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Korean Society of Endourology and Robotics (KSER) recommendation on the diagnosis, treatment, and prevention of urolithiasis

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This article provides evidence-based recommendations and expert opinions to aid urologists in making optimal decisions regarding managing urolithiasis in various clinical scenarios. The most frequently asked questions by urologists in their clinical practice have been collected and answered in the form of FAQs; based on the latest evidence and expert opinions. The natural history of urolithiasis is divided into active treatment and silent phases, with the active treatment stage divided into typical and special situations and peri-treatment management. The authors address 28 key questions, offering practical guidance for the proper diagnosis, treatment, and prevention of urolithiasis in clinical practice. This article is expected to be served as a valuable resource for urologists.

Keywords: Diagnosis; Risk management; Therapy; Urolithiasis

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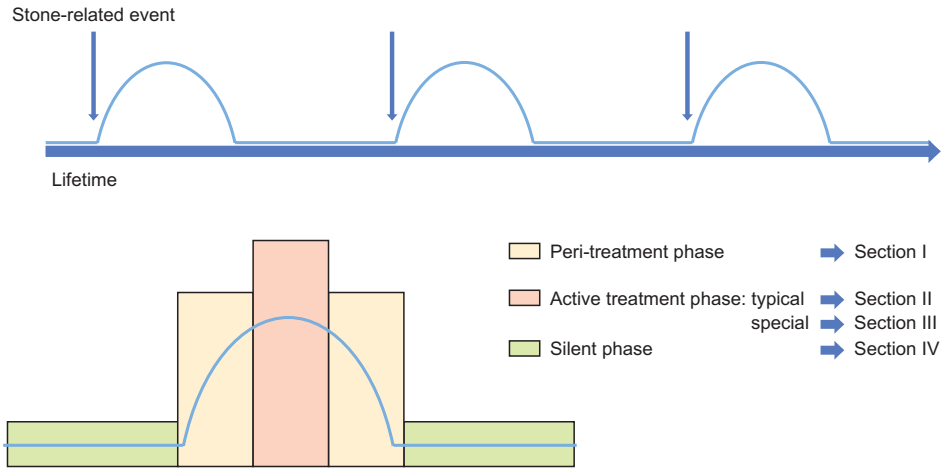

Fig. 1. The natural history of urolithiasis management classified as active treatment and silent phase.

INTRODUCTION

The lifetime prevalence of urolithiasis in Korea is currently 11.5%, with a steady increase observed over the past 11 years [1]. The recurrence rate within five years is also high, at 21.3%, highlighting the importance of both treatment and prevention [1].

Advancements in medical equipment have greatly influenced the treatment of urolithiasis. The introduction of flexible ureterorenoscope, made possible by endoscopic technology advances, has enabled retrograde intrarenal surgery (RIRS). The indications for RIRS have expanded to include relatively large renal stones that were previously thought to require more invasive surgical procedures. Additionally, minimally invasive procedures have evolved through the miniaturization of instruments and the application of robotic technology.

Social factors, such as lifestyle changes, a more westernized diet, and the increasing incidence of metabolic syndromes like obesity, hypertension, and diabetes, have also had an impact on the characteristics of urolithiasis. In Korea, there has been a recent increase in the proportion of uric acid stones [2,3].

These changes have affected the diagnosis, treatment, and prevention of urolithiasis. To address the most common questions from clinicians dealing with urolithiasis, we have compiled a list of frequently asked questions (FAQs) that have been updated to reflect these recent changes.

MATERIALS AND METHODS

In December 2019, the Korean Society of Endourology and Robotics (KSER) Urolithiasis Booklet Project Team was established. The goal was to collect the questions that urologists commonly encounter in their clinical practice regarding urolithiasis and providing evidence-based answers in the form of an FAQ.

An email survey was distributed to KSER members, regardless of their clinical experience, to gather their questions and concerns about treating urolithiasis patients. We received a total of 150 questions, which were then condensed into 28 core questions by grouping together similar queries.

As shown in Fig. 1, the natural history of urolithiasis management was divided into two parts: the active treatment phase and the silent phase. The active treatment stage was further divided into typical and special situations and peri-treatment management. Authors were selected based on their expertise in specific topics and proceeded to write the manuscript.

RESULTS

1. Pre-and post-treatment management of urolithiasis

1) Computed tomography (CT) is the primary diagnostic tool for urolithiasis. Are there any indications for contrast-enhanced CT or intravenous urography (IVU)?

1) Non-contrast enhanced CT is recommended for the diagnosis of urolithiasis, and low-dose non-contrast enhanced CT is also useful in non-obese patients.
2) Contrast-enhanced CT may be helpful for structural confirmation of the kidney (e.g., collecting system) prior to treatment.

2) In which patients is renal function assessment necessary at the time of surgery for urolithiasis, and which tests are most appropriate?

1) In patients with suspected decreased renal function, in

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addition to serum creatinine, nuclear medicine tests (dimercapto succinic acid [DMSA], diethylenetriamine pentaacetate [DTPA], or mercaptoacetyl-triglycine [MAG3] scans) can assess the relative renal function of the bilateral kidneys.
2) A more invasive method is to calculate the glomerular filtration rate after the placement of a percutaneous nephrostomy tube (PCN).
3) Renal function can be estimated by measuring renal cortical thickness or volume with ultrasound or non-contrast enhanced CT.

3) What are the appropriate methods of controlling renal colic, and what are the stages and indications for pharmacotherapy?

1) In acute renal colic, non-steroidal anti-inflammatory drugs (NSAIDS) are first-line treatment.
2) If NSAIDs are not available or less effective, paracetamol can be effective, and if it does not respond, opioids may be considered.
3) If renal colic is not controlled by medication, drainage options like ureteral stent placement, percutaneous nephrostomy, or aggressive stone removal should be considered.

4) What is the recommended use of antibiotics before, during, and after the procedure and surgery for urolithiasis? Is antibiotic treatment necessary if the patient has asymptomatic bacteriuria or pyuria before the procedure or surgery?

1) Patients scheduled for endoscopic surgery of urolithiasis should undergo a urinalysis with microscopic examination and urine culture.
2) Concomitant urinary tract infections (UTIs) before endoscopic stone surgery require treatment, and preoperative prophylactic antibiotics are recommended in all patients.
3) Prophylactic antibiotics are not recommended before or after shock wave lithotripsy (SWL) in patients with urolithiasis without evidence of UTIs, but prophylactic antibiotics should be considered if risk factors for UTIs are present.
4) For infected stones, short- and long-term antibiotic use should be considered.

5) Is prestenting necessary for SWL or transurethral stone removal?

1) Prestenting is not usually required but may be considered for single kidney, large stones, hydronephrosis, or severe pain before SWL.
2) For transurethral stone removal, if there is a history of previous ureteral strictures or the stone is large, prestenting may be considered and should be performed 1–2 weeks before surgery (expert opinion).

6) If a ureteral stent is placed after the procedure, how long should it be left in place and how should ureteral stent-related pain and dysuria managed?

1) The duration of ureteral stent placement after the procedure depends on the degree of ureteral injury or stricture, and it is recommended to keep it in place for a short period, preferably within 2 weeks.
2) Pain and dysuria caused by the ureteral stent can be controlled using NSAIDs or opioids, and lower urinary tract symptoms can be managed using alpha-blockers, ß3 agonists, and antimuscarinic agents alone or in combination.

7) How should the residual stones after a procedure or surgery be managed?

1) For infected stones, more aggressive treatment is necessary as they increase the risk of UTIs or recurrence.
2) Non-contrast enhanced CT is recommended for follow-up of stones due to its high sensitivity and is recommended to be performed 4 weeks or more after surgery.

Additional explanation

It is recommended to screen for asymptomatic bacteriuria, perform a urine culture, and treat it before endoscopic surgery for urolithiasis, especially when submucosal hemorrhage is expected [4]. A single dose of prophylactic antibiotics is sufficient before endoscopic surgery for urolithiasis [5,6].

Multiple studies have shown that even small stones may eventually become clinically significant, resulting in symptomatic stones. Stones larger than 5 mm are more likely to require further treatment than smaller stones [7-11]. Additionally, stones larger than 2 mm are more likely to increase in size but are not associated with a higher rate of further treatment at a one-year follow-up [12].

2. Treatment of Typical Urolithiasis

1) What agents are commonly used in medical expulsive therapy (MET), and at what intervals is imaging appropriate? What are the criteria for switching to more aggressive treatment?

1) MET is generally considered first-line treatment for lower ureteral stones of 10 mm or less.
2) The effectiveness of MET is greater in lower ureteral stones greater than 5 mm.
3) Alpha-blockers are the most commonly used agents in MET, and the duration of treatment is usually 1 month.
4) Follow-up image after 7–14 days is recommended to confirm the stone location and presence of hydronephrosis.
5) Consider switching to more aggressive treatment in cases of [13-16]:
   - Stones that are unlikely to pass spontaneously
   - Stones accompanied by infection
   - Persistent pain despite adequate analgesia
   - Persistent obstruction (worsening renal function)
   - Renal insufficiency (renal failure, bilateral obstruction, or single kidney)

2) What factors predict the success of SWL and what can be done to increase the success rate?

1) Proper patient selection and shockwave delivery technique are important to increase the success rate of SWL and minimize complications.
2) Patient selection should be based on stone size, location, composition, CT density (Hounsfield units, HU), patient characteristics (body mass index and skin-to-stone distance), and anatomic anomalies.
3) On the technical side, the efficiency of SWL can be increased by optimizing the sequence of shock waves, dose escalation of shock wave energy, and the number (2,000–4,000) and frequency (1.0–1.5 Hz) of shock waves.
4) Alpha-blockers may be considered for efficient expulsion of the fragmented stones.

3) What is the appropriate follow-up interval for SWL? How is it determined when to consider surgical treatment during follow-up?

1) After SWL, follow-up examinations are typically performed at 1–4 week intervals.
2) Imaging studies used for follow-up include kidney-ureter-bladder (KUB), IVU, ultrasonography, and CT and are selected based on accuracy and radiation exposure.
3) Consider surgical treatment if further SWL is not feasible, taking into account the incidence of residual stones and complications after SWL and the patient's condition.

4) How can the surgical success rate of RIRS be improved?

1) Performing a systematic review of all large and small calyces in the kidney during RIRS is a good way to prevent the occurrence of postoperative residual stones and improve endoscopic skills.

5) Are there ways to minimize complications such as ureteral injury or infection during transurethral stone removal?

1) The insertion of a safety guidewire during transurethral stone removal is recommended in prevention for intraoperative complications such as ureteral injury or perforation (expert opinion).
2) Although prestenting is not necessary in all patients, it may facilitate transurethral stone removal, increase stone clearance rate, and decrease the incidence of intraoperative complications.
3) If ureteroscopic access to the ureter is not possible, it is recommended that surgery be performed after 1–2 weeks of ureteral stent placement.
4) Postoperative ureteral stent placement is not necessary in all cases. However, if there are residual stones, ureteral injury, bleeding, perforation, or suspected or confirmed UTIs during surgery, it is recommended that a ureteral stent be placed at the end of surgery and left in for 1–2 weeks (expert opinion).
5) UTIs should be treated with antibiotics prior to ureteroscopic surgery. If an infection associated with ureteral obstruction is identified, drainage should be performed several days prior to stone removal, and a urinalysis and/or urine culture should be performed prior to treatment.
6) High intrarenal pressure during transurethral stone removal increases the likelihood of postoperative complications such as UTIs and sepsis.
7) The use of ureteral access sheath (UAS) can effectively reduce intrarenal pressure and help increase perfusion rate, which can shorten the operative time.
8) UAS insertion may cause damage to the ureter. Prestenting helps to reduce this risk.
9) Transurethral stone removal is associated with a lower risk of bleeding compared to SWL or percutaneous nephrolithotomy (PCNL). It can be performed even if

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anticoagulation therapy cannot be discontinued.

6) What are the appropriate indications for PCNL? What are the options for a percutaneous approach?

1) PCNL may be considered as a first-line treatment for large renal stones (>2 cm) regardless of location or lower pole renal stones (>1 cm).
2) PCNL could be considered as a first-line treatment for renal stones with congenital or acquired renal anomalies, such as lower urinary tract obstruction or urinary tract reconstruction, or ileostomy. Upper ureteral stones that have failed or are expected to fail due to prior transurethral stone removal are also good indications for PCNL.
3) Upper pole puncture provides easy access to multiple lower poles and ureters but carries a slightly increased risk of pneumothorax or hydrothorax caused by pleural injury.
4) If the PCNL is performed without complications, it is possible to complete the procedure without placing a nephrostomy or ureteral stent, which can reduce pain and hospitalization.

7) How can complications such as renal injury or infection be reduced during PCNL?

1) The appropriate size of the endoscope should be selected based on the size of the stone and the patient's anatomy. Miniaturized PCNL may have a lower chance of bleeding compared to standard PCNL.
2) Puncture should follow basic principles (avascular line) and should be precise and targeted towards the renal calyx. If possible, a flexible ureterorenoscope can be used to avoid multiple punctures.
3) Excessive torque of the endoscope should be avoided.
4) Staged operation for difficult-to-treat stones should be considered if multiple punctures are not absolutely necessary.
5) Pre-operative urinalysis and urine culture should be performed, and appropriate prophylactic antibiotics should be used if culture positive.
6) Irrigation pressure should be kept stable and not excessively increased during surgery.

8) When is endoscopic combined intrarenal surgery (ECIRS) helpful? (ECIRS may be considered in the following situations)

1) Coexistence of multiple, large renal, and ureteral stones in ipsilateral or bilateral sides.
2) In need of difficult access with RIRS or PCNL alone (horseshoe kidney, ureteral stones causing complete ureteral stricture and ureteral obstruction, staghorn stones, renal diverticular stones with very narrow or difficult angles to the renal calyx, etc.).
3) Insertion of a flexible ureterorenoscope into a percutaneous passage to access other renal calyces, thereby reducing the number of additional percutaneous passages.
4) When ureteral stent encrustation is so severe that percutaneous or retrograde access alone is insufficient.

9) What are the advantages of robotic or purely laparoscopic surgery and when is it appropriate?

1) Laparoscopic ureterolithotomy may be an alternative to SWL or URS for larger upper ureteral stones. It should be considered as an alternative when SWL, URS, or PCNL have failed or are likely to fail.
2) Laparoscopic ureterolithotomy has the advantage of a high stone-free rate and a low need for additional procedures.
3) Frequency of ureteral stricture is not different between the laparoscopic ureterolithotomy and URS.
4) A laparoscopic approach may be advantageous if there are concomitant anatomic abnormalities, such as ureteropelvic junction stricture, ureteral stricture, or renal diverticulum.
5) Robot-assisted laparoscopic surgery allows for accurate and precise debridement and suturing, allowing for removal of even large stones without comminution.

Additional explanation

In studies of SWL, stones with a density less than or equal to 1,000 HU are associated with a higher success rate due to better crushing ability compared to stones with higher densities [17-19]. For renal stones larger than 1 cm, a shockwave frequency of 60–90 shocks/min (1.0–1.5 Hz) has been reported to be more effective than a frequency of 120 shocks/min (2 Hz) [20-23].

To improve the success rate of RIRS, patient should be evaluated for candidacy for RIRS based on the preoperative stone size, location, and expected composition [24]. During RIRS, dusting method, which crushes the stone into small particles, can be effective if the fragments are difficult to extract. For stones located in the lower pole, moving them to a more accessible calyx may be helpful. Depending on the method used to crush stones, it is often categorized as either dusting or fragmentation. Taking enough time to pulverize

residual stones into a fine dust using the pop-dusting method can reduce postoperative residual stones [25-27]. At the end of the procedure, the UAS should be drawn out with careful endoscopic ureteral inspection.

PCNL is traditionally performed through a 24–30 Fr sheath (standard PCNL), but due to the higher risk of bleeding, smaller sheath of 18 Fr or less (mini-PCNL) are now used in practice quite often [28-30]. ECIRS is a combination of PCNL and RIRS that utilizes the flexible ureterorenoscope in single renal unit [31-33]. Robotic RIRS systems are being developed worldwide [34-36]. Recently, a new robotic endoscopic platform for RIRS has been developed in Korea [37-40].

3. Treatment of Urolithiasis in Special Situations

1) How should urolithiasis be treated in patients on anticoagulant or antiplatelet agent?

1) Aspirin can be continued during low-bleeding risk procedures such as flexible cystoscopy, rigid cystoscopy, and ureteral stent removal, but it is recommended to discontinue or delay its use for high-bleeding risk procedures such as SWL or PCNL.
2) For thienopyridine agents such as clopidogrel, it is recommended to discontinue its use for 5 days prior to the procedure and restart with a loading dose within 24 to 72 hours after the procedure.
3) In patients requiring continuous use of anticoagulant or antiplatelet agents, ureteroscopy is recommended as the primary treatment option.
4) For asymptomatic stones without obstruction or infection, it is advisable to delay treatment until anticoagulant or antiplatelet therapy can be discontinued or to consider conservative management.

2) How should urolithiasis during pregnancy be diagnosed and treated?

1) For suspected urolithiasis in pregnant women, ultrasound is recommended as the primary imaging modality with contrast-free magnetic resonance urography as a secondary option.
2) Low-dose CT should only be considered as a last-resort imaging modality in pregnant women, and the absorbed dose should not exceed 50 mGy.
3) Conservative management is the first-line treatment for uncomplicated urolithiasis during pregnancy.
4) As an alternative to conservative treatment, interventional procedures such as ureteral stent placement or percutaneous nephrostomy can be performed, but the risk of encrustation is higher than in the general population and frequent replacement at 4–6-week intervals is recommended (expert opinion).
5) Transurethral stone removal can be performed in pregnant women if spontaneous passage of ureteral stones fails.

3) How is urolithiasis treated in patients who have undergone renal transplantation or urinary diversion?

1) Several treatment options are available for urolithiasis in patients who have undergone renal transplantation, but transurethral access is often difficult.
2) PCNL using nephroscope or flexible ureterorenoscope is the recommended treatment for large renal stones, difficult retrograde access, or ureteral stones that are not suitable for SWL in patients who have undergone urinary diversion.
3) After stone removal, metabolic evaluation should be performed to determine appropriate prophylaxis, as these patients have a high recurrence rate of urolithiasis.

4) How should the urolithiasis in pediatric population be treated?

1) The indications for treatment of urolithiasis in pediatric patients do not differ significantly from those in adults. All treatment modalities available in adults can be used in pediatric patients with urolithiasis.
2) However, the small organ size and the level of communication to cooperate with treatment are important in determining the appropriate treatment. Therefore, individualized treatment in consideration to these factors is recommended.

5) How should the renal diverticular stone be treated?

1) The treatment of renal diverticular stones depends on the location and size of the diverticulum, anatomy, and patient and operator preference.
2) SWL is not very effective in draining stone fragments within the diverticulum. Therefore, SWL is a limited option for symptomatic patients who are not suitable for surgery and whose renal calyx and diverticular anatomy favors SWL.
3) Renal diverticular stones can be treated by PCNL and RIRS, as well as laparoscopic, robotic-assisted, and open surgery.

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6) What is the appropriate treatment and how can patients with impacted ureteral stones be predicted?

1) The treatment of impacted ureteral stones is usually SWL or transurethral stone removal. However, for large (>15 mm) impacted stones in the upper ureter or ureteropelvic junction, lithotripsy via a percutaneous approach or ECIRS is also an effective treatment. If these minimally invasive procedures fail, open or laparoscopic ureterolithotomy may be attempted.
2) Impacted ureteral stones may be suspected in the following cases [41-49].
   - The stone has been in the same location in the ureter for at least 2 months and contrast does not descend distal to the stone on an IVU or CT urography.
   - The ureteral wall is thicker in the area of the stone (cut-off value: approximately 3.5 mm in or out).
   - The density of the distal ureter to the stone is higher than that of the stone location on non-contrast enhanced CT (cut-off value: approximately 27 HU).
   - Larger stone size, higher stone density, female gender, American Society of Anesthesiologists (ASA) score >1, positive preoperative urine culture, previous ipsilateral ureteral stone treatment, and more severe hydronephrosis increase the likelihood of an impacted ureteral stone.

7) What is the appropriate treatment for steinstrasse after SWL?

1) MET can help expel stones in patients with steinstrasse.
2) Urinary tract decompression, such as percutaneous nephrostomy, is indicated if there is a UTI or signs of decreased renal function.
3) SWL and transurethral stone removal may be effective in treating steinstrasse when conservative treatment fails.

8) How should patients with urolithiasis and UTIs be treated?

1) Obstructive pyelonephritis with ureteral stones is a urologic emergency requiring immediate decompression of the collecting system and the use of broad-spectrum antibiotics.
2) Even after decompression, close observation is necessary because sepsis may develop, and there is no difference in prognosis between ureteral stenting or percutaneous nephrostomy when decompressing the urinary tract, so choose the appropriate method according to the patient and medical environment.
3) Treatment of UTIs should be with appropriate antibiotics based on the susceptibility of the identified strain for approximately 1–2 weeks until the patient's temperature, urine culture, urinalysis, and blood tests return to normal, and treatment of concomitant urolithiasis is recommended after complete resolution of the signs of UTI.

Additional explanation

The rate of spontaneous passage of ureteral stones in pregnant women is similar to that in the general population, ranging from 48%–80% [50,51]. While alpha-blockers are commonly used in MET for ureteral stones, their use in pregnant women is not recommended due to the lack of evidence-based research [52]. Transurethral stone removal under anesthesia can be performed with relative safety during the second trimester of pregnancy [53-55]. However, SWL is contraindicated in pregnancy, and PCNL is relatively contraindicated [56].

4. Managing the Silent Phase of Urolithiasis

1) How should patients with urolithiasis be followed up after stone treatment?

1) Stone analysis is recommended in all patients who have previously experienced treatment for urolithiasis (evacuation). Infrared spectroscopy or X-ray diffraction are preferred methods of analysis.
2) Patients with urolithiasis should be categorized as low- or high-risk for stone formation (Table 1) by baseline examination and stone analysis (if available) [57].
3) Patients at low risk of stone formation should be educated on general preventive measures such as fluid intake and dietary and lifestyle modification, while those at high risk of stone formation should undergo a detailed metabolic evaluation and receive stone-specific recurrence prevention based on the results.
4) For patients with recurrent urolithiasis or those at high risk, imaging follow-up every 3–6 months is recommended.

2) What dietary choices can help prevent urolithiasis?

1) It is recommended that all patients with urolithiasis drink 2.5–3 L of fluids per day (or enough fluids to ensure that the daily urine volume is at least 2.5 L).
2) For patients with calcium stones, it is recommended

Table 1. High risk for stone formation

General factors
Early onset of stone (especially in children and adolescents)
Family history of stones
Stones containing calcium phosphate
Stones containing uric acid and urates
Infectious stones
Solitary kidney (solitary kidney itself does not increase the risk of stone formation, but preventing stone recurrence is especially important)
Conditions associated with stone formation
Hyperparathyroidism
Nephrocalcinosis
Gastrointestinal diseases (jejunal-ileal bypass, bowel resection, Crohn's disease, malabsorptive disease, enteric hyperoxaluria after urinary diversion)
Sarcoidosis
Genetic factors that cause stone formation
Cystinuria (type A, B, and AB)
Primary hyperoxaluria
Renal tubular acidosis type 1
2,8-dihydroxyadeninuria
Xanthinuria
Lesch-Nyhan syndrome
Cystic fibrosis
Medications associated with stone formation
Anatomical abnormalities associated with stone formation
Medullary sponge kidney, (tubular ectasia)
Ureteropelvic junction obstruction, calyceal diverticulum, calyceal cyst
Ureteral stricture
Vesico-uretero-renal reflux
Horseshoe kidney
Ureterocele

to limit salt intake (no more than 4–5 g per day) and to maintain a calcium diet of 1.0–1.2 g per day, as low calcium diets increase the incidence of urolithiasis.

3) Patients with calcium oxalate stones are advised to limit the intake of foods high in oxalate and maintain a normal calcium diet.
4) Patients with calcium stones are advised to consume plenty of fruits and vegetables and limit their intake of non-dairy animal protein (0.8–1.0 g/kg/day).
5) Patients with uric acid stones should limit their intake of non-dairy animal protein.
6) Patients with hyperuricosuric calcium oxalate stones and uric acid stones should limit their intake of foods high in purines and not exceed 500 mg per day.
7) Patients with cystine stones should limit their sodium and protein intake.

3) In which patients should metabolic evaluation for urolithiasis be performed and how?

1) Basic laboratory tests should be performed in addition to a detailed history for patients with a first episode of urolithiasis.
2) High-risk patients with a high probability of stone recurrence should be screened for stone-related risk factors.
3) Since urolithiasis is a metabolic process, stone analysis should be performed, and metabolic evaluation should be considered in recurrent urolithiasis formers.

4) What pharmacotherapy is available in Korea depending on the stone composition and metabolic evaluation?

1) Potassium citrate and thiazide can be prescribed to reduce calcium oxalate stone formation in patients with hypercalciuria.
2) Allopurinol may be prescribed in patients with hyper-

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uricemia.

3) For patients with uric acid stones, potassium citrate or sodium bicarbonate may be prescribed to alkalize urine and prevent or dissolve the stones.

Additional explanation

It is important for patients taking medication to prevent stone recurrence to be closely followed up. The first follow-up is typically a 24-hour urine analysis at 8 to 12 weeks after initiation of stone-preventive medication [57]. If risk factors have not normalized, the dose of the drug is adjusted, and another 24-hour urine analysis is performed [57]. Once the 24-hour urine analysis findings have been corrected, a 24-hour urine analysis may be sufficient once a year, but more research is needed on the timing [57].

Metabolic evaluation is strongly recommended for patients who are at high risk for recurrent stones, or who are prone to recurrent stones even after initial stone formation. The indications for metabolic evaluation are shown in Table 2 [58,59]. Laboratory tests include general chemistries including calcium and uric acid levels, parathyroid hormone, urinalysis, urine culture, and imaging studies depending on stone composition [60]. Stone analysis is recommended at least once [57,60].

Pharmacotherapy for urolithiasis available in Korea based on the stone composition and metabolic evaluations are summarized in Table 3 [60-65].

Table 2. Indications for metabolic evaluation

Patients with high-risk stones requiring metabolic evaluation
Patients with recurrent stones
Patients with a strong family history of stones
Patients with obesity, diabetes, or metabolic syndrome
Patients with concomitant small bowel disease, such as chronic diarrhea
Patients with pathologic fractures
Patients with osteoporosis
Stones accompanied by a urinary tract infection
Patients with gout
Debilitated patients who cannot tolerate repeated stones
Solitary kidney patients
Patients with anatomical abnormalities
Patients with renal failure
Patients with cystine, urate, or struvite stones
All pediatric patients

(1) Calcium oxalate stones

1) Hypercalciuria

- Men >300 mg/d, Women >250 mg/d

Table 3. Pharmacotherapy for urolithiasis available in Korea based on the stone composition and metabolic evaluation

Drug	Product name	Dose	Effects	Side effects	Stone composition
Potassium citrate	Urocitra-K SR® 1,080 mg	2T BID/TID	Alkalization of urine	Hyperkalemia Indigestion	Calcium oxalate Uric acid Cystine
Sodium bicarbonate	Tasna® 500 mg	2T QID 3T TID			Calcium oxalate Uric acid Cystine
Allopurinol	Zyroric® 100 mg	1–3T/d	Treatment of hyperuricosuria	Skin lesions Muscle pain	Calcium oxalate Uric acid Ammonium urate
Thiazide	Dichlozid® 25 mg	1T BID		Hypotension Diabetes	Calcium oxalate Calcium phosphate
Calcium		1,000 mg/d			Calcium oxalate
Magnesium		200–400 mg/d		Diarrhea	Calcium oxalate
Pyridoxine	Pyridoxine® 50 mg	2T/d		Polyneuropathy	Calcium oxalate
Febuxostat	Feburic® 40/80 mg	80 mg 1T–3T/d			Calcium oxalate Uric acid
L-methionine		600–1,500 mg/d	Maintain a urine pH of 5.8–6.2		Infection stones Ammonium urate Calcium phosphate
D-penicillamine	Artamin® 250 mg	1T		Nephrotic syndrome Dermatitis Pancytopenia	Cystine
Captopril		25 mg TID		Skin lesions Cough Hypotension	Cystine

- Dichlozid® 25 mg 1T BID
- Urocitra-K SR® SR 1,080 mg 2T BID/TID
- Tasna® 500 mg 2T QID or 3T TID

2) Hypocitraturia
- <320 mg/d
- Urocitra-K SR® 1,080 mg 2T BID/TID

3) Hyperoxaluria
- >40 mg/d
- Enteric: calcium 1,000 mg and magnesium 200–400 mg/d
- Primary: pyridoxine 50–100 mg/d

4) Hyperuricosuria
- Men >800 mg/d, Women >750 mg/d
- Urocitra-K SR® 1,080 mg 2T BID/TID
- Tasna® 500 mg 2T QID or 3T TID
- Zyroric® 100 mg 1T/d

5) Hyperuricosuria and Hyperuricemia
- Urocitra-K SR® 1,080 mg 2T BID/TID plus Zyroric® 100 mg 1–3T/d

6) Hypomagnesiuria
- <80 mg/d
- Magnesium 200–400 mg/d

(2) Calcium phosphate stones

1) Carbonate apatite
- Hypercalciuria: Dichlozid® 25 mg 1–2T/d
- Urine pH >6.5–6.8: L-methionine 600–1,500 mg/d

(3) Uric acid stones

1) Urine pH <6
- Urocitra-K SR® 1,080 mg 2T BID or TID
- Tasna® 500 mg 2T QID or 3T TID

2) Hyperuricosuria
- Men >800 mg/d, Women >750 mg/d
- Zyroric® 100 mg 1T/d

3) Hyperuricosuria and Hyperuricemia
- Zyroric® 100 mg 1–3T/d

DISCUSSION

This recommendation covers the diagnosis, work-up, preoperative preparation, pharmacologic therapies, and various surgical procedures (such as SWL, URS, RIRS, PCNL, laparoscopic, and robotic surgery) for the management of urolithiasis. It also covers the management of urolithiasis in special situations, prevention, and follow-up management.

Treatment decisions for urolithiasis depends on the size, location, and stone composition, as well as the patient's comorbidities, as well as the healthcare provider's facility and equipment. These recommendations are intended to assist in making appropriate treatment decisions in various clinical situations in Korea.

CONCLUSIONS

This FAQ was authored by experts in urolithiasis in response to common questions posed by urologists regarding the treatment of urolithiasis. We believe that the recommendations provided can be a valuable resource to urologists in their clinical practice.

CONFLICTS OF INTEREST

The authors have nothing to disclose.

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