Clinics in Surgery

Research Article
Published: 21 Apr, 2022

Bilateral Same-Session Ureteroscopy (BSSU) for Bilateral Upper Urinary Stones (BUUS): Safety and Efficacy

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Abstract

Objective: This study aimed to explore the effectiveness and safety of bilateral same-session ureteroscopy for bilateral upper urinary stones.

Methods: Between January 2014 and October 2020, 88 cases in our hospital were retrospectively collected and analyzed. Patients were divided into two groups according to the stone size: <20 mm group and ≥ 20 mm groups. Based on the stone position, patients were divided into three groups: Ureter stones group, renal stones group, and ureteral + renal stones group. The operation time, initial Stone-Free Rate (SFR), final SFR, postoperative complications, total hospital stay, and postoperative hospital stay were compared.

Results: The initial SFR and total SFR were 60.2% and 84.1%, respectively. The complication rate was 11.4%. The initial SFR was significantly different between the low-size group and the high-size group (71.4% *vs*. 32%, $P<0.05$). Remarkable differences in the operative time, initial SFR, and total SFR were presented among different stone location groups ($P<0.05$).

Conclusion: BSSU may be safe and effective for the management of BUUS, especially for patients with low stone load and ureteral stones.

Keywords: Bilateral; Same-session; Ureteroscopy; Safety; Efficacy; Calculi

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Received Date: *28 Feb 2022*
Accepted Date: *08 Apr 2022*
Published Date: *21 Apr 2022*

Citation:
Wu Q, Huang J, Tan C, Wang X, Wang H, Huang Y, et al. Bilateral Same-Session Ureteroscopy (BSSU) for Bilateral Upper Urinary Stones (BUUS): Safety and Efficacy. Clin Surg. 2022; 7: 3491.

Introduction

As one of the common diseases of urology, patients with stones occupied the first place in urology inpatients. Bilateral Upper Urinary Stones (BUUS) accounted for 15% of patients with stones [1]. Acute obstructive renal failure caused by BUUS is one of the common critical diseases in urology, which has a great impact on overall renal function. It is prone to cause water, electrolyte, and acid-base imbalance, and even endangers the lives of patients. Therefore, it is necessary to master the principles of surgery, timely remove the obstruction and recover renal function. Traditionally, staged ureteroscopy was selected for the management of BUUS. However, the same-session minimally invasive treatment of BUUS has been possible due to the progress of minimally invasive technology, the improvement of the urinary instrument, the advance of lithotripsy technology, and the increase of surgical experience. A review concluded that bilateral same-session endoscopic surgery is safe and effective in the treatment of bilateral renal stones through careful selection [2]. However, the surgical options, safety, and efficacy remain controversial. The patients with BUUS who underwent BSSU from January 2014 to October 2020 in the Affiliated Hospital of North Sichuan Medical College were enrolled and analyzed. The safety and effectiveness of BSSU were discussed.

Materials and Method

Inclusion criteria and exclusion criteria

Eighty-eight cases in the Affiliated Hospital of North Sichuan Medical College between January 2014 and October 2020 were retrospectively collected. The study protocol was approved by the Ethics Committee of Affiliated Hospital of North Sichuan Medical College on April 1st, 2019 (2019ER(A)021). Additionally, the need for written informed consent from all participants

was waived. Inclusion criteria: 1) Patients with BUUS; 2) total stone size ≤ 40 mm; 3) unilateral stone size ≤ 20 mm. Exclusion criteria: 1) Patients with severe preoperative complications such as pyonephrosis and blood coagulation dysfunction; 2) patients with anatomic abnormalities such as ureteropelvic junction stricture; 3) patients with special types of stones such as staghorn stones. The private information of all patients in this study is confidential. All patients voluntarily signed the operation informed consent before the operation. Our study has been reported according to the relevant Equator network guideline.

General data

A total of 88 patients with BUUS in our hospital who underwent BSSU from January 2014 to October 2020 were collected, including 59 males (67.0%) and 29 females (33.0%), with an average age of 49.9 ± 12.6 years (range, 13 to 75 years). The main clinical symptoms are swelling pain and discomfort in the waist, gross hematuria, or microscopic hematuria, some of which are found by physical examination. The average value of Body Mass Index (BMI) was 23.8 ± 3.1 kg/m^2 (range, 18.0 kg/m^2 to 32.0 kg/m^2). Thirty-three patients had a history of lithotripsy, poor efficacy of lithotripsy, or postoperative recurrence. Of these patients with a history of lithotripsy, 11 had a history of ESWL, 7 had a history of PCNL, 8 had a history of URS, and 7 forgot what kind of lithotripsy they had received. Blood routine examination, urine routine examination, biochemical analysis, and urine culture were performed preoperatively. Patients with urinary tract infection were treated with empirical antibiotics before the urine culture results were reported. Once the urine culture results were reported, sensitive antibiotics were selected for adequate anti-infection treatment according to the drug sensitivity test. Ureteral stents can be retained in patients with urinary tract infection and renal insufficiency before the operation. Whether to indwelling the ureteral stents for 5 to 7 days depended on the ureteral conditions and the size of stones, which made the ureter dilated and facilitated the operation. Preoperative CT scans were performed to confirm the diagnosis and evaluate the size, number, location of stones, and the presence of anatomic abnormalities. The patients were divided into two groups under stone size: low stone size (<20 mm) *vs.* high stone size (≥ 20 mm). The patients were divided into the complication group and the non-complication group according to the occurrence of postoperative complications.

Surgical technique

All operations were performed in the lithotomy position and endotracheal intubation was performed under general anesthesia. Preoperative and postoperative antibiotics were given to prevent infection. The side with less stone size and less difficulty was treated firstly. Rigid ureteroscopy (Wolf, 8/9.8 Fr), flexible ureteroscopy (Olympus, URF, P3), ureter access sheath (Cook, 12/14 Fr, male for 45 cm and female for 35 cm), and ureteral stents (6 Fr) were used. Treatment of ureteral stones: Under the guidance of hydrophilic super-slippery guidewire or zebra guidewire, the ureteroscopy was entered below the middle and lower ureteral stones which were observed and then treated with holmium laser lithotripsy. The stone basket (NGage Nitinol stone extractor 2.2 Fr 115 cm basket; Cook Medical) was removed until the absence of visible residual stones, and then the kidney was explored with flexible ureteroscopy. No lithostatic instruments were placed during the operation. If the stone moved up to the kidney, the stone was treated by flexible ureteroscopy according to the renal stones. For the upper ureteral stones, to avoid laser thermal damage to the upper ureter, the stones were pushed back into the kidney by holmium laser lithotripsy and treated based on the standard of the renal stones. Treatment of renal stones: The rigid ureteroscopy entered the ureter under the guidance of guidewire and ascended to the junction of the ureter and pelvis at the same time. Before retraction, another guidewire was inserted from the working channel of the ureteroscopy. The access sheath (Cook Medical, Bloomington, US, Flexor, 12/14 Fr, male for 45 cm, female for 35 cm) was then placed slowly and gently under the guidance of the guidewire to reach the junction of the ureter and pelvis, and the outer sheath was retained. The flexible ureter sheath (Olympus, URF, P3) was inserted into the renal pelvis through the access sheath. Perfusion wash was conducted by artificial water injection. Systematic exploration was carried out according to the order of upper, middle, and lower calyx, renal pelvis, and its junction. After the stone was found, 200 μm holmium laser fiber was implanted for lithotripsy. The power of lithotripsy was 12 W to 30 W (energy 0.6 J to 1.0 J, frequency 20 Hz to 30 Hz). The lower power was selected for brittle stones and the higher for harder stones. The stone was gradually crushed below 2 mm. During lithotripsy, the stones were crushed gradually from the edge of the stone, and the core was finally broken. After lithotripsy, the guidewire was placed and the ureteral access sheath was then withdrawn, and the rigid ureteroscopy was used to place the ureter stents. On the first day after the operation, patients were advised to drink more water and get out of bed to facilitate the stone excretion.

Efficacy judgment

KUB or CT scan was performed at 1 to 3 days and 4 weeks after the operation to understand the position of ureteral stents and to evaluate the residual stones. Postoperative KUB and CT scans were performed in 82 and 6 patients, respectively. CT scans were conducted postoperatively in 6 patients with radiolucent stones. Preoperative ureteral stent placement, operative time, total hospital stays, postoperative hospital stays, postoperative complications, initial SFR, and final SFR were recorded. The definition of initial stone-free and final stone-free is that no residual stones or residual stones <2 mm exist at postoperative 1 to 3 days and 4 weeks, respectively. Criteria for successful lithotripsy: complete absence of stones or residual stones <2 mm. Clavien-Dindo grading system was used to evaluate the postoperative complications. The operation time was the entire anesthesia interval, from anesthesia induction to tracheal extubation.

Statistical methods

SPSS 17.0 software was applied for statistical analysis, and the normality of data was tested. The measurement data were expressed as mean ± standard deviation, and the t test was used for comparison. The counting data were presented as a percentage and compared by the chi-square test. P<0.05 was considered statistically significant.

Results

The basic clinical data of 88 patients with BUUS, compared to the low-size group, the initial SFR in the high-size group was less (32.0% *vs.* 71.4%, P=0.001) and the operation time in high-size group was longer (107.92 min *vs.* 83.96 min, P=0.002). No significant difference was found in other variables. That significant difference in initial SFR, total SFR, and operation time were found among the bilateral ureter group, bilateral kidney group, and ureter plus kidney group. The initial SFR was the highest in the ureter group, followed by the ureter plus kidney group, and finally the kidney group (77.8% *vs.* 37.0% *vs.* 14.3%, P<0.001). The total SFR was the highest in the

ureter group, followed by the kidney group, and finally the ureter plus kidney group (94.0% *vs.* 71.4% *vs.* 66.6%, P=0.004). The operation time was the longest in the kidney group, followed by the ureter plus kidney group, and finally the ureter group (123.57 min *vs.* 99.33 min *vs.* 82.24 min, P=0.002). No significant difference was discovered in other variables. Patients in the complication group were older (57.1 *vs.* 48.9 years, P=0.05) and had more stones (2.8 *vs.* 2.3, P=0.063) in comparison to those in the non-complication group, although there was no statistical difference.

Discussion

There are different options for the treatment of upper urinary stones, such as Extracorporeal Shock Wave Lithotripsy (ESWL), Percutaneous Nephrolithotripsy (PCNL), Ureteroscopic Lithotripsy (URL), and laparoscopic Ureterolithotomy (LUL). Traditionally, a staged procedure is selected for the patients with BUUS. Additionally, with the development of technology and the increasing experience of urologists, it is possible to treat patients with BUUS [3-7] or even with complex BUUS in the same-session [8]. The simultaneous combination of different endoscopes is also one of the treatment methods [9-11]. Recently, increasing relevant studies support the treatments in a single procedure for BUUS patients [3,12-16], which not only reduce the total operation time and anesthesia needs but decrease the total course of disease and convalescence. However, some researchers indicated that SSBU is not safe and effective. Bandi [17] demonstrated that one patient suffered from anuric renal failure after SSBU. Hollenbeck [18] insisted that the complication rate of patients treated with SSBU was twice as high as that of patients treated with unilateral ureteroscopy (29% *vs.* 14%, P<0.05). A recent prospective study [19] demonstrated that the complication rate in patients receiving SSBU was more than twice that in patients receiving unilateral ureteroscopy (39.9% *vs.* 15.9%, P=0.03). Among the 88 patients in this study, the initial SFR was 60.2% (53/88), the overall SFR was 84.1% (74/88), and the complication rate was 11.4% (10/88), which were consistent with a previous study [20]. However, the initial SFR in the high stone load group was significantly lower than that in the low stone load group (32.0% *vs.* 71.4%, P=0.001). If we only focus on the initial SFR, SSBU was not effective at first glance. But it took time for the stone fragments to be removed after the operation. Fortunately, the total SFR showed that SSBU was effective between the high load group and the low load group (76.0% *vs.* 87.3%, P=0.191). The independent factors affecting the SFR of BSSU include stone hardness, surface area, stone size, composition, location, and anatomical abnormalities [21,22]. In this study, the operation time in the low stone load group was markedly lower than that in the high stone load group (83.96 min *vs.* 107.92 min, P=0.002). It is not hard to imagine that the greater the stone load, the longer the operation time. In our present study, patients were divided into bilateral ureteral stones group, unilateral ureter + contralateral kidney stones group, and bilateral kidney stones group according to the position of stones. A previous study [20] has confirmed that the closer the stones to the distal ureter, the higher the SFR. The results of this study are consistent with the above conclusions. Both the initial SFR and the total SFR indicated that the SFR in the bilateral ureteral stones group was higher than that in the unilateral ureteral stones + contralateral renal stones group and bilateral renal stones group. Postoperative complications in the bilateral kidney stone group were about twice as high as those in the kidney stone + ureteral stone group and approximately four times as high as those in the bilateral ureteral stone group (28.6% *vs.* 14.8% *vs.* 7.4%, P<0.05). It can be seen that postoperative complications in patients with renal stones were significantly higher than those in patients with ureteral stones. This may be related to the more difficult treatment and longer operation time of renal stones. However, the results could be biased since only 7 included patients had bilateral kidney stones. The above three points indicate that when the stone size is lower and located in the bilateral ureter, the operation is easier and effective and the SFR is higher. Furthermore, compared to the non-complication group, the high levels of age, preoperative creatinine, number and size of stones were presented in the complication group. Although the difference was not statistically significant possibly due to the small number of patients included, it may provide some reference for the management of patients with BUUS. It is impertinent that the complication rate of SSBU is twice as high as that of staged ureteroscopy [18] or unilateral ureteroscopy [19]. The overall risk is equivalent and is determined by the renal unit treated. At first glance, the risk of complications in SSBU doubled compared with staged ureteroscopy, but in practice the risk of complications in staged unilateral procedure is diluted by time rather than being faced immediately when bilateral same-session procedure. As we all know, BSSU has the advantages of avoiding patients with bilateral upper urinary stones to undergo second operation, limiting the number of anesthesia, decreasing the total operation time, and saving operating room resources to a certain extent. The duration of surgery and anesthesia were considered as important predictors of postoperative pulmonary complications SSBU can avoid second anesthesia and may reduce the risk of postoperative pulmonary complications [23-25]. As one study pointed out [26], we should make full use of operating room resources during the COVID-19 pandemic. Therefore, SSBU should be more encouraged for suitable patients with bilateral upper urinary stones. Related literature [20] reported that postoperative complications of BSSU mainly included pain, postoperative fever, and gross hematuria, with an incidence of 20.0%, 4.0%, and 4.0%, respectively. Other complications included urosepsis, urinary tract infection, mucosal avulsion, stone emigration, and ureteral perforation, accounting for 6.0% of the total complications. In this study, the incidence of early postoperative complications was 11.4% (10/88), which was similar to a recent study [12]. Among the complications, there were 7 patients with fever, 1 with continuous hematuria, 1 with septic shock, and 1 with acute renal insufficiency. All these complications were improved after active treatment. Fever and septic shock after ureteroscopy were mainly related to the presence of preoperative infection, high intraoperative pelvic pressure, and injury of the pelvis mucosa. One patient with septic shock belonged to the unilateral ureteral stones + contralateral kidney stones group. One patient with acute renal insufficiency belonged to the bilateral ureteral stones group. Both of the two patients belonged to the high load group. Patients with postoperative septic shock had preoperative urinary tract infection, which was consistent with a previous study [27]. Patients with postoperative acute renal insufficiency had unilateral preoperative obstruction and severe hydronephrosis. Fortunately, both patients were improved and discharged after active treatment. Therefore, adequate preoperative anti-infection treatment, careful intraoperative operation, and rational utilization of ureter access sheath are suggested and the operation time should be controlled within 120 min. Continuous hematuria may be related to ureteral mucosa injury caused by improper manipulation, polyp bleeding, or indwelling ureteral stents. The patients with complications were improved after adequate anti-infection treatment, rational use of hemostatic drugs, and absolute bed rest. However, the patients with continuous

hematuria were improved after removing bilateral ureteral stents and receiving hemostatic drugs, indicating that it was related to the indwelling ureteral stents. Therefore, the guidewire and the ureteral stents should be placed under direct vision during the operation, and the soft and smooth guidewire and the ureteral stents should be selected to master the pushing depth of the ureteral stents. There are some deficiencies in this study. This is a single-center study with retrospective nature collecting a small number of participants. Small sample sizes may lead to inaccurate safety conclusions, especially in patients with bilateral renal stones. Another limitation is that there may be indeed a potential bias in measuring the stone-free rate due to the different imaging methods before and after surgery. However, our study confirmed the previous research conclusions and provided a reference for the clinical treatment of patients with BUUS. Furthermore, we performed subgroup analysis on stone burden and stone location to explore the factors affecting the safety and efficacy of BSSU. Further multicenter randomized controlled trials with a large number of patients should be conducted in the future to demonstrate the safety and efficacy of BSSU.

Conclusion

In conclusion, BSSU may be safe and effective in the treatment of BUUS and may be used as one of the same-session treatment methods. However, the safety and efficacy of SSBU gradually declined when patients had kidney stones. When the stone size was less than 20 mm and located in both ureters, the effectiveness was more satisfactory. Nevertheless, indications should be strictly controlled and appropriate patients should be carefully selected to avoid the occurrence of serious complications such as urosepsis, continuous hematuria, and aggravation of acute renal function insufficiency.

Acknowledgement

This study was supported by grants from the Science and Technology Strategic Cooperation Project of Nanchong and North Sichuan Medical College (19SXHZ0185).

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