Management of Calculus Anuria Using Ureteroscopic Lithotripsy as a First Line Treatment: Its Efficacy and Safety

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Purpose: To present our experience with emergency ureteroscopic lithotripsy (URSL) for ureteral calculi associated with acute kidney injury (AKI).

Materials and Methods: We retrospectively evaluated the 61 patients consisted of 90 ureteral units (UU), who underwent URSL. The cause of anuria was bilateral calculus obstructions in 29 cases, and unilateral calculus obstruction with, absent, nephrectomized contralateral kidney in 32 cases. In the case of bilateral synchronous ureteric calculi same-session bilateral ureteroscopy (SBBU) was done. The duration of anuria varied between 12 to 72 hours. At the end of the procedure, ureteral stent was systematically left in place in all patients. Surgery was performed 6-12 hours after admission to hospital. Patients were followed at least 1 month postoperatively.

Results: The stone free rates (SFR) were determined as baseline, on the first post-operative day, and as overall on the 30 days after procedure. The greatest success was achieved in the distal localization of stones up to 10 mm (93%). Renal function returned in 51 (83.6%) patients within 7 days. In 18 (29.5%) patients [18 (20%) UU] we performed second procedure as extracorporeal shockwave lithotripsy in 16.7% and open surgery in 2.2%. In 43 (70.5%) patients URSL was a successful therapeutic approach in dealing with pain, obstruction and calculus.

Conclusion: Calculus anuria is a medical emergency that requires rapid diagnosis and prompt treatment for the purpose of decompression. URSL is the proper method of choice for selected patients and can be performed safely and has high success rates with minimal morbidity.

Keywords: ureteral calculi, surgery; ureteroscopy; lithotripsy; kidney, abnormalities; anuria, therapy; treatment outcome.

INTRODUCTION

Acute kidney injury (AKI) has been defined in multiple studies using varying changes in serum creatinine, urine output, need for renal replacement therapy and estimated glomerular filtration rate.[1] Acute reversible kidney injury (ARKI) secondary to bilateral ureteral obstruction (BUO) is a common urological problem and the underlying etiology can be malignant or benign.[2]

Post renal anuria is a urologic emergency that must be managed rapidly and carefully; otherwise the glomerular filtration rate (GFR) will decline rapidly, with rise of blood urea and serum creatinine and water-electrolytes imbalance. Then a series of symptoms in other organs will be evident and lastly multiple organs failure will result and the patient's life will be threatened.[3] The patient who presents with acute urinary obstruction is in need of urgent drainage of the urinary tract either by ureteral stenting or percutaneous nephrostomy (PCN). Timely decompression may result in complete recovery of renal function.[4] Post renal anuria is mostly due to obstruction of the urinary tract and the most common cause of urinary obstruction is ureteral calculi.[5] Calculus anuria is a urological emergency and anuria can be due to bilateral ureteric calculus impaction or to unilateral ureteric calculus impaction of a solitary kidney or to only a single functioning kidney. Acute unilateral ureteral obstruction due to stones is a frequent event, affecting 5% to 15% of the population worldwide.[6]

Ureteroscopic lithotripsy (URSL) represents the golden standard for the treatment of ureteric stones in the case of bilateral synchronous ureteral calculi, and the options are a staged or a synchronous URSL procedure. Bilateral same-session ureteroscopy (SSBU) can reduce in overall operative time and hospital stay, prevent multiple surgical procedures and anesthesia, minimize the duration of convalescence and also complications, provided that the surgeon has enough experience in endoscopic procedures. Conversely, the technique would expose both ureters to injury that could lead to significant morbidity. Gunlusoy and colleagues reported that bilateral single-session pneumatic lithotripsy can be performed safely and has high success rates with minimal morbidity and short hospital stay.[7]

Patients with a solitary kidney need to become stone-free as soon as possible due to risk of acute obstructive renal insufficiency. Since URSL offers both immediate relief from symptoms and stone fragmentation with minimal complications, it may be successfully used for the management of ureteral calculi in patients with a solitary kidney.

We report our experience with urgent URSL and with SSBU-URSL as a first line treatment in condition of acute anuria caused by obstructive calculi. The primary endpoint of the study was to determine the outcomes of treatment for patients with obstructive anuria.

MATERIAL AND METHODS

Patients and Study Design

This retrospective chart analysis was conducted at the Department of Urology, Dr. D. Mišović Hospital, Belgrade, Serbia. From among nearly 1234 patients who had undergone URSL in our clinic, between January 1998 and January 2013, 61 patients presented clinically as acute calculus anuria and treated urgently with URSL or SSBU. A total of 3 surgeons performed these procedures.

The cause of anuria was bilateral obstruction by the calculi in 29 cases, and unilateral obstruction with /absent/ nephrectomized contralateral kidney in 32 cases. In unilateral cases nephrectomy had been already done due to tumor in 8 patients, calculosis in 19 patients and non-functioning diseased kidney in 5 patients.

Retrospectively, the patients are grouped on the basis of the duration of anuria. Group A included patients with anuria lasting up to 48 hours and group B included patients with anuria of over 48 hours in duration. These two groups are compared with regard to post-operative recovery of renal function, at the 7th post-operative day. We defined recovery of renal function on the basis of amount of post-obstructive diuresis and levels of serum creatinine. Thus, we compare the relation between the duration of anuria and early post-operative recovery of renal function after successful relief of obstruction via emergency URSL using Fisher's exact test. Generally patients were selected for SSBU based on surgeon judgment that each side could be treated safely and effectively. URSL was initially started on the side in which stone size was smaller and lower localization than the other.

Clinical Procedure

All interventions were carried out under regional or general anesthesia, with a semi-rigid single channel Olympus 9.8

Table 1. Clinical and stone characteristics of study population.

Variables	
Anuria < 100 mL/24-hour, no. (%)	
Duration, no. (%)	9 (14.8)
48-hour	38 (62.3)
72-hour	14 (23)
Hydronephrosis, no. (%)	
Grade 1	23 (25.6)
Grade 2	48 (53.3)
Grade 3	19 (21.1)
Level of serum creatinine (µmol/L)	492 (range, 200-800)
Level of blood urea (mmol/L)	27 (range,11-39)
Plasma potassium level (mmol/L)	6 (range 5.7- 6.9)
Stone size (mm)	
Overall	9 (5-16)
< 10 mm	56 (62.2%)
>10 mm	34 (37.8%)
Stone number, no. (%)	
Solitary	84 (93)
Multiple	6 (7)
Stone opacity (%)	
Radiopaque	82
Radiolucent	18
Localization, no. (%)	
Proximal ureter	27 (30)
Distal ureter	63 (70)
Time to operation (hour)	6-12
Mean operative time (min)	34 (range, 19-65)
Mean hospitalization stay (day)	5.4 (2-12)
Basket / grasper / forceps use (per ureteral unit)	59 (65.5%)

channel (Ch) ureteroscope. An EKL (electrokinetic) and electrohydraulic (EHL) generator, Lithotron Walz EL-27 Compact (Walz, Germany) was used.

Patients were admitted on an emergency basis. On admission, detailed history of pain, urinary output, fever, hematuria and uremic symptoms with durations were recorded. Urine output between 0-100 mL/24 hours was regarded as anuria. General physical examination and systemic examination with especial reference to the genitourinary tract was performed and positive findings were recorded. Investigations included complete hematologic examination, blood urea, serum creatinine, serum electrolytes including plasma potassium level. Ultrasonography (US) and plain film of the abdomen were performed in all cases to evaluate the size, site and number of stones, degree of hydronephrosis (UHN), echogenicity, renal cortical thickness, and presence of either kidneys or solitary kidney. Before surgery (45 min), the patients received a single dose of antibiotics intravenously (cephalosporin or fluoroquinolone), which was then continued during the hospitalization.

URS access was successfully achieved in all cases without the need for ureteral orifice dilatation. Endoscopic inspection was done at the end of the procedure to rule out any residual calculi > 2 mm or ureteral lesion. Operation time was calculated from the time the ureteroscope was introduced into the urethra to the time of final removal of the endoscope. Proximal and distal ureteral stones were defined as those above and below the pelvic brim, respectively, as suggested by Hollenback and colleagues.[8] Pigtail ureteral 6 Fr polyurethane stent or ureteral probe 6 Ch we routinely placed in all patients. Ureteral probes have been removed at postoperative days 1-4 (mean 2.5).

The decision on displacement of the ureteral stent was based on clinical and intraoperative characteristics including duration of anuria, the size and number of calculi, the degree of calculus impaction and mucosal edema, stone free status on the first post-operative days, the volume of urine output, laboratory analysis. Double J (DJ) ureteral stents were removed after 2-4 weeks under local anesthesia. Post-operatively, all patients were evaluated by monitoring urine output, serum creatinine blood urea and plasma potassium daily, until normal or acceptable levels were obtained. We used ≥ 33% decrease in serum creatinine after intervention as confirmation of AKRI.[9] Plain film of the abdomen and ultrasonography were performed at the first day post-operatively (to assess the initial stone-free rate and to confirm the correct stent position) and during the follow-up visits (after 2 weeks and 4 weeks). Close collaboration between urological, nephrological and radiological services was been required, and care was taken to avoid hypovolemia that could potentially cause further injury.

Follow-up Procedure

For the success criteria (intraoperative success was defined endoscopically), we determined stone diameters ≤ 2 mm as stone-free rate (SFR). Fragments less than 2 mm were left, since they can pass, but larger fragments were extracted by

Table 2. Stone-free rates as function of stone location.

Stone Free Rate	Ureteral Units	Stone Localization		Stone Size	
-----	-----	Proximal n = 27	Distal n = 63	< 10 mm n = 56	> 10 mm n = 34
Postoperative	56 (62)	9 (33)	46 (73)	39 (70)	16 (47)
Overall, 30 days after operation	73 (81)	15 (56)	59 (94)	52 (93)	21 (62)

*are presented as number (%).

Dormia sound or stone grasper.

Postoperative success (overall stone-free status) was determined as no significant stone fragments greater than 2 mm in diameter on initial follow-up radiography and plain abdominal X-ray performed at least 1 month after surgery, due to the limited availability of non-contrast abdomino-pelvic computed tomography (CT) scan as gold standard in our country. Intraoperative and postoperative complications associated with procedure were recorded and reported according to the Clavien-Dindo classification of surgical complications.[10]

This study protocol was approved by the Ethical Committee of the Hospital Dragiša Mišović and the research was carried out in compliance with the Helsinki Declaration. All patients gave written informed consent before participation and then underwent ureteroscopy.

RESULTS

In the 27 (44%) men and 34 (56%) women with a mean age of 52 years old (range 34 to 81) a total of 88 urgent URSL were done. Percutaneous nephrostomy was performed in 2 (3.3%) patients, 2 (2.2%) ureteral units (UU) with bilateral calculus, with severely impacted hard distal stones. These patients were candidates for open surgery, ureterolithotomy, 6 to 8 weeks after the primary intervention (URSL+PCN).

The duration of anuria varied between 1 to 3 days. We did not observe any cases of pyuria during the procedure. Stone burden was determined by measuring the maximum stone dimension. In cases of multiple stones, these dimensions were added together. The clinical and stone characteristic of our study population are shown in Table 1. Stone-free rates are stratified by stone location in Table 2.

Stone migration to the kidney (push-back) occurred in 12 UU (12 patients), in 7 UU (7 patients) with unilateral, and in 5 UU (5 patients) with bilateral obstruction during upper ureteric stone manipulation, and DJ stents were left in these ureters. Migrated stones were subjected to extracorporeal shockwave lithotripsy (SWL) 5-11 days after URSL, after normalization of serum creatinine.

At the end of the procedure ureteral stent was placed bilaterally in 44 UU (22 patients) and unilaterally in 32 UU (25 patients with solitary kidney and in 7 patients with BUO, ureteral stent placed unilaterally). Nine patients, returned to the emergency room because of pain 24 hours after removing the ureteral stent. Ultrasound showed UHN, and a DJ stent was placed in order to secure urinary drainage. Six of these patients had a solitary kidney, and were complemented by medical expulsive therapy (MET) treatment while in three patient, three ureteral units, the planned secondary procedure was SWL.

Post-operative monitoring of patients is shown in Table 3. Post-operative monitoring of urine volume revealed post-obstructive diuresis or polyuria in recovery phase, in all patients, but the urine output gradually decreased to reach normal level within the 1st week postoperatively. Also, serum creatinine, blood urea and plasma potassium levels returned to normal or acceptable levels within 7-10 days.

In Table 4, the patients are grouped according to the duration of anuria (up to 48-hour and over 48-hour). Recovery of renal function as indicated by post-obstructive diuresis and serum creatinine is compared in these two groups of patients using Fisher's exact test. It is seen that the recovery of renal function was poorer in the patients with longer duration of anuria. Recovery of renal function at discharge was confirmed in 51 (83.6%) patients.

In 44 (72%) patients URSL is a successful therapeutic approach for relief of obstruction and removal of calculus.

Table 3. Postoperative monitoring of study population.

Monitoring	POD 1	POD 3	POD 7	POD 10
Ultrasonography	+	+	Distal n = 63	< 10 mm n = 56
Plain abdominal film	+		46 (73)	39 (70)
Postobstructive diuresis Range, 2400-8300 mL/24-hour	+	-----	59 (94)	52 (93)
Laboratory analysis				
Mean complete blood count	+	+	+	-----
Serum creatinine	+	+	+	+
Blood urea	+	-----	+	+
Plasma potassium	+		+	+
Urine from ureteral stent for UC	+		-----	-----

Keys: POD, postoperative day; UC, urine culture.
* Optional.

Treatment modalities in relation to UU are shown in Table 5. A secondary procedure was required in 17 (18.9%) UU. A classification (modified Clavien system) has been proposed to grade perioperative complications (Table 6). Major complications (such as sepsis, perforation, and avulsion) were not observed during the procedure.

URSL provoked significant mucosal laceration with guide wire at the site of impacted ureteral stone in 5 (8.2%) patients. To treat this complication ureteral stent placement was sufficient. Stone or fragment migration was seen at 12 (19.7%) patients, all in the upper stone localization, and that was the major cause of failure of the procedure.

Mild macroscopic hematuria was observed in the first 24 hours which did not require treatment. There was postoperative high grade fever in 8 (13.1%) patients. The body temperature returned to normal within 4 days after receiving maximum dose and intravenously injected 3rd generation cephalosporin antibiotic (urine from ureteral stent for urine culture - with positive urine culture results, Escherichia coli). Postoperative "pain" (renal colic), was the most frequent complication, mandating a readmission in two patients (3.3%) with solitary kidney, emergency department visit in 9 (14.8%) patients (of whom 4 patients had bilateral stent), or re-instrumentation second URSL in 1 (1.6%) patient treated for large bilateral calculi > 15 mm in one session.

Minor complications such as lower urinary tract symptoms (LUTS), mild hematuria, flank and pelvic pain improved within one week after stent removal.

DISCUSSION

The standard first-line approach in the management of symptomatic ureteral stone is relief of obstruction by insertion of a nephrostomy tube or a DJ ureteral stent and fragmentation of the stone subsequently. Insertion of a nephrostomy tube under local anesthesia is relatively less invasive and is considered to be better if there is evidence of sepsis at the time of presentation. Nevertheless, its potential disadvantages are leakage, dislodgement of the tube and the need to manage the stoma.[11] Ureteroscopy is a relatively complication-free procedure. However, if complications do occur, they may be related to the procedure itself. The main advantages of URSL are immediate relief of symptoms and stone fragmentation. Quick ureteral stone removal may be important in patients with calculus anuria. Ureteroscopy has variable complications (9-20%) including bleeding, ureteral perforation, false passage, urinoma formation, strictures and, in a few cases, ureteral avulsion.[12] Lee and Bagly reported that ureteroscopy should be safe with regard to renal function, there is no puncture, as in percutaneous nephrolithotomy (PCNL), and no shock-waves directed to renal parenchyma, as in SWL. However,

Table 4. Indicators of recovery of renal function on the 7th post-operative day in relation to duration of anuria prior to admission.*

Variables	Group A	Group B	*P*
Diuresis			
< 2500 mL/24-hour	40	5	.0007
≥ 2500 mL/24-hour	7	9	
Serum creatinine (μmol/L)			
50-110	44	6	.0001
≥110	3	8	

* Group A, 47 (77%) patients with anuria time of < 48-hour; Group B, 14 (23%) patients with anuria time of > 48-hour.

other potential mechanisms of injury during URSL such as excessive irrigation may generate sufficient pressure in the kidney to cause pyelovenous backflow and damage the renal parenchyma. Thermal injury may also occur due to the energy of the laser. However, this is unlikely, as frequent irrigation should dissipate the heat energy, so ureteroscopic laser lithotripsy has no harmful impact on renal function in patients with mild to moderate renal insufficiency.[13]

Some authors stated that in comparison with unilateral ureteroscopy, no difference was found with bilateral same session ureteroscopy with regard to complication rate (6.7%) or stone-free rate (80%) and concluded that bilateral same-session ureteroscopy is a safe and effective procedure in the management of bilateral ureteral stones. Bilateral same-session ureteroscopy can prevent frequent surgeries and anesthesia and reduce hospital stay. Proper patient selection, ample experience of the surgeon, and appropriate instruments, all reduce complications and increase treatment success.[14] Initial opposition to SSBU arose from concerns that each renal unit could be compromised simultaneously. While it is rare, anuric renal failure after atraumatic SSBU has been reported.[15]

In the present study, 90 ureteral units with obstructive ureteral stones were evaluated. The intervention, URSL was implemented among patients without changes on 12-lead electrocardiography.[16] After single endoscopic procedure, a stone-free rate was achieved in 53 (62%) ureteral units. Approximately 70% of the stones were located in the distal ureter. The procedure was successful for distal ureteric stones in 73%. For patients with calculi less than 10 mm and greater than 10 mm, the initial stone-free rate after ureteroscopy was 70% and 47%, respectively. As was shown by the results of our study, the best candidates for urgent and bilateral same-session ureteroscopy are patients with distal ureteral stone. Thirty days after the initial procedure, in ureteral units with ureteral stones up to 10 mm and localized in the distal ureteral stones, the SFR was 93%. The American Urological Association (AUA) ureteral stones clinical guidelines panel and European Association of Urology (EAU) guidelines on urolithiasis have reported that URSL stone-free rates (97%) were better than SWL stone-free rates (86%) for distal ureteral stones < 10 mm.[17] Ureteral stenting of patients with multiple unilateral (in two distinct locations) and bilateral calculi appears to lessen the risk of a postoperative complication. Protecting the urinary tree after a bilateral procedure DJ ureteral stent placement seemed important to us; and added little operative time to the procedure, although there was a slight increase in postoperative discomfort and hematuria. An important counterpoint is provided by the findings of Hollenbeck and colleagues, who noted that patients were 70% more likely to have postoperative complications when a ureteral stent was not placed after treatment for bilateral or multiple unilateral calculi.[18] AUA and EAU guidelines on urolithiasis reported that stenting after uncomplicated URSL is optional, but solitary kidney is one of the indications for stenting after URSL.[17] Thus, while stent-free ureteroscopy has proven to be safe after uncomplicated unilateral procedures, its role in SSBU is less defined.[19]

The technique of ureteroscopy based on stone fragmentation

Table 5. Treatment modalities in relation to ureteral units.

Type of Treatment	Ureteral Units, no. (%)
URSL + Ureteral stent	73 (81.1)
URSL + DJ stent + SWL	15 (24.6)
URSL + PCN + OP	2 (2.2)

Keys: URSL, ureteroscopic lithotripsy; DJ, double J; SWL, extracorporeal shockwave lithotripsy; PCN, percutaneous nephrostomy; OP, open surgery.

Table 6. Complications classified according to the modified Clavien system.

CCS Grade	Patients-Ureteral Units no. (%)
Grade 1	
Mucosal laceration	5 (8.2)-5 (5.6)
Stone/fragment migration	12 (19.7)-12 (13.3)
Fever	8 (13.1)
Hematuria	3 (4.9)
Renal colic	9 (14.8)
Grade 2	
Urinary tract infection	5 (8.2)
Pyelonephritis	2 (3.3)
Grade 3	
Stent migration	1 (1.6)

Key: CCS, Clavien-Dindo classification system.

with the electropneumatic generator, Lithotron Walz EL-27 Compact produces larger fragments (3-4 mm) that may potentially cause problems in terms of spontaneous passage. Some authors recommend using forceps to reduce re-treatment rate.[20] Similarly, in this study, stone forceps were used to remove stone fragments ≥ 2 mm in 59 (65.5%) of UU to reduce the risk of a second or auxiliary procedure.

Our attitude to routinely placement of ureteral stent, primarily for drainage of urine may be corrected in the future in the sense that the surgeon is provided with a choice, to stent or not to stent after SSBU. The selective use of stents according to surgeon preference made it challenging to determine their role in SSBU. However, the decision to stent placement was left to the attending urologist's discretion. The perceived complexity of the case was undoubtedly related to the decision to stent.

Open surgery was required for two of our patients (3.3%) with large, hard stones. PCN was performed as an urgent treatment. Ureterolithotomy was done (in two patients, i.e. two units of bilateral ureteral calculi) 6 to 8 weeks after the primary intervention (URSL+PCN). Sharma and colleagues[21] reported that open mini-access ureterolithotomy is a safe and reliable minimally-invasive procedure; its role is mainly confined to salvage for failed first-line stone treatments. In selected cases, however, where a poor outcome can be predicted from other methods, it is an excellent first-line treatment.

Calculus anuria is a urological emergency. Management in form of urinary diversion and definite surgical treatment can save the patient from developing chronic renal failure.[22] Although the need for rapid management of ureteral stones has been accepted, the best modality of treatment is still a matter of debate. The best procedure to choose is dependent on several factors, besides stone size and location, including the operator's experience, patient preference, available equipment and related costs.[23] Finally, there is still no consensus on single-session URSL for the management of bilateral ureteric stones and the use of postoperative stents is still controversial.

Limitations of our study are that it is retrospective, non-randomized and that no comparison with a control group was done. Patients presenting in the same manner (anuria due to ureteral stone) who were initially managed with PCN or stents are not a good comparison group, because the only addressed anuria, not calculosis.

CONCLUSION

The presented results suggest that urgent ureteroscopic lithotripsy, URSL, is the method of choice for patients with renal calculi and anuria. The reasons for this conclusion are, the method preserves renal function, which is achieved via controlled relief of obstruction with establishment of prompt diuresis, it provides a high stone-free rate for patients with distal calculus location, and there is small number of relatively mild post-operative complications. The question is raised as to whether routine stent placement is indicated post-procedurally.

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CONFLICT OF INTEREST

None declared.

REFERENCES

1. James M, Pannu N. Methodological considerations for observational studies of acute kidney injury using existing data sources. J Nephrol. 2009;22:295-305.
2. Allen DJ, Longhorn SE, Philp T, Smith RD, Choong S. Percutaneous urinary drainage and ureteric stenting in malignant disease. Clin Oncol (R Coll Radiol). 2010;22:733-9.
3. Praught ML, Shlipak MG. Are small changes in serum creatinine an important risk factor? Curr Opin Nephrol Hypertens. 2005;14:265-70.
4. Sood G, Sood A, Jindal A, Verma DK, Dhiman DS. Ultrasound guided percutaneous nephrostomy for obstructive uropathy in benign and malignant diseases. Int Braz J Urol. 2006;32:281-6.
5. Scarpa RM, De Lisa A, Porru D, Usai E. Holmium: YAG laser ureterolithotripsy. Eur Urol. 1999;35:233-8.
6. Moe OW. Kidney stones. Pathophysiology and medical management. Lancet. 2006;367:333-44.
7. Gunlusoy B, Degirmenci T, Arslan M, et al. Bilateral single-session ureteroscopy with pneumatic lithotripsy for bilateral ureter stones: feasible and safe. Urol Int. 2008;81:202-5.
8. Hollenbeck BK, Schuster TG, Faerber GJ, Wolf JS Jr. Comparison of outcomes of ureteroscopy for ureteral calculi located above and below the pelvic brim. Urology. 2001;58:351-356.
9. Macedo E, Bouchard J, Mehta RL. Renal recovery following acute kidney injury. Curr Opin Crit Care. 2008;14:660-5.
10. Clavien PA, Barkun J, de Oliveira ML, et al. The Clavien-Dindo classification of surgical complications: five year experience. Ann Surg. 2009;250:187-96.
11. Joshi HB, Obadeyi OO, Rao PN. A comparative analysis of nephrostomy, JJ stent and urgent in situ extracorporeal shock wave lithotripsy for obstructing ureteric stones. BJU Int. 1999;84:264-9.
12. Alapont JM, Broseta E, Oliver F, Pontones JL, Boronat F, Jiménez-Cruz JF. Ureteral avulsion as a complication of ureteroscopy. Int Braz J Urol. 2003;29:182-3.
13. Lee DI, Bagley DH. Long term effects of ureteroscopic laser lithotripsy on glomerular filtration rate in the face of mild to moderate renal insufficiency. J Endourol. 2001;15:715-7.
14. El-Hefnawy AS, El-Nahas AR, El-Tabey NA, et al. Bilateral same-session ureteroscopy for treatment of ureteral calculi: critical analysis of risk factors. Scand J Nephrol Urol. 2011;45:97-101.
15. Bandi G, Vicentini FC, Triest JA. Anuric renal failure after same-session bilateral atraumatic flexible ureteroscopy. Int Braz J Urol. 2007;33:193-4.
16. Clinical practice guidelines treatment of acute hyperkalemia in adults, UK Renal Association (2005 and 2007). Accessed in: http://www.renal.org/Libraries/Guidelines/Treatment_of_Acute_Hyperkalaemia_in_Adults_-_FINAL_VERSION_JULY_2012.sflb.ashx
17. Preminger GM, Tiselius HG, Assimos DG, et al. 2007 guideline for the management of ureteral calculi. J Urol. 2007;178:2418-34.
18. Hollenbeck BK, Schuster TG, Faerber GJ, Wolf JS Jr. Safety and efficacy of same-session bilateral ureteroscopy. J Endourol. 2003;17:881.
19. Haleblian G, Kijvikai K, de la Rosette J, Preminger G. Ureteral stenting and urinary stone management: a systematic review. J Urol. 2008;179:424.
20. Gonen M, Cenker A, Istanbulluoglu O, Ozkardes H. Efficacy of dretler stone cone in the treatment of ureteral stones with pneumatic lithotripsy. Urol Int. 2006;76:159-62.
21. Sharma DM, Maharaj D, Naraynsingh V. Open mini-access ureterolithotomy: the treatment of choice for the refractory ureteric stone? BJU Int. 2003;92:614-6.
22. Westenberg A, Harper M, Zafirakis H, Shah PJ. Bladder and renal stones: management and treatment. Hosp Med. 2002;63:34-41.
23. Autorino R, Osorio L, Lima EA. Rapid extracorporeal shock wave lithotripsy for proximal ureteral calculi in colic versus noncolic patients. Eur Urol. 2007;52:1264-5.