	Staged: n/a	n/a		23% post-op	n/a
Huang 2012[11]	SSBU = 25	100%	5.3F flexible	16%	70%
	Staged = n/a	n/a		n/a	n/a
Mushtaque 2012[7]	SSBU = 60	0%	7.8F	10% intra-op	85%
	Staged = n/a	n/a		27% post-op	n/a
Gunlusoy 2012[8]	SSBU = 55	0%	8/10F	7% intra-op	90%
	Staged = n/a	n/a		22% post-op	n/a
Isen 2012[5]	SSBU = 41	0%	8/9.8F	7% intra-op	90%
	Staged = n/a	n/a		44% post-op	n/a
El-Hefnawy 2011[6]	SSBU = 89	0%	8/10F	12% intra-op	86%
				3% post-op	
	Unilateral URS = 105	0%		7% intra-op	80%
	Staged = n/a	n/a		n/a	n/a
Watson 2011[12]	SSBU = 71	93%	6.7F flexible	10%	64%
	Staged = n/a	n/a		n/a	n/a
Gunlusoy 2008[10]	SSBU = 384	0%	8/10F	7% intra-op	88%
	Staged = n/a	n/a		26% post-op	n/a
Darabi 2005[6]	SSBU = 19	0%	8-10.5F	26%	92%
	Staged = n/a	n/a		n/a	n/a
Hollenback 2003[5]	SSBU = 23	87%	6.9F semirigid	4% intra-op	73%
			6.9F flexible	29% post-op	
	Staged = 11	86%		5% intra-op	79%
				14% post-op	
	Unilateral URS = 54	98%		0% intra-op	73%
				11% post-op	
Deliveliotis 1996[7]	SSBU = 18	0	10.5-11F	22%	n/a

may be related to a desire to limit the number of anesthetics these high-risk patients receive. About a quarter of all patients in this study were prestented which likely is the result of either presenting with an obstructing ureteral stone or being a tertiary referral center. In the current study, patients with a cumulative stone burden greater than 2 cm were more likely to get a staged procedure (81% vs 63%, *P* = .0007). Patients with a large stone burden in 1 kidney compared to the other may also be appropriate for SSBU. Table 2 illustrates that laser lithotripsy

was used in only 71% of the RU during SSBU compared to the 99% of RU in the staged group ($P = .0001$). We hypothesized this may be the result of a smaller stone burden in one RU that could quickly be removed with basket extraction without the need of laser lithotripsy or postoperative ureteral stent (Table 2); however, when we evaluated the absolute difference in stone burden between RU there was no significant difference. Therefore, the data do not support this assumption (Table 1).

In the current study, there was no significant difference in the postoperative complication rate between the two groups. The postoperative minor complication rate of 15.9% in the SSBU group and 24.3% in the staged group is on par with those published in a recent meta-analysis.[18] Stent pain was the most common postoperative complication. Others include urinary tract infections, hematuria, urinary retention, and need for reoperation. One major concern when performing bilateral URS is that 2 ureteral stents if placed will result in significantly more postoperative stent pain. Interestingly, complaints of stent discomfort were more common in the staged group (14%) vs the SSBU group (11%) although this was not statistically significant, $P = .72$. This could be related to patient selection for staged vs SSBU preoperatively, as some patients who have previously had 1 stent may have elected to avoid the potential for bilateral stents with a SSBU procedure. More specifically, in 46 of 63 patients bilateral ureteral stents were placed. Of these patients, 4 (8.7%) were seen in the ER for stent pain compared to 5 patients (14%) in the staged cohort, all of which only had unilateral stents in place. Two prior studies documented when stents were placed bilaterally but neither commented on whether this correlated to more complications.[12,15] In contrary to our study, Watson et al found that the complication rate in patients who had bilateral, unilateral, and no postoperative stents was 17%, 0%, and 3.6%, respectively. Given these conflicting results, more studies are needed to determine if bilateral ureteral stent placement increases postoperative pain and complication rates.

Most of the stones in our study were nonobstructing renal calculi and therefore a flexible ureteroscope was used in 93% of the RUs during SSBU. Many of the earlier studies used a semirigid ureteroscope the majority of the time given, most of the stones were located in the ureter. There are a few studies that focused primarily on flexible URS; however, many did not compare to a staged approach.[11-17] In 2003, Hollenbeck et al compared complication rates of 23 patients treated with SSBU to 11 treated with staged bilateral URS and found a significant higher complication rate in patients undergoing SSBU compared to staged procedures (29% vs 14%, $P = .04$).[3] Similar to the current study, the most common complication was an ER visit or readmission secondary to pain. The SFR was 73% for the SSBU cohort and 79% for the staged cohort although these were based solely on plain radiograph (kidney ureter bladder x-ray). In the current study with a larger patient cohort, we found no difference in complication rate or SFR between the SSBU and the staged groups. Again, this difference is likely related to improved endoscopic technology and training.

SFRs after URS correlate with stone burden.[19] The current series had a relatively large total stone burden at 30.9 mm in the SSBU group and 32.4 mm in the staged URS group ($P = .71$). Many of these patients were too high risk for PCNL due to medical comorbidities and hence the need for SSBU or planned staged URS. Comparatively, the cumulative stone burden in the previous large series using predominantly flexible URS ranged from 16 to 30 mm.[3,11-17] Our SFR of 62% in the SSBU group and 43% in the staged group should be interpreted and compared with previous studies using appropriate context. There is a lack of consensus on what should be used as the definition of "stone free" and furthermore, what size residual fragments are clinically relevant. We used a strict definition of "stone free" meaning no stones were seen on any postoperative imaging. Previous studies that have reported high SFR have been largely based on semirigid URS for ureteral stones, follow up using kidney ureter bladder x-ray alone or used a definition of residual stones < 2-4 mm as "stone free."[4-17] The majority of postoperative imaging done in this study was with RUS or CT scan 6 weeks postoperatively (Table 3). Lastly, about 10% of patients in each group had their stones treated via the dusting technique, which has been associated with a higher rate of residual stone fragments on short-term follow up.[20] Given the above, our SFR may not be reliably compared to other studies that use looser definitions. When compared to a study that used postoperative CT scans to determine SFR, our SFR was similar.[17] Furthermore, a recent prospective evaluation of SFR by CT scan after aggressive URS showed an overall SFR of 55%.[21] It is important to note that we had a low rate of additional procedures needed within the short-term follow up of 3 months (SSBU 3.1% vs staged 2.7%, $P = .89$). This low rate may illustrate the fact that most residual stone fragments < 4 mm either remain asymptomatic or spontaneously pass.[22]

The recently published data from the CROES URS database represent the largest series of patients undergoing URS for multiple bilateral and ipsilateral stones. Data from over 11,500 patients from 114 centers in 32 countries were analyzed. This study showed bilateral URS was associated with a lower SFR, increased readmission and re-treatment rates, longer operative times and longer hospital stays compared to unilateral URS for multiple stones. Similar to the current series, there was no difference in complication rates between the 2 groups. This study is different than the current study as the CROES database looked at SSBU vs unilateral URS for multiple stones whereas our study compared SSBU to a planned staged bilateral URS. Furthermore, being a multicenter database, the CROES study has several limitations. The database did not include stone size or surgical technique including if the nonobstructing renal stones were actually treated or observed. The study did not comment on complication types nor did it distinguish between retreatment and readmission as these were combined together. Lastly, there

were no data on which postoperative imaging modality was used to determine stone-free status.[11]

There are limitations to our study. It is a retrospective study where patients were not randomized to staged bilateral or SSBU, making selection bias for each type of procedure by the physician and patient a possibility. Given the fact that the cohort was taken from a large tertiary referral center, it is possible that not all post procedure acute events were captured. Lastly, one operative procedure may have a cost benefit, although we were not able to directly evaluate cost in this study.

CONCLUSION

In conclusion, this study shows that SSBU is safe and effective for treating bilateral nephrolithiasis compared to planned staged URS. Bilateral ureteral stent placement did not increase the rate of unplanned visits. To our knowledge, this is the largest study comparing SSBU to a planned staged URS approach to treat bilateral nephrolithiasis. Future research is needed to determine cost effectiveness, appropriate patient selection, and ways to limit postoperative stent pain.

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