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Expanding Indications of Flexible Ureteroscopy in Renal and Ureteral Stones

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Abstract

Retrograde Intrarenal Surgery (RIRS) performed using a flexible Ureterorenoscope marked the beginning of a new era in urology. RIRS renders smaller kidney stones more accessible and upper urinary tract tumours treatable, using minimally invasive methods. RIRS was first used to treat small kidney stones. The approach attracted a great deal of attention and it was suggested that larger stones and stones in anomalous kidneys could also be treated, albeit over longer operative times. Initially, medium and then larger stones were treated with RIRS. The choice of instruments during RIRS should be based on increased surgical efficiency, decreased complications, and improved cost-benefit ratio.

Keywords: Kidney; RIRS; Stone

Introduction

Retrograde Intrarenal Surgery (RIRS) refers to the surgical management of upper urinary tract pathologies with a retrograde ureteroscopic approach. With the development of new surgical instruments, better deflection mechanism, improved visualisation the durability of scopes has improved. Flexible URS is an efficient therapeutic tool, benefiting from reduced ureteroscope size, greater working channel size, and smaller stone baskets for stone extraction and holmium laser fibres for stone fragmentation. The active deflection of the flexible ureteroscope into acute angles enables access to all calyces, including the lower calyx and abnormally located kidneys.

History of Development of Flexible Ureteroscopes

The structure of Flexible ureteroscope consist of light bundles, working channel and deflection mechanism [1]. It also has the optical system that forms fibreoptic image. Ureterorenoscopy was first done in 1912 when Dr Young inadvertently entered the ureter of a male patient with posterior urethral valves [2]. There was not much progression until 1959 when Professor Harold H. Hopkins introduced the rod-lens optical system and fibreoptic cold-light source was developed by Karl Storz [3]. The initial flexible ureteroscopy procedures were performed in the 1960s which neither had integrated deflecting systems or working channels [4,5]. Almost all flexible ureteroscope currently available have working channels of at least 3.6 Fr in size, which permits adequate irrigation and insertion of stone retrieval devices. Newer flexible scopes have two channels. They have a smaller working channel diameter of 3.3 Fr. These small working channels overcome the limitation of a single channel and have better visual fields and surgical outcomes. However, the diameter of the outer sheaths was increased to 9.9 French. The Latest digital flexible ureteroscope attempts to provide improved image quality and durability as they do not need separate camera head and light cable. The deflection capacity (flexion of the tip from a straight to an angled position) in digital ureteroscope varies in different available models. Primary deflection is the initial degree of deflection achieved from a neutral straight position of the scope tip, whereby secondary deflection is a further degree of deflection in relation to an already curved or 'Flexed' ureteroscope tip. Secondary deflection of 130° up or down allows the surgeon to achieve a total deflection angle up to 270°. This wide range of deflection allows urologist to access virtually any area of the intrarenal collecting system [6]. The latest advances in the technical aspects of flexible ureteroscopes and newer laser lithotripsy systems, better ureteral access sheaths and highly advanced and flexible stone baskets have become the important prerequisites for performing good RIRS [7].

Expanding Role of Flexible Ureteroscopy

Size of Stones

Because of the advances in endoscopic technology, Retrograde Intrarenal Surgery (RIRS) is being increasingly applied to larger renal stone burdens. The available options for active treatment of renal calculi are Shock Wave Lithotripsy (SWL), Percutaneous Nephrolithotomy (PCNL), and RIRS. Various indications for treatment of renal stones are symptoms due increasing size of stones, obstructive uropathy with or without renal infections. Other indications are haematuria, Patient preference associated comorbidities, and patients' profession or amount of travel [8]. There are various guidelines that suggests SWL as the treatment choice for kidney stones with sizes less than 2 cm and treatment of larger stones with PCNL.

The lower pole stone results are poor with other modalities so primary PCNL might be justified for stones larger than 1.5 cm in this location. Till now flexible URS has not been mentioned by most guidelines. It may offer an alternative to ESWL or PNL. Very few data are available on the use of flexible URS for lower polar Kidney stones. Flexible ureteroscopy with laser lithotripsy is now becoming more popular for last few years with various technical advancements in endourologic equipment's and increasing surgeon experience. The latest ureterenoscopes allow access to almost all calices and, together with laser lithotripsy, ureteral access sheaths and vide variety of baskets and retrieval devices, allows the removal of most calculi [9] Initially various authors reported RIRS in patients with large stone burden who were either unfit for surgery or combined this procedure with other procedure such as SWL. evaluated the patients who were not willing or were not fit for PCNL. They performed combined RIRS with SWL in same sitting in 14 patients. In their study, the mean calculated stone surface area was 847 mm2 (Range 58 mm2-1850 mm2). Their overall stone free rate was 77% although they had only 14% clearance after 1st sitting [10]. In another study Grasso, et al. treated renal stones that were 2 cm or greater with RIRS. All patients in their study had comorbid conditions and in them PCNL was not possible, and they achieved an excellent overall stone free rate of 93% in renal and 100% in upper ureteric calculus [11] Chung et al retrospectively analysed and compared RIRS with PCNL. They performed primary RIRS for kidney stones 1-2 cm size (Ave 1.25 cm). RIRS was done as outpatient procedure while PCNL had an average of two days of hospital stay. There was no complication in RIRS group and complication rates were 13% in PCNL group. They reported Stone-free rate of 67% in RIRS group and 87% in PCNL group [12].

Prabhakar reported 30 cases of upper ureteric and renal stones (1.6 -3.5 cm) who were treated by RIRS with combined flexible and semi rigid ureteroscope. They reported that 26 patients out of 30(86.6%) had complete clearance in the first sitting and 4 (13.3%) patients needed re-look flexible ureteroscopy. The stone free rate in RIRS is 86.6% in the first sitting and 100% at second sitting [13]. Another study was done at our centre on 94 patients who underwent RIRS in whom stone size was 2.3 ± 0.2mm. Stone free rate was 85.1 (80/94) at the first procedure and 97.87% after the additional procedure (ureteroscopy). Twelve patients (12.7%) needed an additional procedure because significant residual fragments, at the first month. In eight patients (8.5%), minor complications were observed, whereas no major complications were noted. We concluded that RIRS and laser lithotripsy can be performed safely and effectively in patients with renal stones more than 2 cm which were previously managed by other more invasive techniques. Further prospective randomised trials are needed for this subset of patient [14].

Kursad Zengin, et al. contributed to the debate by comparing the success and complication rates of PNL and RIRS in the treatment of renal pelvis stones 2-3 cm in diameter. They studied medical records of 154 patients (74 PNL, 80 RIRS). They found complete stone-free rates were 95.5% in the PNL group and 80.6% in the RIRS group 1 month postoperatively. The respective complication rates (evaluated using the Clavien system) were 13.5% and 8.8%. They concluded that RIRS affords a comparable success rate, causes fewer complications than PNL, and seems to be a promising alternative to PNL when larger stones are to be treated. Prospective randomized controlled trials are needed to confirm these findings [15].

Multiple Small Renal Stones

In the era of rigid Ureteroscopy (URS) for ureteral stones, asymptomatic renal stones were often left in place. With the advent of flexible URS, however, the treatment of such renal stones became an attractive option. Managing asymptomatic renal stones at the time of URS for symptomatic ureteral stones significantly prolongs surgery duration but does not lengthen hospital stay, increase complications, or lower success rates. This combined approach reduces the need for future procedures and is probably more cost effective [16]. Asymptomatic renal stones are common in urological patients. They would be symptomatic without a complete retrieval at a certain time and may require surgical treatment. Although the current recommended method is active surveillance in EUA guidelines, it will be associated with a higher risk of surgical intervention. Ipsilateral asymptomatic renal stone associated with symptomatic ureteral stone is not a rare event, and the recommended treatment policy was not declared clearly in any guidelines, especially in patients who had already removed symptomatic ureteral stone by ureteroscopy. Dehui L, et al. reviewed 415 patients with symptomatic ureteral stone and ipsilateral asymptomatic renal stones. They reviewed two groups, who were treated with simultaneous modality (group A, N=72), or ureteroscopy alone (group B, N=72). Ureteral SFR was 100% in each group. Renal SFR for RIRS was 86.1%. Complication rates in group A were higher (22.2% vs 13.9%), but the differences were not statistically

significant (P=0.358). In group A, complications were significantly less in pre-stented patients (3/25 vs 5/11, P=0.04). Auxiliary treatment rate was significant higher in group B (69.4% vs 5.6%, P<0.001) during follow-up (mean >18 months). They concluded that Simultaneous RIRS for ipsilateral asymptomatic renal stones in patients with ureteroscopic symptomatic ureteral stone removal can be performed safely and effectively. It promises a high SFR with lower auxiliary treatment rate, and does not lengthen hospital duration and increase complications [17] Other authors have also studied Concomitant renal and ureteric stones safely removed by RIRS in a single session. This combined approach is expected to reduce the need for future procedures and seems to be more cost-effective [18].

Bilateral Renal Calculi

Only a few studies have examined the safety and efficacy of RIRS in treating bilateral renal stones. In 2005, Chon et al. first reported the efficacy of Simultaneous Bilateral RIRS (SB-RIRS) [19] In another study by the same investigators, they assessed their treatment outcomes in four patients with significant co-morbidities who had undergone SB-RIRS, and the authors observed no major complications [20]. Bilateral single-session RIRS and laser lithotripsy can be performed safely and effectively with a high success rate and low complication rate in patients with bilateral renal stones. In one study total of 42 patients (28 male, 14 female) were studied. The mean stone size was 24.09 ± 6.37 mm and the SFRs were 92.8% and 97.6% after the first and second procedures, respectively, and there were no major complications were noted in their study [21]. We did a study on 74 patients in whom mean stone size was 11.7 ± 2.4 mm. The stone-free rates were 86.84% and 97.29% after the first and second procedures, respectively. In eight patients (10.8%), minor complications were observed, whereas no major complications were noted. We Concluded that in patients with bilateral renal stones up to 1.5 cm bilateral single-session RIRS with flexible ureteroscope can be safely performed with low complication rate [22].

Bleeding Disorders

RIRS does not need a percutaneous procedure and has little or no possibility of vessel injury during the surgical procedure, RIRS seems to be superior to PCNL or SWL for patients who take anticoagulant therapy. Until now, the ureteroscopic procedure including RIRS has shown its safety in patients with bleeding disorders with an acceptable level of increase in complications [23,24].

Renal Stones in Anomalous Kidneys

Due to the presence of structural and anatomical differences that accompany anomalous kidneys, currently available endourological modalities such as SWL and PNL may be insufficient, or additional laparoscopic assistance may be required. Many Authors have evaluated the efficacy and safety of retrograde flexible ureterorenoscopic stone treatment in patients with kidney anomalies. Weizer, et al. evaluated 4 patients with horseshoe kidneys and 4 patients with pelvic kidneys. Their patients had an average preoperative stone size of 1.4 cm, out of these 5 stones were in the renal pelvis, 2 in the upper pole, and 4 in lower pole calyces. Six patients had complete clearance of the stone on postoperative imaging. 88% of patients asymptomatic after their procedure. No patients required additional surgical intervention [25]. Twenty-five patients with renal anomaly were evaluated in another study which consisted of 3 horseshoe kidneys 1 cross-fused ectopic kidney, 13 ectopic kidneys [6 pelvic and 7 lumbar kidneys], four renal malrotations and four duplicate ureters. These patients were treated by flexible Ureterorenoscopy and laser lithotripsy. They had a Complete clearance in 16 patients (64 %) after a single session. Seven of the patients with residual stones underwent a second session and the remaining three patients were subsequently treated with SWL. The overall complete clearance rate reported was 88 % (22 patients). There were no serious postoperative complications except for one case (4 %) of urosepsis. The authors concluded that Flexible Ureterorenoscopy with holmium laser lithotripsy is a safe option for the treatment of renal stones in anomalous kidneys with satisfactory success rates [26].

Molimard, et al. reviewed 17 patients of Horse shoe kidneys who had undergone Retrograde intra renal surgery. The stone-free rate in their study was 88.2% [27]. Similarly, Atis, et al. reported 20 patients and 25 renal stones in HSK patients with a mean stone size of 17.8 ± 4.5 mm. The stone-free rate was 70% after a single procedure and Six patients needed shock wave lithotripsy. Comparing with PNL, RIRS harbor advantages such as less invasiveness, no need for blood transfusion, shorter hospital stays and fewer contraindications [28] Jie Ding, et al. evaluated sixteen patients of Horse shoe kidney who underwent flexible URS. In their patients Mean stone burden was 29 ± 8 mm. Ten patients obtained stone-free status with one session while four obtained stone-free status after two sessions. Single session stone-free rate was 62.5%, overall stone-free rate was 87.5%. Two patients had small residual stones in the lower pole [29] Since last seven years an increasing number of successful reports on using Flexible URS in treating HSK urolithiasis are reported, we started to perform F-URS on Horse shoe kidney patients with renal stones. Recently we evaluated the files of 9 patients (7 men and 2 women) who underwent RIRS for the treatment of lower calyceal stones in a HSK between April 2012 and December 2014 at our tertiary centre for stone diseases. Total, 12 renal units with lower calyceal stones were treated, as 3 patients had stones in both kidneys. The average stone size was 15.41 ± 2.9 mm. In 4 renal units (33.3%) access to the lower calyx was very difficult due to an acute bending of the lower calyx, and therefore stone fragmentation proved to be inadequate. Complete stone clearance in one sitting was achieved in 8 renal units (67.7%), while 2 sittings were required for 3 renal units. One patient with a stone sized 18 mm still had residual stones after two sittings and, therefore, underwent PCNL for stone clearance.

The average operative time was 84.2 minutes. It was reported by us that RIRS for the treatment of stone disease in HSKs is a relatively safe and effective procedure. However, due to the anatomical abnormality, a second look may be needed to render the patient completely stone-free [30].

Combined RIRS with Other Procedures ECIRS (Endoscopic Combined Intrarenal Surgery)

Combination of flexible Ureterorenoscopy and PCNL or extracorporeal lithotripsy (lithotripsy endoscopically controlled by Ureterorenoscopy) may lead to better surgical outcomes, especially in complex renal stone cases [31-33].Cracco, et al. concluded that Supine PNL and ECIRS are not superior to prone PNL in terms of urological results, but guarantee undeniable anaesthesiologic and management advantages for both patient and operators ECIRS can be performed also in particular cases, irrespective to age or body habitus. The use of flexible endoscopes during ECIRS contributes to minimizing radiation exposure, haemorrhagic risk and post-PNL renal damage [32]. Furthermore, combined procedures deserve consideration for removal of stones associated with infundibular stenosis and caliceal diverticulum [34].

Complications of PCNL versus RIRS

Several reports suggest patients undergoing Ureteroscopy may have less Clavien level II or higher complications as compared to PCNL. In Clinical Research Office of the Endourological Society(CROES) report of 5800 patients undergoing PCNL, 11% had Clavien level I complications including postoperative fever and pain, while 9.4% had Clavien level II or higher surgical complications, with an overall transfusion rate of 5.7%. Additional level II or greater complication rates reported included a 4.7% rate of urosepsis, a 3.1% rate of pleural injury, a 1.4% rate of renal hemorrhage, and 0.8% incidence of colonic injury. Taking the potential risk of these complications into account, a ureteroscopic approach to the stones should be strongly considered in some patients with significant comorbidities, where a high tract transgressing the pleural is anticipated with a PCNL. In contrast, Aboumarzouk, et al. showed an overall complication rate of 10% for ureteroscopic treatment of large renal stones in a meta-analysis of 445 patients. Minor complications were reported in 4.8% of the cases and major complications in 5.3%. Major complications included steinstrasse, subcapsular hematoma, acute prostatitis, obstructive pyelonephritis, cerebrovascular accident, and hematuria with clot retention. Self-limiting hematuria occurred as a minor complication, and no transfusions were needed. While this study did not classify complications into the Clavien system, minor complications generally are classified as level I, requiring only pharmaceutical intervention. In a large retrospective review of patients with coagulopathy treated with ESWL, PCNL or URS, URS had no major complications, including transfusions. The lower risk of major bleeding and transfusion in URS makes it an ideal option for patients needing to avoid blood loss or at increased risk for hemorrhage. The incidence of urosepsis appears to be similar for PCNL and URS. The risk of urosepsis after URS has been reported as 3%-5%, and is associated with an increase in stone size. Skolarikos and de la Rosette reported the risk of urosepsis after PCNL to be approximately 4.7%. Similar to URS, the risk of postoperative fever and urosepsis increases with stone size.10. The prudent use of preoperative urine cultures and appropriate perioperative antibiotic use remains vital for this group of patients, regardless of the treatment modality [35-37].

Changing Trends in Renal Calculi Management at Out Tertiary Centre

RIRS as a treatment modality management of Renal Calculi has dramatically during the last decade. We started RIRS as a treatment modality in the year 2010-2011 with one patient out of total of 262 cases which increased to 62.4% (378/606) of all the kidney stones in the year 2015-2016. We found That Use of SWL is decreasing steadily over time while PCNL percentage also decreased over time. In our study RIRS had taken over SWL by 2013-2014 and over PCNL by 2014-2015 (Figure 1).

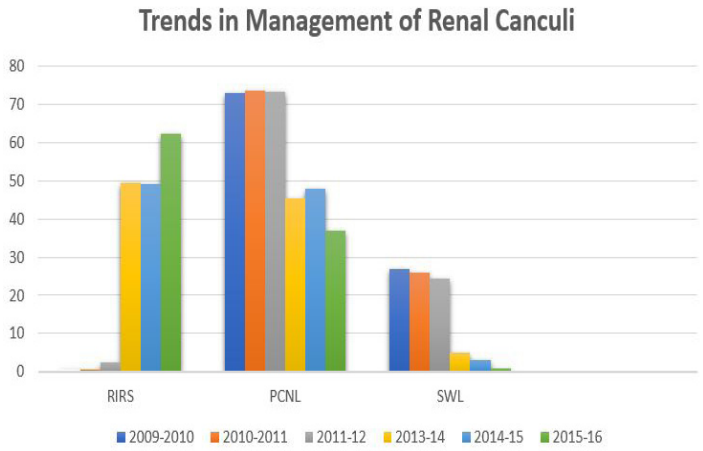

Figure 1: Trends in Management of Renal Canculi.

Conclusion

With the development of new surgical instruments, the deflection mechanism, improved visualisation the durability of RIRS have improved. The advent of newer Ureteroscopes and techniques RIRS indications have expanded to all types of upper ureteric and Renal Calculus disease. RIRS will continue to evolve through technical improvements to the instrumentation.

References

1. Zilberman DE, Mor Y, Duvdevani M, Ramon J, Winkler HZ (2007) Retrograde intra-renal surgery for stone extraction. Scand J Urol Nephrol 41: 204-207.
2. Young HH and McKay RW (1929) Congenital valvular obstruction of the prostatic urethra. Surg Gynecol Obstet 48: 509-535.
3. Hopkins HH (1959) Rod lens image transmission. British Patent 1959.

4. Marshall VF (1964) Fiber Optics in Urology. J Urol 91: 110-114.

5. Takagi T, Taijun Go, Hisao Takayasu, Yoshio Aso (1971) Fiberoptic pyeloureteroscope. Surgery 70: 661-663.

6. Wetherell DR, Ling D, Ow D, Koonjbeharry B, Sliwinski A, et al. (2014) Advances in ureteroscopy. Transl Androl Urol 3: 321-327.

7. Cho SY (2015) Current status of flexible ureteroscopy in urology. Korean J Urol 56: 680-688.

8. Türk C, T Knoll, A Petrik, K Sarica, A Skolarikos et al. (2016) Guidelines on urolithiasis 2016.

9. Türk C, T Knoll, A. Petrik, K. Sarica, A Skolarikos et al. (2016) Guidelines on Urolithiasis 2016.

10. Hafron J, Fogarty JD, Boczko J, Hoenig DM (2005) Combined ureterorenoscopy and shockwave lithotripsy for large renal stone burden: an alternative to percutaneous nephrolithotomy? J Endourol 19: 464-468.

11. Grasso M1, Conlin M, Bagley D (1998) Reterograde ureteropyiloscopic treatment of 2 cm or greater upper urinary tract and minor Staghorn calculi. J Urol 160: 346-351.

12. Chung BI, Aron M, Hegarty NJ, Desai MM (2008) Ureteroscopic versus percutaneous treatment for medium-size (1-2-cm) renal calculi. J Endourol 22: 343-346.

13. Prabhakar M (2010) Retrograde ureteroscopic intrarenal surgery for large (1.6-3.5 cm) upper ureteric/renal calculus. Indian J Urol 26: 46-49.

14. Bansal P and Sehgal A (2016) Safety and Efficacy of Retrograde Intra Renal Surgery in Renal Stones Larger than 2 cm. J Urol Res 3: 1044.

15. Zengin K, 1 Serhat Tanik, Nihat Karakoyunlu, Nevzat Can Sener, Sebahattin Albayrak, et al. (2015) Retrograde Intrarenal Surgery versus Percutaneous Lithotripsy to Treat Renal Stones 2-3 cm in Diameter. Biomed Res Int 2015: 914231.

16. Goldberg H, Holland R, Tal R, Lask DM, Livne PM (2013) The impact of retrograde intrarenal surgery for asymptomatic renal stones in patients undergoing ureteroscopy for a symptomatic ureteral stone. J Endourol 27: 970-973.

17. Lai D, Dehui Lai,corresponding Meiling Chen, Yongzhong He, Xun Li (2015) Simultaneous retrograde intrarenal surgery for ipsilateral asymptomatic renal stones in patients with ureteroscopic symptomatic ureteral stone removal. BMC Urol 15: 22.

18. Alkan E, Avci E, Ozkanli AO, Acar O, Balbay MD. (2014) Same-session bilateral retrograde intrarenal surgery for upper urinary system stones: safety and efficacy. J Endourol 28: 757-762.

19. Chon CH, Chung SY, Ng CS, Fuchs GJ (2005) Simultaneous bilateral retrograde intrarenal surgery for bilateral complex upper tract stone disease. Urology 65: 572-574.

20. Chung SY, Chon CH, Ng CS, Fuchs GJ (2006) Simultaneous bilateral retrograde intrarenal surgery for stone disease in patients with significant comorbidities. J Endourol 20: 761-765.

21. Atis G, Koyuncu H, Gurbuz C, Yencilek F, Arikan O, et al. (2013) Bilateral single-session retrograde intrarenal surgery for the treatment of bilateral renal stones. Int Braz J Urol 39: 387-392.

22. Bansal P, Bansal N, Sehgal A, Singla S (2016) Bilateral single-session retrograde intra-renal surgery: A safe option for renal stones up to 1.5 cm. Urol Ann 8: 56-59.

23. Turna B, Stein RJ, Smaldone MC, Santos BR, Kefer JC, et al. (2008) Safety and efficacy of flexible ureterorenoscopy and holmium: YAG lithotripsy for intrarenal stones in anticoagulated cases. J Urol 179: 1415-1419.

24. Aboumarzouk OM, Somani BK, Monga M (2012) Flexible ureteroscopy and holmium: YAG laser lithotripsy for stone disease in patients with bleeding diathesis: a systematic review of the literature. Int Braz J Urol 38: 298-305.

25. Weizer AZ, Springhart WP, Ekeruo WO, Matlaga BR, Tan YH, et al. (2005) Ureterorenoscopic management of renal calculi in anomalous kidneys. Urology 65: 265-269.

26. Ugurlu İM, Akman T, Binbay M, Tekinarslan E, Yazıcı Ö, et al. (2015) Outcomes of retrograde flexible ureteroscopy and laser lithotripsy for stone disease in patients with anomalous kidneys. Urolithiasis 43: 77-82.

27. Molimard B, Al-Qahtani S, Lakmichi A, Sejiny M, Gil-Diez de Medina S, et al. (2010) Flexible ureterorenoscopy with holmium laser in horseshoe kidneys. Urology 76: 1334-1337.

28. Atis G, Resorlu B, Gurbuz C, Arikan O, Ozyuvali E, et al. (2013) Retrograde intrarenal surgery in patients with horseshoe kidneys. Urolithiasis 41: 79-83.

29. Ding J, Huang Y, Gu S, Chen Y, Peng J et al. (2015) Flexible Ureteroscopic Management of Horseshoe Kidney Renal Calculi. Int Braz J Urol 41: 683-689.

30. Bansal P, N. Bansal, A. Sehgal, S. Singla (2016) Flexible ureteroscopy for lower calyceal stones in a horseshoe kidney - Is it the new treatment of choice? Afr J Urol 22: 199-201.

31. Hamamoto S, Yasui T, Okada A, Koiwa S, Taguchi K, et al (2015) Efficacy of endoscopic combined intrarenal surgery in the prone split-leg position for staghorn calculi. J Endourol 29: 19-24.

32. Cracco CM and Scoffone CM (2011) ECIRS (Endoscopic Combined Intrarenal Surgery) in the Galdakao-modified supine Valdivia position: a new life for percutaneous surgery? World J Urol 29: 821-827.

33. Traxer O and Letendre J (2014) Extracorporeal lithotripsy endoscopically controlled by ureterorenoscopy (LECURS): a new concept for the treatment of kidney stones - first clinical experience using digital ureterenoscopes. World J Urol 32: 715-721.

34. Palmero JL, Miralles J, Garau C, Nuño de la Rosa I, Amoros A, et al. (2014) Retrograde intrarenal surgery (RIRS) in the treatment of calyceal diverticulum with lithiasis. Arch Esp Urol 67: 331-336.

35. Skolarikos A and de la Rosette J (2008) Prevention and treatment of complications following percutaneous nephrolithotomy. Curr Opin Urol 18: 229-234.

36. De la Rosette J, Assimos D, Desai M, Gutierrez J, Lingeman J, et al. (2011) The Clinical Research Office of the Endourological Society Percutaneous Nephrolithotomy Global Study: indications, complications, and outcomes in 5803 patients. J Endourol 25: 11-17.

37. Aboumarzouk OM, Monga M, Kata SG, Traxer O, Somani BK (2012) Flexible ureteroscopy and laser lithotripsy for stones 2cm: a systematic review and meta-analysis. J Endourol 26: 1257-1263