University of Diyala

College of medicine

Department of Surgery

Review article in

The latest updates in the management of Urinary stones

Student name: Aya Mohammed Mahmood

Supervised by:Dr. Waleed Khalid Mohammed

2022

Abstract

Urolithiasis is a very old and problematic disease and it is very common disorder of urinary tract. It's affected all ages and races without exceptions. It's characterized by cramping, intermittent Abdominal pain, hematuria, nausea and vomiting make it not so easy to diagnose and need further investigations. There are many investigations available but the imaging studies are the best. The conservative management not always working leaving it the surgical interventions such as shock wave lithotripsy and open surgery. We discussed the latest updates on the medical in interventional therapies in management of Urolithiasis.

Keywords: Urolithiasis, Shockwave, Alkalinization

Introduction

Human kind has been afflicted by urinary stones since centuries dating back to 4000 B.C. and it is the most common disease of the urinary tract. The prevention of renal stone recurrence remains to be a serious problem in human health. The prevention of stone recurrence requires better understanding of the mechanisms involved in stone formation. Kidney stones have been associated with an increased risk of chronic kidney diseases, end-stage renal failure, cardiovascular diseases, diabetes, and hypertension. It has been suggested that kidney stone may be a systemic disorder linked to the metabolic syndrome. Nephrolithiasis is responsible for 2 to 3% of end-stage renal cases if it is associated with nephrocalcinosis (1). Urolithiasis is a worldwide problem that can affect all groups of ages and is one of the major sources of morbidity around the world. The prevalence of lifetime risk for urolithiasis has been increasing over time. It has been reported, that about 50% of patients with a history of urinary stones will have a recurrence of a second stone forming within the next 10 years. In addition, other known causes of forming ureteric stones both in pediatric and adult populations include socioeconomic status, stone size, and location in urinary system, renal anatomy and abnormalities, climate and other factors, all of which have influence on the treatment outcome as well as the choice of intervention (2). The characteristic cramping and intermittent abdominal and flank pain occur as kidney stones travel within the urinary tract. The pain is often accompanied by hematuria, nausea or vomiting, and malaise; fever and chills may also be present. However, stones in the renal pelvis may be asymptomatic. The differential diagnosis includes infections in the urinary tract or abdomen, malignancies, and musculoskeletal inflammation or spasm (3). It's a common disease (Stones are the third most common disorder of the urinary tract, behind urinary tract infections and prostate conditions.) and the methods of treatment have been developed considerably in the last 50 years and now it could be managed conservatively in the hospitals or in the outpatient clinics (4).

In this short review, we will discuss the latest methods in diagnosis and treatment of urinary stones and how to prevent them.

Literature review

Small non-obstructing and intraparenchymal stones may potentially neither grow nor move down the ureter and, thus, not cause symptoms. By 3 years, 22% will grow significantly, 28% will cause colic, and another 2% will cause silent obstruction. Observation, with serial imaging to assess for interval growth, is a reasonable alternative in these cases, at least in the short term, as the risk of complications of intervention may not outweigh the benefit (5). The diagnosis mainly consist of history, physical exam , lab investigation and imaging (6). Stone composition is the basis for further diagnostic and management decisions. Stones can be classified by cause, aetiology of formation, composition, and risk of recurrence (table 1).

Stone Type	Metabolic Abnormality	Clinical Setting
Calcium oxalate	Hypercalciuria	Hyperparathyroidism, immobilization, high vitamin D, sarcoidosis, Cushing syndrome, increased dietary sodium, genetic predisposition
	Hyperoxaluria	Increased oxalate absorption (inflammatory bowel disease), primary hyperoxaluria, high doses of dietary Vitamin C
Calcium phosphate	Hypocitraturia Hypercalciuria High urine pH (> 7)	Similar to calcium oxalate, as well as distal renal tubular acidosis, and intake of medications with carbonic anhydrase inhibitory action
Struvite	High urinary ammonium and bicarbonate levels	Urinary tract infection with urease-splitting organisms
Uric Acid	Low urine pH (< 5.5) Hyperuricosuria	Metabolic syndrome, insulin resistance, type 2 diabetes
Cystine	Cystinuria	Genetic disorder

Table 1. Types of stones

Further classifications are based on stone size and location or X-ray characteristics (plain X-ray appearance on kidney-ureter-bladder [KUB] radiography). Non–contrast-enhanced CT (NCCT) can be used to classify stones according to density and composition (7). Evaluation includes a detailed medical history, physical examination, appropriate imaging, and basic evaluation. Patients with ureteral stones usually present with loin pain, vomiting, and sometimes fever, whereas renal stones may be asymptomatic (8). Imaging has a critical role in the initial diagnosis, treatment planning and post-treatment surveillance of patients with urolithiasis. Ultrasound (US) should be used as the primary diagnostic imaging tool, although pain relief and other emergency measures should not be delayed by imaging assessments. US can identify stones located in the kidney and pyeloureteral and vesicoureteric junctions, but frequently fails to detect ureteral calculi. The upper urinary tract is usually dilated in patients with ureteral stones. For all stones, US has sensitivity of 19–93% and specificity of 84–100% (9).

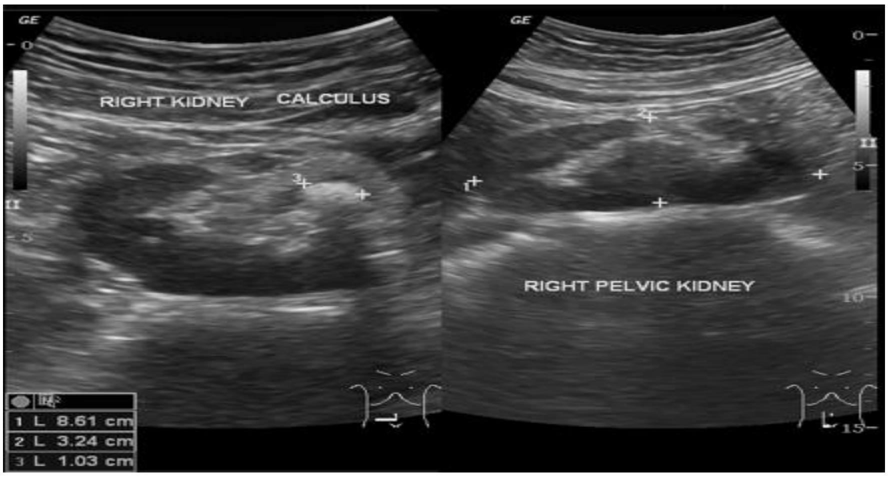

Figure 1. Urolithiasis on ultrasonography

The sensitivity and specificity of KUB radiography for stone identification are 44–77% and 80–87%, respectively. KUB radiography may be helpful in differentiating between radiolucent and radiopaque stones and for comparison during follow-up. Magnetic resonance urography cannot be used to detect urinary stones. NCCT has become the standard for diagnosing acute flank pain, and has replaced intravenous urography as it seems to be more accurate (10).

Figure 2. Urolithiasis on KUB

Non-contrast CT offers several advantages compared with alternative imaging techniques such as plain radiography and ultrasound, including high sensitivity and specificity (>95% and >96%, respectively) for the detection of stones, easy availability, faster speed of acquisition and absence of need for administration of intravenous contrast. With the emergence of multi-detector CT (MDCT) and advanced technologies like dual-energy CT (DECT), the scope of CT in urolithiasis management has further expanded (11).

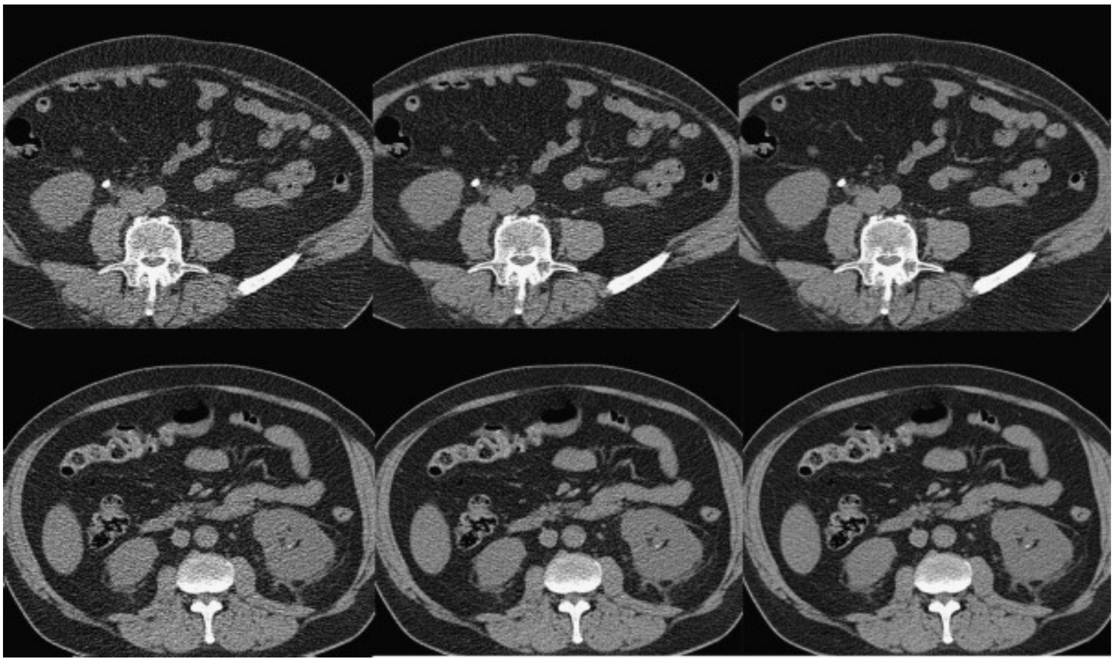

Figure 3. Urolithiasis on CT scan

Medical management consist of consists of adequate high fluid intake, low sodium diet and the recommended ingestion (RDA) of protein and calcium to reduce the hypercalciuria. Dietary compliance is particularly difficult in children and adolescents, leading to usage of pharmacotherapy. Pharmacological therapy is typically added if dietary treatment fails (12). A randomized controlled trial pointed to beneficial effects of citrate use in adults with Urolithiasis. Improvement of bone mineral density was also reported in adults with calcium oxalate stones after long-term use of potassium citrate (13-14). Increased urinary levels of oxalate may be due to primary hyperoxaluria. Deficient production of the enzyme alanine-glyoxylate aminotransferase by the liver is responsible for the more serious form of the illness, leading to end-stage renal disease. High fluid intake, thiazides diuretics, citrate, pyrophosphates and magnesium oxide compose the mainstay treatment (15). Another therapeutic option to enhance colonic secretion of oxalate involves probiotics. Studies with a naturally occurring bacterium, *Oxalobacter formigenes*, showed an inverse association with the presence of calcium oxalate stones. Nevertheless, degradation of intestinal oxalate also acts sinergystically with the colonic secretion, reducing blood and urine oxalate levels (16). Alkalinization is the pillar of treatment of Uric Acid stones. Potassium citrate preparations are preferred due to a possible increased calcium excretion secondary to sodium load in sodium citrate. Several meta-analyses have demonstrated the effectiveness of alpha-adrenergic agonists (eg, tamsulosin) for the medical management of urolithiasis, demonstrating higher stone passage rates, quicker time to stone passage, decreased analgesic requirement, and lower rates of hospitalization (17).

The decision to pursue surgical intervention (eg, lithotripsy, ureteroscopic removal, percutaneous nephrolithotomy) often depends upon stone size, duration of symptoms, and modifying factors (eg, solitary kidney, renal transplant, renal dysfunction, associated pyelonephritis, refractory pain) (18). One study found that the passage rate for 1-mm stones was 87%, 2-to-4-mm stones was 76%, 5-to-7-mm stones was 60%, 7-to-9-mm stones was 48%, and greater than 9-mm stones was 25% (19). Surgical intervention is very challenging because of the choice of procedure. Surgical treatment of ureteral calculi depends on stone location and size. The AUA guidelines state that earlier classifications split the ureter into thirds and that this was because of the surgical approaches available.

Nowadays, the ureter is divided into two sections marked by the crossing of the iliac vessels. All guidelines use a cut--off level of 10 mm to define the surgical approach (20). The available surgical modalities include: shock wave lithotripsy, uretroscopy, percutaneous nephrolithotomy and open or laporascopic surgery.

Shock wave lithotripsy

The basis of shock wave lithotripsy (SWL) is to fracture stones using focused shock waves into smaller fragments, which can then be passed spontaneously. Numerous versions of SWL devices (lithotripters) are available, with different means of generating the shockwave. These include electrohydraulic (spark gap), electromagnetic, and piezoelectric shockwaves. The shockwave is generated inside the lithotripter and then it is focused to an external point with parabolic reflectors or acoustic lenses.

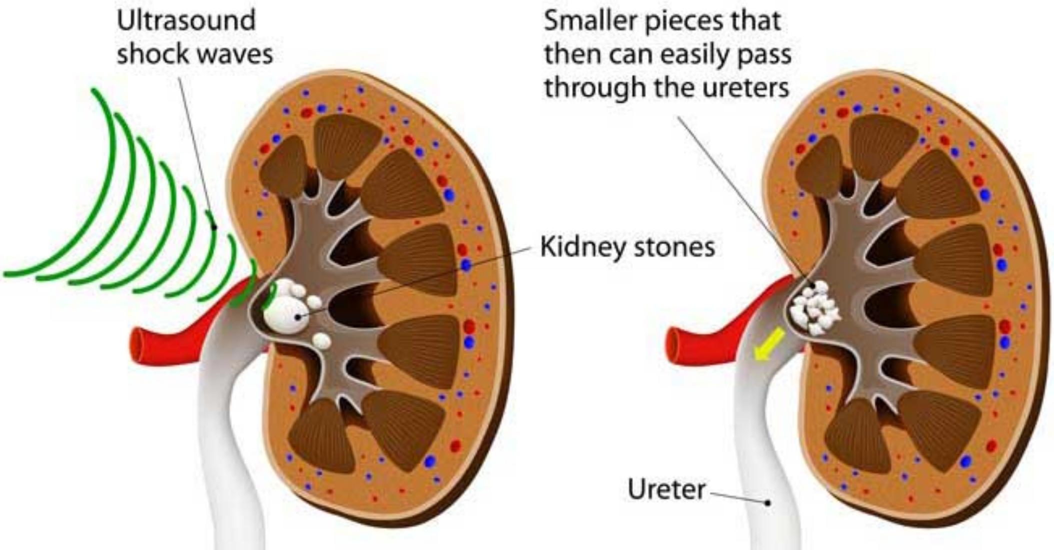

Figure 4. Shockwave lithotripsy

The patient is positioned in such a way that the focal point is on the stone in question. To ensure correct position of the patient and stone, fluoroscopic or ultrasound guidance is used and the patient or lithotripter moved until the stone is in the focal point (21). The primary benefit of SWL is that it does not require instrumentation of the patient's urinary tract or placement of a ureteral stent. Many patients poorly tolerate stent because of bladder spams and flank discomfort. However, SWL for many stone locations has a lower likelihood of rendering the patient stone free, as it may be difficult to verify that the stone was fractured into small enough pieces to pass down the ureter spontaneously (22).

Ureteroscopy

The basis of ureteroscopy is to advance a small diameter scope (most often 2–3 mm in diameter) in a retrograde manner up the urethra and bladder to the ureter and kidney and fracture the stone(s) with laser energy via a laser fiber through the scope. The fragments can either be broken down into smaller fragments that can then be extracted with a wire basket or further fractured to submillimeter fragments (dusting) with the plan of having them pass spontaneously.This method can be achieved either with a semirigid scope in the distal ureter, allowing for better irritant flow and visibility, or a flexible ureteroscope in the more proximal ureter and kidney, allowing for complete inspection of the urinary collecting system. Ureteroscopy offers superior stone-free rates to those of SWL in most clinical scenarios and, thus, fewer secondary procedures for residual stones (23-24).

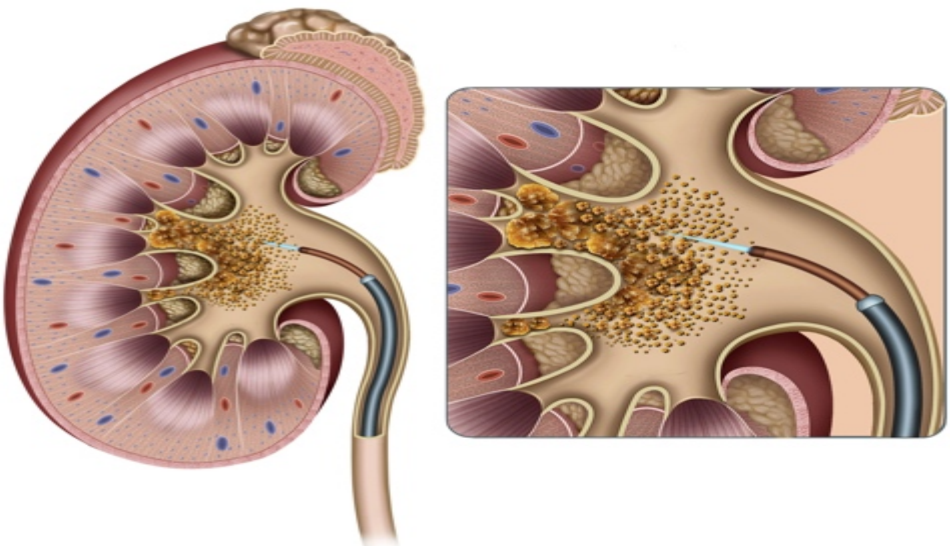

Figure 5. Ureteroscopy

Percutaneous nephrolithotomy

PCNL has replaced open or laparoscopic surgery as the standard treatment for larger renal stones (in general >2 cm size) because of its minimal invasiveness, lower morbidity, shorter operative time and hospital stay, with the stone-free rate approaching that of open surgery.

The absolute contraindications for PCNL are active and untreated UTI, and uncorrected coagulopathy (25). PCNL is usually carried out under

GA. However, reports also suggested that local anesthesia with intravenous sedation is feasible, if the GA risk is high. Regional anesthesia is also an alternative. Therefore, the choice of anesthesia depends on the patient's preference, position preference by surgeon, surgical expertise and estimated procedure time (26).

Although access to the collecting system can be achieved blindly without any imaging system, it is more appropriate to carry out the puncture under image guidance Recently, there has been a report on a robot-assisted device for puncture, using ANT-X, which was successful at the first attempt in a human trial.49 Although the results of this study are quite promising, the use of robot-assisted puncture requires further investigations (27). Traditionally, the puncture is recommended to go through the calyceal fornix to avoid vascular injury. A recent trial showed that the infundibular approach for PCNL to the posterior middle renal calyces is not associated with higher blood loss. Further studies are required to confirm this new observation (28).

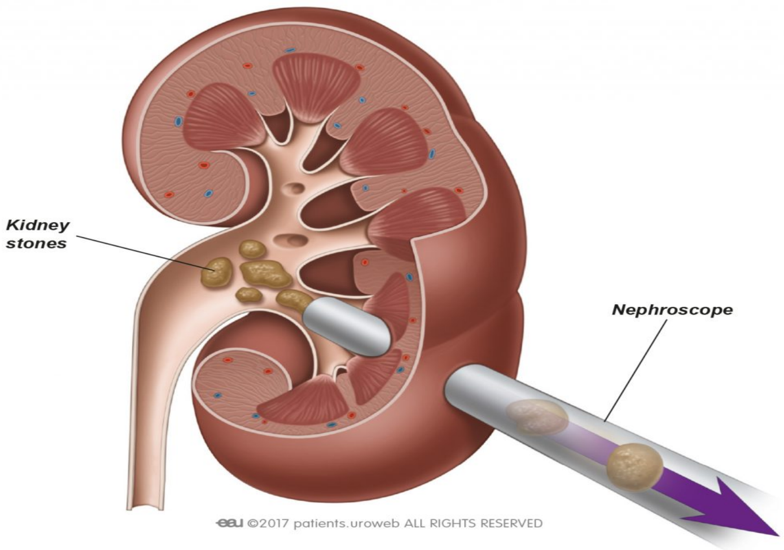

Figure 6. PCNL

Open surgery

The surgical procedures for management of urolithiasis have dramatically changed over the past 3 decades. Back in 1980s, urologist routinely had to perform open surgery to extract stones from the urinary tract. Recent advances in endourological field, in the form of percutaneous nephrolithotomy (PCNL) and laparoscopy have resulted in a rapid decrease in the use of higher aggressive treatment approaches. Open surgery is needed in 1-5.4% of cases, according to the expertise worldwide (29). The current indications for open surgery according to European Association of Urology (EAU) are as follows: complex stone burden, unsuccessful minimally invasive procedures such as ESWL or PCNL, comorbid medical diseases, morbid obesity, anatomical abnormalities (such as infundibular stenosis, PUJ obstruction, and stricture), skeletal deformity and nonfunctional kidney (nephrectomy) (30).

References

1. Alelign T, Petros B. Kidney stone disease: an update on current concepts. Advances in urology. 2018 Feb 4;2018.
2. Shafi H, Moazzami B, Pourghasem M, Kasaeian A. An overview of treatment options for urinary stones. Caspian journal of internal medicine. 2016;7(1):1.
3. Frassetto L, Kohlstadt I. Treatment and prevention of kidney stones: an update. American family physician. 2011 Dec 1;84(11):1234-42.
4. Roudakova K, Monga M. The evolving epidemiology of stone disease. Indian J Urol. 2014;30:44–8.
5. Türk C, Petřík A, Sarica K, Seitz C, Skolarikos A, Straub M, Knoll T. EAU guidelines on interventional treatment for urolithiasis. European urology. 2016 Mar 1;69(3):475-82.
6. Gottlieb M, Long B, Koyfman A. The evaluation and management of urolithiasis in the ED: A review of the literature. The American journal of emergency medicine. 2018 Apr 1;36(4):699-706.
7. Kim SC, Burns EK, Lingeman JE, Paterson RF, McAteer JA, Williams Jr JC. Cystine calculi: correlation of CT-visible structure, CT number, and stone morphology with fragmentation by shock wave lithotripsy. Urol Res 2007;35:319–24.
8. Wimpissinger F, Turk C, Kheyfets O, Stackl W. The silence of the stones: asymptomatic ureteral calculi. J Urol 2007;178:1341–4.

9. Ray AA, Ghiculete D, Pace KT, Honey RJ. Limitations to ultrasound in the detection and measurement of urinary tract calculi. Urology 2010;76:295–300.
10. Türk C, Petřík A, Sarica K, Seitz C, Skolarikos A, Straub M, Knoll T. EAU guidelines on diagnosis and conservative management of urolithiasis. European urology. 2016 Mar 1;69(3):468-74.
11. Andrabi Y, Patino M, Das CJ, Eisner B, Sahani DV, Kambadakone A. Advances in CT imaging for urolithiasis. Indian journal of urology: IJU: journal of the Urological Society of India. 2015 Jul;31(3):185.
12. Schwaderer A, Srivastava T. Complications of hypercalciuria. *Front Biosci (Elite Ed)* 2009;1:306–315.
13. Penido MG, Tavares Mde S. Pediatric primary urolithiasis: Symptoms, medical management and prevention strategies. *World J Nephrol*. 2015;4(4):444-454. doi:10.5527/wjn.v4.i4.444.
14. Pak CY, Peterson RD, Poindexter J. Prevention of spinal bone loss by potassium citrate in cases of calcium urolithiasis. *J Urol.* 2002;168:31–34.
15. Xu H, Zisman AL, Coe FL, Worcester EM. Kidney stones: an update on current pharmacological management and future directions. *Expert Opin Pharmacother.* 2013;14:435–447.
16. Ivanovski O, Drüeke TB. A new era in the treatment of calcium oxalate stones? *Kidney Int.* 2013;83:998–1000.
17. Campschroer T, Zhu Y, Duijvesz D, et al. Alpha-blockers as medical expulsive therapy for ureteral stones. Cochrane Database Syst Rev. 2014 Apr 2;(4):CD008509.
18. Leveridge M, D'Arcy FT, O'Kane D, et al. Renal colic: current protocols for emergency presentations. Eur J Emerg Med. 2016 Feb;23(1):2-7.
19. Preminger GM, Tiselius HG, Assimos DG, et al; American Urological Association Education and Research, Inc; European Association of Urology. 2007 Guideline for the management of ureteral calculi. Eur Urol. 2007 Dec;52(6):1610-31.
20. Conort P, Dore B, Saussine C, Comite Lithiase de l'Association Francaise dU. Guidelines for the urological management of renal and ureteric stones in adults. Prog Urol. 2004;14(6):1095–102.

21. Cleveland RO, McAteer JA. Physics of shock wave lithotripsy. In: Smith AD, Badlani GH, editors. Smith's textbook of endourology. West Sussex (United Kingdom): Wiley-Blackwell; 2012. p. 529–53.
22. Preminger GM, Tiselius HG, Assimos DG, et al. EAU/AUA nephrolithiasis guideline panel. 2007 guideline for the management of ureteral calculi. J Urol 2007; 178:2418–34.
23. Lahme S. Ureteroscopic management of renal calculi. In: Smith AD, Badlani GH, editors. Smith's textbook of endourology. West Sussex (United Kingdom): WileyBlackwell; 2012. p. 529–53.
24. Ingimarsson JP, Krambeck AE, Pais VM. Diagnosis and management of nephrolithiasis. Surgical Clinics. 2016 Jun 1;96(3):517-32.
25. Al-Kohlany KM, Shokeir AA, Mosbah A et al. Treatment of complete staghorn stones: a prospective randomized comparison of open surgery versus percutaneous nephrolithotomy. J. Urol. 2005; 173: 469–73
26. Malik I, Wadhwa R. Percutaneous nephrolithotomy: current clinical opinions and anesthesiologists perspective. Anesthesiol. Res. Pract. 2016; 2016: 9036872.
27. Oo MM, Gandhi HR, Chong K-T et al. Automated needle targeting with Xray (ANT-X) – Robot-assisted device for percutaneous nephrolithotomy (PCNL) with its first successful use in human. J. Endourol. 2018; https://doi.org/10.1089/end.2018.0003.
28. Kallidonis P, Kyriazis I, Kotsiris D, Koutava A, Kamal W, Liatsikos E. Papillary vs nonpapillary puncture in percutaneous nephrolithotomy: a prospective randomized trial. J. Endourol. 2017; 31(S1): S-4–9.
29. Honeck P, Wendt-Nordahl G, Krombach P, et al. Does open stone surgery still play a role in the treatment of urolithiasis? Data of a primary urolithiasis centre. J Endourol 2009; 23: 1209-12.
30. Bichler KH, Lahme S, Strohmaier WL. Indications for open stone removal of urinary calculi. Urol Int 1997; 59: 102-8