Comparative analysis of retrograde intrarenal surgery and modified Ultra-mini percutaneous nephrolithotomy in management of lower pole renal stones (1.5-3.5 cm)

Zhuohang Li
Sun Yat-Sen University

Cong Lai (421268045@qq.com)
Sun Yat-Sen Memorial Hospital

Arvind K. Shah
Bir Hospital

Weibin Xie
Sun Yat-Sen University

Cheng Liu
Sun Yat-Sen University

Li Huang
Sun Yat-Sen University

Kuiqing Li
Sun Yat-Sen University

Hao Yu
Sun Yat-Sen University

Kewei Xu
Sun Yat-Sen University

Research article

Keywords: Lower pole stones · modified Ultra-mini percutaneous nephrolithotomy · Semi-supine combined lithotomy position · Retrograde intrarenal surgery

Posted Date: September 23rd, 2019

DOI: https://doi.org/10.21203/rs.2.14792/v1

Version of Record: A version of this preprint was published at BMC Urology on March 16th, 2020. See the published version at https://doi.org/10.1186/s12894-020-00586-6.

Abstract

Purpose To compare the safety and efficacy of retrograde intrarenal surgery (RIRS) and modified Ultra-mini percutaneous nephrolithotomy (UMP) in semi-supine combined lithotomy position for the management of 1.5-3.5 cm lower pole renal stones (LPSs). Methods A total of 63 patients with 1.5-3.5 cm LPSs who underwent RIRS (n= 33) or modified UMP (n= 30) in diameter between January 2017 and January 2019 were analyzed retrospectively. Modified UMP was performed in semi-supine combined lithotomy position and a 9.5/11.5 F ureteral access sheath (UAS) was inserted during the procedure in order to maintain low pelvic pressure and to facilitate the removal of stone fragments. Base-line parameters, stone characteristics, illness condition, operation time, postoperative hemoglobin (Hb) drop, postoperative creatinine (Cr) elevation, length of hospital stay, length of postoperative hospital stay, stone-free rate (SFR) and complications were compared between the two groups. Results There were no significant differences between the two groups in base-line parameters, stone characteristics and illness condition. The mean operating time of RIRS group was longer than UMP group (95.61 ± 21.9 vs. 55.0 ± 16.1 min, p< 0.001). The mean postoperative Hb drop was less in RIRS group (7.42 ± 4.7 vs. 15.70 ± 9.8 g/L, p< 0.001). The length of hospital stay and postoperative hospital stay for RIRS were shorter than UMP (4.76 ± 1.1 vs. 5.83 ± 0.8 d, p< 0.001, 2.97 ± 0.9 vs. 4.07 ± 0.9 d, p< 0.001). The Early SFR was higher in UMP group (54.5 vs. 80.0%, p< 0.050) while SFR at 1-month and 3-months postoperatively was similar in both groups (p= 0.504, p= 0.675). There were no significant differences between the two groups in complications (p= 0.228). Conclusion For patients with 1.5-3.5 cm LPSs, both modified UMP and RIRS are safe and viable. The modified UMP technique was used in this study, application semi-supine combined lithotomy position and the retention of UAS can improve the surgical efficiency and maintain low pressure perfusion in the kidney, which resulted in superior treatment efficacy. Therefore, we highly recommend this technique for LPSs with heavy stone burdens.

Background

Due to the anatomic characteristics of the lower calyx, LPSs are difficult to be eliminated through the ureter, even if the stones had been fragmented [1]. RIRS can be used to deal with LPSs of 1.0-2.0 cm, while Percutaneous nephrolithotripsy (PCNL) is mainly used to deal with LPSs with larger diameter or when RIRS failed to resolve the stone. With the growing advancement of medical devices and technologies, the application of RIRS has gradually expanded to kidney stones with a size of more than 2.0 cm or even more than 3.0 cm [2, 3]. On the other hand, many emerging miniaturized PCNL technologies, including UMP, which can reduce the risk of kidney injury after surgery, are also increasingly used for the treatment of stones [4, 5]. RIRS and UMP both have their own advantages and disadvantagesleading to controversies regarding the use of these surgical techniques to treat LPSs.

RIRS is performed through natural orifice. It can reduce hospitalization time and the risk of bleeding. Previous studies indicated that although the safety is more guaranteed, the SFR of RIRS may not be so effective in the treatment of stones larger than 2.0 cm [2]. However, owing to the accumulation of ureteroscopic surgery experience and the rapid improvement of ureteroscope apparatus, the clinical

application of RIRS is more extensive. It has been reported that the SFR can reach 73.6% when RIRS is used to treat the 2.0-3.5 cm kidney stones and 90.2% when used to treat LPSs with a diameter of 1.5-2.5 cm [2, 6].

Compared to RIRS, PCNL could reach a higher SFR though it presents greater surgical risks. In 2013, Janak Desai developed the Ultra-mini percutaneous nephrolithotomy (UMP) with a channel size of 11-14 F in order to reduce the risk of complications [7]. As the percutaneous tract becomes smaller, the operation efficiency decreases and the intra-renal pressure may soar too high during the procedure. Therefore, it has been reported that the best indication of UMP is for kidney stones less than 2 mm [8]. We have previously reported a modified UMP technique where operation was performed under the semi-supine combined lithotomy position with the presence of the ureter access sheath (UAS) to increase perfusion while maintain low intrapelvic pressure. We have demonstrated that this technique could be used to treat renal calculi within 3.0 cm with good safety, while achieving 90.9% of the primary stone clearance rate and 100% of the SRF after auxiliary treatment [9].

Previous studies have shown that UMP and RIRS are both safe and effective in the treatment of medium-sized (1.0-2.0 cm) urinary calculi, the SRF immediately after surgery was high (UMP, 84%; RIRS, 87%) [10]. Zhang et al. reported that the 3-months SRF of UMP and RIRS in the treatment of 1.0-2.0 cm LPSs was 98% and 92%, respectively [11]; while SFR for these methods in the treatment of 1.0-3.5cm renal stones was 92% and 96%, respectively [12]. However, these studies did not compare the efficacy and safety of UMP and RIRS in the treatment of larger diameter LPSs.

In this study, we analyzed two groups of large LPSs (1.5-3.5 cm) cases who underwent modified UMP or RIRS in our hospital to compare the efficacy and safety of the two techniques.

Methods

This was a retrospective analysis of patients treated between January 2017 and January 2019 in department of Urology, Sun Yat-sen Memorial Hospital, approved by the hospital ethics committee. Informed consents were signed by all patients. Patients aged between 18-80 years with single LPS of 1.5-3.5cm were included in this study. Exclusion criteria are as follows: patients with renal malignancy, ectopic kidney, transplanted kidney stone, spongy kidney, polycystic kidney and uncontrolled pyonephrosis. All included patients were thoroughly evaluated by medical history, physical examination, blood and urine routine tests, urine culture, blood biochemistry and other laboratory tests. Intravenous urography (IVU) and urinary system CT examination were conducted. LPSs were diagnosed by IVU and CT plain scan. The size of the stone was measured by the long axis. Ultrasonography was used to evaluate the presence of hydronephrosis. The patients were divided into two groups depending on the treatment method, RIRS group (n= 33) and UMP group (n= 30). Blood routine and serum biochemical tests were performed in all patients after surgery. Plain abdominal radiograph of the kidney, ureter and bladder (KUB) were performed on 24-48 h, 1-month and 3-months after surgery to evaluate the early SFR,

1 month SRF and 3 months SRF, respectively. Residual fragments less than 2 mm were considered “stone-free”.

RIRS techniques

For RIRS procedure, patients were put in lithotomy position under epidural anesthesia. Ureteroscope was performed to insert a guidewire (Boston Scientific®) into the pelvis. The guide-wire was inserted and a 12/14 F or 9.5/11.5 F ureter access sheath (UAS) (COOK®) was placed through it into the proximal ureter. Then a detachable flexible ureteroscope (POLY DIANOST®) was used to examine the collection system and locate to the LPSs. The stones that were mobile were repositioned into the upper or middle calyx, and those that were immobile are treated with laser lithotripsy in situ. Holmium: YAG laser (Lumenis®) was set at low energy and high frequency (0.6-1.2 J, 20-30 Hz) for lithotripsy. Large fragments were removed by a nitinol basket. Prior to the completion of the operation, a 6F JJ stent was placed.

Modified UMP techniques

In the modified UMP group, patients were put in the semi-supine combined lithotomy position with operating side elevated at 45º under epidural anesthesia. A 9.5/11.5 F UAS was inserted using the same protocol as the RIRS group. 30-50 ml of saline was injected through the UAS to obtain artificial hydronephrosis. Percutaneous renal puncture was performed under the guidance of ultrasonography. Immediately after that, 10 F and 14 F fascia dilators were used sequentially to establish the tract. After the placement of the 13 F sheath, UMP was performed by holmium laser lithotripsy (1.0-2.0 J, 20-30 Hz). Stone fragments were washed out by an irrigation pump. The UAS was used as an outflow tract for irrigation fluid along with stone fragments. After lithotripsy, ultrasonography was performed again to check for residual stones. The retention of JJ stent and/or nephrostomy tube was determined according to the removal of stone fragments and bleeding of the tract at the end of surgery. The nephrostomy tube was removed between 24-48 h after the operation. The JJ stent was removed around 2-4 weeks in both groups.

Statistical Analysis

Data analysis was performed on SPSS 23.0 software. Continuous data was presented as mean±SD, and the Student’s t-test or rank sum test was used to analyze the differences. Dichotomous data was analyzed by the chi-square or Fisher’s exact tests. $p < 0.05$ was considered statistically significant.

Results

There were no statistically significant differences between RIRS group and UMP group in mean age (49.12 ± 11.5 vs. 52.50 ± 11.2 years, $p = 0.242$), gender ($p = 0.824$), mean body mass index (24.20 ± 2.9 vs. 23.45 ± 2.7 kg/m^2, $p = 0.289$), mean stone size (2.57 ± 0.5 vs. 2.68 ± 0.5 cm, $p = 0.377$), stone side ($p = 0.479$), comorbidities ($p = 0.894$), degree of hydronephrosis ($p = 0.740$) and preoperative urine WBC ($p =$

0.246) (**Table 1**). Three of the patients had positive urine culture before surgery and received anti-infection treatment for two weeks prior to surgery.

In the RIRS group, 87.87% (29/33) of patients used 12/14 F ureter access sheath and the remaining patients switched to 9.5/11.5 F UAS due to difficulty in placement. In UMP group, single channel (13 F) lithotripsy was used for stone extraction. There were no intraoperative complications or changes of surgical methods in the two groups. The mean operation time of RIRS group was longer than UMP group (95.61 ± 21.9 vs. 55.0 ± 16.1 min, $p < 0.001$). The mean postoperative Hb decline of the two groups was statistically significant (RIRS: 7.42 ± 4.7 vs. UMP: 15.70 ± 9.8 g/L, $p < 0.001$). The mean postoperative Cr elevation was 7.88 ± 9.1 mg/dl in RIRS and 11.40 ± 13.5 mg/dl in UMP respectively ($p = 0.235$). The mean postoperative hospital stay of RIRS group was shorter than that of UMP group (2.97 ± 0.9 vs. 4.07 ± 0.9 d, p 0.001). The mean hospitalization stay of RIRS group was shorter than that of UMP group (4.76 ± 1.1 vs. 5.83 ± 0.8 d, p 0.001). (**Table 2**)

In terms of complications, there were four cases of postoperative fever (Clavien I) in RIRS group and three cases in UMP; and all patients improved after being treated with antipyretic drugs. One case of postoperative urosepsis (Clavien) were presented in RIRS group and showed improvement after treatment. Two patients presented postoperative gross hematuria (Clavien I) in UMP group and were spontaneously relieved after 48 h. Patients in UMP group did not have complications such as blood transfusion, interventional embolization, colon injury and pleural injury. The difference in complications between the two groups was not statistically significant ($p = 0.228$). SFR in UMP group was higher than RIRS group at all points, early SFR(80.0% vs. 54.5%, $p < 0.001$), 1-month SRF (93.3% vs. 84.8%, $p = 0.504$) and 3-month SRF (96.7% vs. 90.9%, $p = 0.675$) although the latter two groups did not present statistical significance (**Table 2**). In the UMP group, one case of remaining stones were excreted after extracorporeal shock wave lithotripsy (ESWL). There were three cases of residual stones in the RIRS group, two cases were treated with ESWL, and RIRS was re-performed in one case. The final SFR of both groups was 100%.

Discussion

The treatment of lower pole renal calculi is a difficult point in urology. As the anatomical structure of the lower calyceal is not conducive for stone excretion, ESWL is less effective in the treatment of LPSs [1, 13]. Some surgeons believed that either RIRS or PCNL surgery is needed even if the diameter of LPSs is less than 1.0 cm [14]. Endourology surgery is widely used to treat calculi with diameter less than 2.0 cm [15]. The application of RIRS or PCNL in the treatment of calculi larger than 2cm in diameter is rarely reported.

RIRS has developed rapidly in recent years and its indications for the treatment of kidney stones are becoming more extensive. It has been reported that SFR of kidney stones over 2.0 cm treated with RIRS is about 66.7-94.1% [16]. However, flexible ureteroscope still has its own drawbacks, including instrument damage and iatrogenic infection [17, 18, 19]. In this study, disposable and detachable flexible ureteroscope was used to avoid those problems. The lower calyx calculi were moved to the renal pelvis or

the upper calyx by a stone basket to facilitate the operation of lithotripsy. However, due to the low efficiency of RIRS, the operation time is linearly correlated with the stone volume, which could lead to the increase in the incidence of postoperative fever and urosepsis [20, 21]. In our study, the mean operative time was 95.61 ± 21.9 min, with postoperative fever in four cases and sepsis in one case. Furthermore, when RIRS was used to treat large renal stones, SFR was low and the possibility of subsequent treatment or staging surgery was increased. In this study, SFR at 1-month after surgery was 84.8%, and SFR at 3-months after surgery was 90.9%, with three patients needed follow-up treatment.

Although PCNL has the advantages of high lithotripsy efficiency and freedom from anatomical factors, while the incidence of complications is high [22]. The most common complications are bleeding and infection. Channel size is the main factor that affect bleeding after PCNL. UMP was first used in 2013 by Desai et al. [7, 8], where they reported 61 patients who underwent lithotripsy using 6 F nephroscopy to insert 11-13 F PCN channels, which resulted in good surgical safety. However, studies have shown that the decrease of PCN channels may lead to (i) the decrease of perfusion efficiency and(ii) incomplete fragmentation of the stones. These drawbacks may result in prolonged operative time and increased intrapelvic pressure, increasing the risk of postoperative infection [23]. Therefore, to date, that the best indication of UMP is kidney stones less than 2.0 cm and its efficiency was equivalent to RIRS [8, 24].

Our research group improved UMP technology in the early stage [9]. Patients were placed in the semi-supine combined lithotomy position and retrograde indwelling the UAS sheath, which improved perfusion efficiency and reduced intrapelvic pressure. The results indicated that this improved surgical method for the treatment of 2.0-3.0 cm kidney stones had good efficacy and safety. Intraoperative intrapelvic pressure was stable at 5-10 mmHg, lower than the urine reflux threshold (30 mmHg). In this study, we adopted this modified UMP technique to treat 1.5-3.5 cm LPSs. The results showed that the operation time needed for UMP was significantly less than RIRS. The SFR of UMP group reached 96.7% which is higher than that of RIRS group while the incidence of surgical complications was similar between the two groups. Compared with the data reported in literature, this improved UMP surgery method has better efficacy and safety than the traditional UMP surgery method. However, our data showed that the decrease of Hb after surgery and the incidence of postoperative hematuria in UMP group were higher than that in RIRS group and the postoperative hospitalization time in UMP group was also longer than that in RIRS group. It indicates that the bleeding risk is high and the postoperative recovery is slow in UMP group.

The most commonly used position for PCNL is the prone position. However, the prone position has some drawbacks, including chest and abdomen compression, longer surgery time due to the position changes of intraoperative, high pressure in the renal pelvis and so on. Therefore, we attempted to improve the postoperative position of PCNL to increase surgical safety and reduce surgical complications. Since 2002, we carried out 45° semisupine position PCNL surgery [25]. Ibarluzea put forward the Galdakao-modified supine Valdivia position (GMSV) in 2007 [26], in the same year that our center was launched. Studies have shown that it has advantages of short operative time, low intrapelvic depression and low risk of colon or pleural injury. The lower calyx is at the forward position, therefore good operating space can be obtained under this position. In addition, PCNL and RIRS can be combined when necessary under

this position to improve the surgical efficacy: it is also applicable to complicated cases such as multiple stones and staghorn stones [27, 28].

In terms of postoperative catheterization, we adopted a conservative strategy for the RIRS group. There was no indwelling JJ stent in RIRS group before the operation. Considering that the ureteral injury was relatively large during the operation, JJ stent was routinely indwelling for 2-4 weeks after the operation. The retention of JJ stent and/or nephrostomy tube was determined according to the intraoperative removal of stone fragments and bleeding in UMP group. The purpose of indwelling nephrostomy tube was to observe the characteristics of drainage fluid. Studies have shown that tubeless can be used in UMP to speed up its postoperative recovery, which warrants further study.

The results indicated that our modified UMP surgery has obvious advantages in the treatment of 1.5-3.5 cm LPSs. However, we are well aware of the small sample size of this retrospective study. Therefore, future prospective studies with larger sample sizes should be carried out to yield more definitive evidence for the usage of the modified UMP in LPSs.

Conclusions

Taken together, our results indicated that the modified UMP surgical approach has a higher stone clearance rate, while having similar incidence of postoperative complications to RIRS. Therefore, the semi-supine combined lithotomy position UMP and intraoperative retrograde ureteral sheath for the treatment of 1.5-3.5 cm LPSs is safe and effective. Therefore, we strongly recommend this improved UMP technique for urologists in the treatment of larger sized LPSs.

Abbreviations

RIRS retrograde intrarenal surgery; UMP Ultra-mini percutaneous nephrolithotomy; LPSs lower pole renal stones; UAS ureteral access sheath; Hb hemoglobin; Cr creatinine; SFR stone-free rate; ESWL extracorporeal shockwave lithotripsy; EAU European society of urology; PCNL percutaneous nephrolithotomy; IVU intravenous urography; CT computed tomography; KUB examinograph of the kidney, ureter and bladder; GMSV Galdakao-modified supine Valdivia position

Declarations

Acknowledgments

Not applicable

Funding National Natural Science Foundation of China, Grant numbers: 81572511; Guangzhou Science and Technology Project, Grant numbers: 201803030029; Natural Science Foundation of Guangdong

Province, Grant numbers: 2016A030313317.

Author's contribution

KX, ZL Project development; CL, AK, WX Data collection or management; CL, LH, KL,HY Data analysis; ZL, CL Manuscript writing; AK, WX Manuscript editing.

Conflict of interest

The authors declared no conflict of interest.

Consent for publication

Not applicable.

Ethics approval and consent to participate

This study was approved by the ethics approval institution review committee of Sun Yat-sen memorial hospital, Sun Yat-sen university.

References

1. Donaldson J F, Lardas M, Scrimgeour D, Stewart F, MacLennan S, Lam T B L, McClinton S. Systematic Review and Meta-analysis of the Clinical Effectiveness of Shock Wave Lithotripsy, Retrograde Intrarenal Surgery, and Percutaneous Nephrolithotomy for Lower-pole Renal Stones. European Urology. 2015; 4:612-616
2. Palmero J L, Duran-Rivera A J, Miralles J, Pastor J CBenedicto A. Comparative study for the efficacy and safety of percutaneous nefhrolithotomy (PCNL) and retrograde intrarenal surgery (RIRS) for the treatment of 2-3,5 cm kidney stones. Arch Esp Urol. 2016; 2:67-72
3. Jung G H, Jung J H, Ahn T S, Lee J S, Cho S Y, Jeong C W, Lee S B, Kim H HOh S J. Comparison of retrograde intrarenal surgery versus a single-session percutaneous nephrolithotomy for lower-pole stones with a diameter of 15 to 30 mm: A propensity score-matching study. Korean J Urol. 2015; 7:525-32
4. Ghani K R, Andonian S, Bultitude M, Desai M, Giusti G, Okhunov Z, Preminger G Mde la Rosette J. Percutaneous Nephrolithotomy: Update, Trends, and Future Directions. European Urology. 2016; 2:382-396

5. Jones P, Elmussareh M, Aboumarzouk O M, Mucksavage PSomani B K. Role of Minimally Invasive (Micro and Ultra-mini) PCNL for Adult Urinary Stone Disease in the Modern Era: Evidence from a Systematic Review. Curr Urol Rep. 2018; 4:27
6. Li M, Yang H, Liu X, Qi HWeng G. Retrograde intrarenal surgery vs miniaturized percutaneous nephrolithotomy to treat lower pole renal stones 1.5-2.5 cm in diameter. World Journal of Clinical Cases. 2018; 15:931-935
7. Desai JSolanki R. Ultra-mini percutaneous nephrolithotomy (UMP): one more armamentarium. BJU International. 2013; n/a-n/a
8. Desai J, Zeng G, Zhao Z, Zhong W, Chen WWu W. A novel technique of ultra-mini-percutaneous nephrolithotomy: introduction and an initial experience for treatment of upper urinary calculi less than 2 cm. BioMed research international. 2013; 490793-6
9. Shah A K, Xu K, Liu H, Huang H, Lin T, Bi L, Jinli H, Fan X, Shrestha RHuang J. Implementation of Ultramini Percutaneous Nephrolithotomy for Treatment of 2-3 cm Kidney Stones: A Preliminary Report. J Endourol. 2015; 11:1231-6
10. Schoenthaler M, Wilhelm K, Hein S, Adams F, Schlager D, Wetterauer U, Hawizy A, Bourdoumis A, Desai JMiernik A. Ultra-mini PCNL versus flexible ureteroscopy: a matched analysis of treatment costs (endoscopes and disposables) in patients with renal stones 10-20 mm. World J Urol. 2015; 10:1601-5
11. Zhang H, Hong T Y, Li G, Jiang N, Hu C, Cui X, Chu CZhao J L. Comparison of the Efficacy of Ultra-Mini PCNL, Flexible Ureteroscopy, and Shock Wave Lithotripsy on the Treatment of 1-2 cm Lower Pole Renal Calculi. Urol Int. 2018; 1-7
12. Wilhelm K, Hein S, Adams F, Schlager D, Miernik ASchoenthaler M. Ultra-mini PCNL versus flexible ureteroscopy: a matched analysis of analgesic consumption and treatment-related patient satisfaction in patients with renal stones 10-35 mm. World J Urol. 2015; 12:2131-6
13. Lee S W, Chaiyakunapruk N, Chong H YLiong M L. Comparative effectiveness and safety of various treatment procedures for lower pole renal calculi: a systematic review and network meta-analysis. BJU Int. 2015; 2:252-64
14. Raman J DPearle M S. Management options for lower pole renal calculi. Curr Opin Urol. 2008; 2:214-9
15. Bozzini G, Verze P, Arcaniolo D, Dal Piaz O, Buffi N M, Guazzoni G, Provenzano M, Osmolorskij B, Sanguedolce F, Montanari E, Macchione N, Pummer K, Mirone V, De Sio MTaverna G. A prospective randomized comparison among SWL, PCNL and RIRS for lower calyceal stones less than 2 cm: a multicenter experience : A better understanding on the treatment options for lower pole stones. World J Urol. 2017; 12:1967-75
16. Kang S K, Cho K S, Kang D H, Jung H D, Kwon J KLee J Y. Systematic review and meta-analysis to compare success rates of retrograde intrarenal surgery versus percutaneous nephrolithotomy for renal stones >2 cm: An update. Medicine (Baltimore). 2017; 49:e9119
17. Noronha A MBrozak S. A 21st century nosocomial issue with endoscopes. BMJ. 2014; g2047

18. Chang C L, Su L H, Lu C M, Tai F T, Huang Y CChang K K. Outbreak of ertapenem-resistant Enterobacter cloacae urinary tract infections due to a contaminated ureteroscope. J Hosp Infect. 2013; 2:118-24
19. Knudsen B, Miyaoka R, Shah K, Holden T, Turk T M, Pedro R N, Kriedberg C, Hinck B, Ortiz-Alvarado OMonga M. Durability of the next-generation flexible fiberoptic ureteroscopes: a randomized prospective multi-institutional clinical trial. Urology. 2010; 3:534-8
20. Azili M N, Ozcan F, Tiryaki T. Retrograde intrarenal surgery for the treatment of renal stones in children: factors influencing stone clearance and complications. J Pediatr Surg. 2014; 7:1161-5
21. Xu Y, Min Z, Wan S P, Nie HDuan G. Complications of retrograde intrarenal surgery classified by the modified Clavien grading system. Urolithiasis. 2018; 2:197-202
22. Seitz C, Desai M, Hacker A, Hakenberg O W, Liatsikos E, Nagele UTolley D. Incidence, prevention, and management of complications following percutaneous nephrolitholapaxy. Eur Urol. 2012; 1:146-58
23. Tepeler A, Akman T, Silay M S, Akcay M, Ersoz C, Kalkan S, Armagan ASarica K. Comparison of intrarenal pelvic pressure during micro-percutaneous nephrolithotomy and conventional percutaneous nephrolithotomy. Urolithiasis. 2014; 3:275-9
24. Datta S N, Solanki R, Desai J. Prospective Outcomes of Ultra Mini Percutaneous Nephrolithotomy: A Consecutive Cohort Study. J Urol. 2016; 3:741-6
25. Xu K W, Huang J, Guo Z H, Lin T X, Zhang C X, Liu H, Chun J, Yao Y S, Han J L, Huang H. Percutaneous nephrolithotomy in semisupine position: a modified approach for renal calculus. Urol Res. 2011; 6:467-75
26. Ibarluzea G, Scoffone C M, Cracco C M, Poggio M, Porpiglia F, Terrone C, Astobieta A, Camargo I, Gamarra M, Tempia A, Valdivia U JScarpa R M. Supine Valdivia and modified lithotomy position for simultaneous anterograde and retrograde endourological access. BJU Int. 2007; 1:233-6
27. Huang T Y, Feng K M, Lo I S. Corrigendum re: "Percutaneous Nephrolithotomy: Update, Trends, and Future Directions for Simultaneous Supine Percutaneous Nephrolithotomy and Retrograde Ureterolithotripsy in the Galdakao-modified Supine Valdivia Position for Large Proximal Ureteral Calculi" [Eur Urol 2017;71:837-8]. Eur Urol. 2017; 5:e148
28. Scoffone C M, Cracco C M. Invited review: the tale of ECIRS (Endoscopic Combined IntraRenal Surgery) in the Galdakao-modified supine Valdivia position. Urolithiasis. 2018; 1:115-123

Tables

Table 1 Comparison of the baseline characteristics of included patients

	RIRS	UMP	*P*
No. patients	33	30	
Male/female *n*(%)	20/13(60.6%/39.4%)	19/11(61.9%/38.1%)	0.824
Mean age (years)	49.12±11.5(26-77)	52.50±11.2(22-70)	0.242
Mean BMI (kg/m^2)	24.20±2.9(19.11-30.39)	23.45±2.7(16.44-27.11)	0.289
Mean stone size (cm)	2.57±0.5(1.5-3.3)	2.68±0.5(1.6-3.5)	0.377
Stone side *n* (%)			0.479
Left	18(54.5%)	19(63.3%)	
Right	15(45.5%)	11(36.7%)	
Comorbidities *n* (%)			0.894
None	20(60.6%)	18(60.0%)	
Hypertension	5(15.2%)	5(16.7%)	
Diabetes	5(15.2%)	3(10.0%)	
Others	3(9.1%)	4(13.3%)	
Hydronephrosis *n* (%)			0.740
0 degree	20(60.6%)	15(50.0%)	
1 degree	9(27.3%)	9(30.0%)	
2 degree	2(6.1%)	4(13.3%)	
3 degree	2(6.1%)	2(6.7%)	
Preoperative urine WBC *n* (%)			0.246
□	14(42.4%)	14(46.7%)	
+	6(18.2%)	10(33.3%)	
++	4(12.1%)	3(10□0%)	
+++	9(27.3%)	3(10.0%)	

Table 2 Comparison of the curative effect of the two groups of patients

	RIRS	UMP	*P*
No. patients	33	30	
Mean operation time (min)	95.61±21.9(35-145)	55.0±16.1(30-95)	0.001
Mean Hb drop (g/L)	7.42±4.7(1-22)	15.70±9.8(0-41)	0.001
Mean Cr elevation (mg/dl)	7.88±9.1(0-49)	11.40±13.5(0-63)	0.235
Hospital stay (d)	4.76±1.1(3-8)	5.83±0.8(4-8)	0.001
Postoperative hospital stay (d)	2.97±0.9(2-6)	4.07±0.9(2-6)	0.001
Early SFR, *n* (%)	18(54.5%)	24(80.0%)	0.050
1 month SFR, n (%)	28(84.8%)	28(93.3%)	0.504
3 month SFR, n (%)	30(90.9%)	29(96.7%)	0.675
Post-op complications, *n* (%)			0.228
Fever (Clavien I)	4(12.1%)	3(10.0%)	
Hematuria (Clavien I)	0	2(6.7%)	
Urosepsis (Clavien)	1(3.0%)	0	