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Surgical Management of Kidney and Ureteral Stones: AUA Guideline (2026) Part I: Evaluation and Treatment of Patients With Kidney and/or Ureteral Stones

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Purpose: This Guideline covers the evaluation and treatment of patients with kidney and/or ureteral stones. The summary presented herein represents Part I of the III-part series dedicated to Surgical Management of Kidney and Ureteral Stones. Please refer to Parts II and III for additional information on this topic.

Materials and Methods: This systematic review was conducted in 2 planned stages, including a search for systematic reviews followed by a search for primary literature. OVID was used to systematically search MEDLINE and EMBASE databases for articles evaluating surgical management of kidney and ureteral stones. The Panel selected control articles that were deemed relevant and the articles were compared with the literature search strategy output. The methodologist then updated the strategy as necessary to capture all control articles. Databases were searched for studies published from January 2000 through May 2025 (week 20). In addition to the MEDLINE and EMBASE databases searches, reference lists of included systematic reviews and primary literature were scanned for potentially useful studies.

Results: The Panel addressed adult and pediatric patients with kidney and/or ureteral stones for whom surgical intervention may be indicated. Each statement herein addressed a particular patient scenario for which the choice of surgical intervention was reviewed and justified. In addition, the Panel reviewed and analyzed the utility of specific surgical techniques, technologies, or medications aimed at improving patient outcomes.

Conclusions: Selection of optimal treatment modalities for patients with kidney and/or ureteral stones is determined by patient factors, urinary tract anatomy, and stone

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characteristics and are guided by shared decision-making that additionally takes into account patient goals and preferences, resource availability, and physician expertise. This Guideline serves as a resource for clinicians and patients to provide the best available evidence on which to base discussions with patients in a shared decision-making process to arrive at appropriate treatment decisions.

Key Words: kidney calculi, urolithiasis, nephrolithiasis, urinary calculi, ureteral calculi, ureterolithiasis kidney stones, ureteral stones, urinary stones, kidney calculi, kidney calculus, renal calculus, percutaneous nephrolithotomy, shockwave lithotripsy, ureteroscopy, lithotripsy, ureterolithotomy, retrograde intrarenal surgery, percutaneous nephrostomy, ureteral access sheath, medical expulsive therapy, diagnostic imaging, molecular imaging, ultrasonography, magnetic resonance imaging, kidneys, ureters, bladder radiograph

THE American Urological Association (AUA) has been committed to providing evidence-based recommendations for the comprehensive surgical management of patients with kidney and/or ureteral stones, including the decision to observe, rather than to treat select patients. In the current Guideline, the literature search included articles published between January 2000 through May 2025. The overlap of articles published between 2000 and 2015 between the 2 Guidelines was primarily because most shockwave lithotripsy (SWL) literature was published before 2015, and some other relevant key trials that have not been replicated fell within that time frame. The Panel's intention was not to simply expand upon the previous systematic review from the 2016 Guideline, but rather to limit the search to a time frame that reflects modern endoscopic and non-invasive surgical modalities.

In order to provide evidence-based recommendations that encompass the most common clinical patient scenarios, the Panel specified the patient population for which each statement is intended. However, unless otherwise specified, the population addressed in the Guideline statements should be assumed to be non-pregnant with an anatomically normal urinary tract. The lack of extensive published data on the surgical management of stones in pediatric patients precluded a clear set of Guideline recommendations in this patient population. Consequently, where sufficient data exist to support evidence-based directives for pediatric patients, separate Guideline statements were developed. However, when sufficient evidence was unavailable, but the Panel surmised that the recommendations for adult patients could be reasonably applied to the pediatric population based on Expert Opinion, their recommendations were added to the supporting documentation for the corresponding Guideline statements based on evidence in the adult population.

For the purposes of this Guideline, ureteral stone locations are categorized as *proximal*—extending

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from the ureteropelvic junction to the superior border of the sacroiliac joint; *middle*—overlying the bony pelvis; and *distal*—from the inferior border of the sacroiliac joint to the ureterovesical junction. The visual summary of the Guideline recommendations can be found in Figure.

GUIDELINE STATEMENTS

Note: information on meta-analyses conducted for the purposes of this Guideline are available with the full Guideline at www.AUAnet.org/Guidelines.

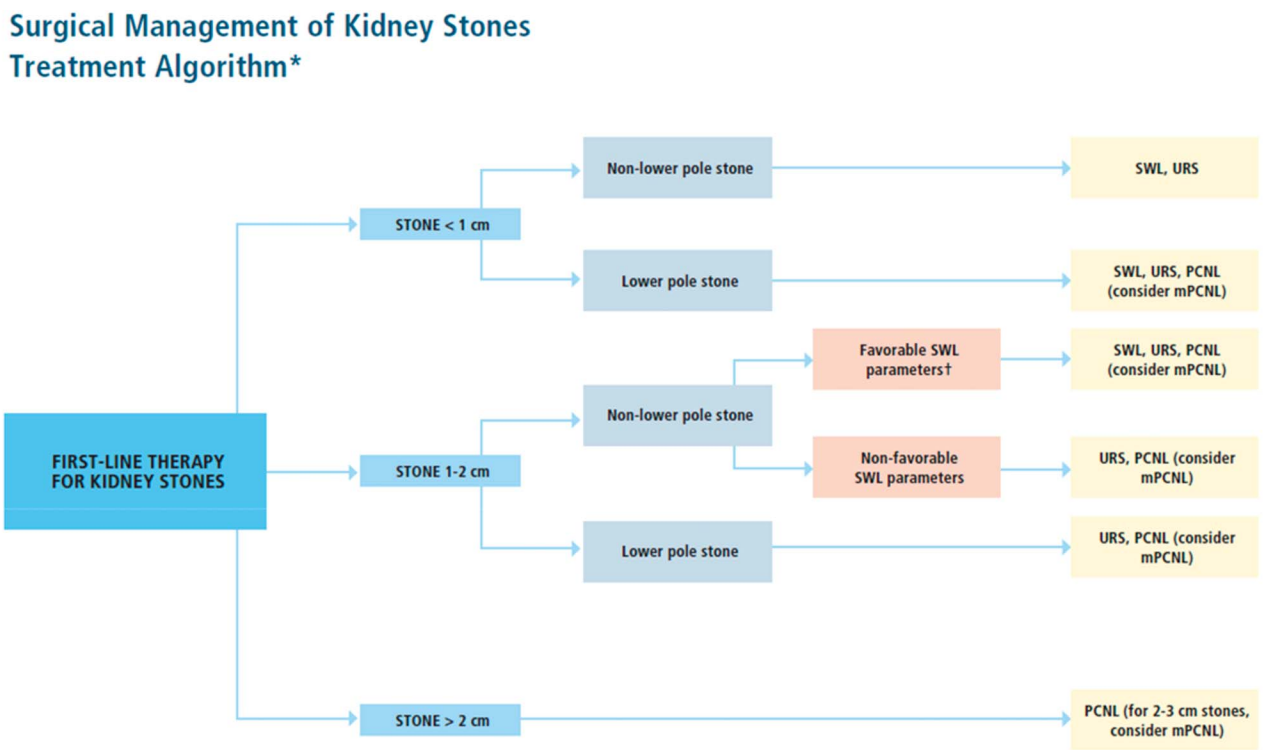
PRE-OPERATIVE EVALUATION AND PREPARATION

For adult and pediatric patients undergoing surgical intervention for kidney and/or ureteral stones, clinicians should obtain a medical history, perform a relevant physical examination, and obtain laboratory studies appropriate to procedural risk and patient comorbidities. (*Clinical Principle*)

The Panel recommends a focused medical history and physical examination in patients undergoing upper urinary tract stone surgery. The Panel advocates a patient-specific laboratory assessment, underscoring that in patients with anemia or renal insufficiency, assessment of preoperative hemoglobin and renal function is particularly relevant. In patients undergoing SWL or percutaneous nephrolithotomy (PCNL), the Panel recommends obtaining a coagulation panel in patients with known bleeding diatheses or prior episodes of abnormal bleeding (eg, abnormal bleeding during tooth extraction). In selected patients who may require additional expertise in pre- and perioperative planning, consultation with relevant specialties (eg, cardiology, anesthesiology) should be considered.

For adult and pediatric patients with kidney and/or ureteral stones, clinicians should obtain a urinalysis and/or urine culture prior to surgical intervention. (*Clinical Principle*)

Obtaining urine testing prior to urological intervention supports safe surgical outcomes and informs timely antimicrobial therapy before, during, and/or following stone surgery. The Panel recommends



Abbreviations: mPCNL= mini percutaneous nephrolithotomy, PCNL= percutaneous nephrolithotomy, SWL= shockwave lithotripsy, URS= ureteroscopy
*The algorithm for surgical management of ureteral stones is not offered due to heterogeneity of study reporting criteria †Favorable parameters include Hounsfield units <1000 and skin-to-stone distance <10 cm

Figure. Surgical management of kidney stones treatment algorithm.

urinalysis prior to surgery for upper urinary tract stones, including PCNL, ureteroscopy (URS), and SWL. Urine culture should be performed when urinalysis suggests that infection may be present.

If testing demonstrates positive urine culture or bacterial growth, clinicians should prescribe culture-directed therapy to attempt to sterilize the urine prior to surgery.[1] Antimicrobial therapy should also be considered in asymptomatic patients with known colonization. Confirmation of a negative culture following culture-directed antimicrobial therapy is not routinely necessary[2] and may prove impossible, particularly in patients with infection stones.

For adult and pediatric patients with kidney and/or ureteral stones and untreated bacteriuria/funguria, clinicians should not proceed with definitive stone surgery. (*Clinical Principle*)

If a properly obtained urine culture prior to surgical treatment for upper tract stones reveals bacterial or fungal growth, the Panel recommends treatment with appropriate culture-specific antibiotics or antifungals prior to surgery, even if the patient is asymptomatic.

For adult patients with kidney and/or ureteral stones, clinicians may obtain cross-sectional imaging to guide surgical treatment selection. (*Conditional Recommendation; Evidence Level: Grade C*)

Non-contrast abdominopelvic computed tomography (CT) is the most reliable imaging modality for evaluating stone size and volume, location, number, and density, all of which directly influence the success rates and appropriateness of stone procedures. CT also allows assessment of anatomic variations, relational anatomy of the kidney, intrarenal geometry including infundibular angle, hydronephrosis, the presence of distal obstruction, and patient factors such as body habitus and stone-to-skin distance that may affect procedural choice and outcomes.

Magnetic resonance imaging (MR) and ultrasound (US) may provide some relational and intrarenal anatomic detail that can guide treatment selection. However, neither MR nor US reliably measures stone density and MR does not reliably visualize upper urinary tract stones. In addition, US estimates stone size, number, and location less accurately than CT. These factors may limit the utility of these non-CT modalities in informing suitability for SWL in particular.[3]

For adult patients undergoing PCNL for kidney and/or ureteral stones, clinicians should obtain a CT prior to surgery. (*Moderate Recommendation; Evidence Level: Grade C*)

In patients undergoing PCNL for kidney and/or ureteral stones, non-contrast abdominopelvic CT provides detailed anatomic information that is important for surgical planning. CT facilitates accurate assessment of stone burden and optimal sites of percutaneous renal access, including relational anatomy to adjacent organs. CT also provides useful information about skin-to-stone distance and stone volume.[4]

For adult and pediatric patients undergoing surgical intervention, clinicians should assess differential renal function if there is suspicion of clinically relevant loss of renal function in the involved kidney. (*Expert Opinion*)

Upper urinary tract stone disease may contribute to renal functional loss due to chronic obstruction or infection. Clinicians may suspect functional loss based on clinical history, laboratory studies, or imaging findings.[5] Determination of differential function using functional imaging (eg, dimercaptosuccinic acid [DMSA] scan) may help clinicians determine whether surgical stone removal is indicated or if an alternative management strategy, such as nephrectomy or observation, would be preferred.

TREATMENT OF PATIENTS WITH URETERAL STONES

For adult and pediatric patients with ≤ 10 mm distal ureteral stones, clinicians should offer medical expulsive therapy (MET) with alpha-adrenergic blockers for approximately 30 days to facilitate stone passage. (*Strong Recommendation; Evidence Level: Grade A*)

For patients who elect a trial of spontaneous passage for a $\leq$ 10 mm distal ureteral stone, initiation of pharmacotherapy with any alpha-adrenergic blocker (ie, tamsulosin, alfuzosin, doxazosin, terazosin, and silodosin) has been shown to increase the likelihood of spontaneous stone passage, reduce associated pain, and result in fewer unplanned healthcare encounters.

For the purposes of this Guideline, a meta-analysis was performed comparing outcomes of patients with $\leq$ 10 mm distal ureteral stones treated with any alpha-adrenergic blocker vs a control or no-treatment group that included 49 studies comprising more than 8000 patients (refer to full Guideline). It showed that use of any alpha-adrenergic blocker resulted in a statistically significantly higher rate of stone passage compared to the control group, as well as a reduction in pain episodes, the need for pain medication, the rate of unplanned healthcare encounters as measured by emergency department visits, and the need for surgical intervention.

For adult patients with ≤ 10 mm stones in the middle and proximal ureter, clinicians may offer MET with alpha-adrenergic blockers for approximately 30 days to facilitate stone passage. (*Conditional Recommendation; Evidence Level: Grade B*)

In a meta-analysis prepared for this Guideline, which included 4 studies totaling nearly 200 patients with stones $\leq$ 10 mm in the middle ureter and 6 studies encompassing nearly 650 patients with stones $\leq$ 10 mm in the proximal ureter, no significant difference in rates of spontaneous stone expulsion was found between the MET and control groups (refer to full Guideline).

However, in this meta-analysis stratified outcomes according to stone location should be interpreted with caution, as few studies specifically included or stratified outcomes by stone location, particularly in the middle ureter, but also in the proximal ureter. The Panel concluded that despite the lack of benefit demonstrated for MET for stones in the middle and proximal ureter, the safety and success demonstrated with MET for patients with stones in the distal ureter across a range of outcomes (refer to full Guideline) make it reasonable to consider this adjuvant pharmacotherapy for ureteral stones at all locations.

When surgical treatment is indicated for adult patients with distal ureteral stones ≤ 10 mm, clinicians may offer URS or SWL. (*Conditional Recommendation; Evidence Level: Grade B*)

URS and SWL are the 2 most common surgical modalities for the treatment of patients with ureteral stones.[6] While contemporary studies comparing SWL and URS for treatment of distal ureteral stones published within the time frame of this Guideline are relatively sparse, older studies outside the designated time frame demonstrated a significantly higher stone-free rate for URS compared to SWL.[7,8]

Clinicians should engage in a discussion with patients regarding additional relevant advantages and disadvantages of the 2 procedures, including the likelihood of requiring additional procedures, complications, anesthesia requirements, and the possible need for a ureteral stent.

When surgical treatment is indicated for adult patients with < 2 cm proximal ureteral stones, clinicians may offer URS or SWL. (*Conditional Recommendation; Evidence Level: Grade B*)

A meta-analysis of randomized controlled trials (RCTs) comparing stone-free rates for URS vs SWL for the treatment of patients with proximal ureteral stones showed a higher stone-free rate in a single procedure with URS compared to SWL (refer to full Guideline). Data on the specific use of semi-rigid, flexible or antegrade URS are less clear. However, contemporary comparative studies have shown no definite advantage of URS or SWL for proximal ureteral stones with regard to retreatment rates, salvage procedures, hospital length of stay, operative time, or complication rates.[9-11]

For adult patients with ureteral stones in whom SWL fails to result in complete stone clearance, clinicians may offer a second SWL procedure or proceed to URS. If a second SWL procedure fails, clinicians should offer URS. (*Conditional Recommendation; Evidence Level: Grade C*)

The Panel recommends an alternative surgical modality (eg, URS) if the initial SWL treatment results in no evidence of stone fragmentation or clearance. Furthermore, if the treated ureteral stone continues to cause obstruction after the initial treatment, consideration should be given to a modality that will relieve the obstruction in a timely fashion to avoid irreversible loss of kidney function (eg, ureteral stent, URS, or nephrostomy tube).

A second SWL session may be offered to patients with incomplete stone clearance. However, for patients who undergo 2 unsuccessful sessions of SWL for treatment of a ureteral stone, an alternate treatment modality (eg, URS) should be undertaken for the next surgical treatment. Treatment failure is defined as significant residual stone (> 2 mm) within the ureter or incomplete stone clearance.

For adult and pediatric patients with > 2 cm ureteral stones or with ureteral stones that have not been successfully treated with previous retrograde URS or SWL or are not amenable to these procedures, clinicians should offer a percutaneous antegrade approach. (*Expert Opinion*)

For patients with medium to large or complex stone burdens, SWL and URS may have relatively low single procedure stone-free rates.[10,12] A percutaneous approach would include PCNL, mini-PCNL or antegrade URS. Although emerging data with newly developed suction devices for URS have shown improvement in stone-free rates with suction-assisted URS compared to standard URS techniques,[13] studies directly comparing URS with suction to PCNL for the treatment of large stones are lacking. Despite the limited data and variability of stone sizes included in the identified studies, the Panel recommends percutaneous treatment for large (> 2 cm) proximal ureteral stones because of consistently higher stone-free rates for PCNL than URS or SWL for the treatment of patients with large proximal ureteral stones.

TREATMENT OF PATIENTS WITH KIDNEY STONES

For adult patients with flank pain and non-obstructing kidney stones on the ipsilateral side who have no other identifiable source of pain, clinicians may offer elective surgical treatment. (*Conditional Recommendation; Evidence Level: Grade C*)

The relationship between non-obstructing kidney stones and pain remains uncertain. Several studies have shown a reduction in pain for patients undergoing surgery for this indication.[14-16] Accordingly, the Panel believes that patients with pain and non-obstructing kidney stones that would otherwise be left untreated, may be offered surgical intervention when the pain is consistent with stone-related symptoms and other causes have been reasonably excluded. Clinicians should engage in shared decision-making with patients, emphasizing the limited evidence supporting surgery in this setting and setting realistic expectations regarding the possibility of persistent or unchanged pain after treatment.

For adult and pediatric patients with asymptomatic non-obstructing kidney stones, clinicians may offer either active surveillance or pre-emptive surgical intervention. (*Conditional Recommendation; Evidence Level: Grade C*)

Asymptomatic non-obstructing kidney stones are increasingly encountered clinically, in part due to the greater use of abdominal imaging for a growing range of indications.[17,18] Retrospective cohort studies following adult patients with asymptomatic kidney stones vary in duration of follow-up, imaging protocol, and indications for surgical intervention.[19,20] This heterogeneity in studies may account for the wide range in the reported proportion of patients experiencing spontaneous stone passage (8% to 84%) or stone growth (11% to 49%), requiring urological intervention (12% to 55%), or remaining asymptomatic (23% to 68.2%). It is challenging to counsel patients with asymptomatic stones about surgery vs observation because factors that lead to the development of stone-associated symptoms and/or of stone growth over time are not completely understood.

Therefore, the choice of observation vs surgical intervention requires shared decision-making and discussion with the patient regarding quality of life, risk of surgery, and patient preference. For patients who elect active surveillance, clinicians may offer periodic imaging studies, and metabolic evaluation and management (as urinary supersaturation has been correlated with faster stone growth).[21,22]

For adult patients with recurrent or persistent urinary tract infections (UTIs) and non-obstructing calyceal stones, clinicians may offer elective surgical stone removal for the purpose of reducing the risk of recurrent UTIs. (*Conditional Recommendation; Evidence Level: Grade C*)

Patients with suspected struvite kidney stones, which are associated with infection and rapid stone growth, are typically managed with aggressive stone removal and are not the intended target of this Guideline statement. Patients with recurrent UTIs and suspected non-obstructing non-struvite calyceal stones may benefit from endoscopic stone removal to reduce recurrent UTIs. Shared decision-making between the clinician and the patient is encouraged to balance the risks and benefits of the procedure, especially since not all patients will be rendered infection-free by treatment of their stones.

For adult patients undergoing SWL for kidney stones, clinicians may initiate treatment with low energy shockwaves and gradually increase the energy during the session in order to reduce the risk of bleeding complications. (*Conditional Recommendation; Evidence Level: Grade C*)

Initiating SWL treatment at lower energy followed by an increase in energy decreases the risk of bleeding compared to initiating treatment at higher energy levels. However, there is insufficient evidence to support a specific rate, escalation strategy, or incorporation of a pause prior to escalation of energy or after a particular number of shocks regarding bleeding complications or stone-free rates.[23-25]

For adult patients with < 1 cm lower pole kidney stones, clinicians may offer SWL, URS, or a percutaneous approach after engaging in shared decision-making. (*Expert Opinion*)

The efficacy of URS and SWL for the treatment of patients with < 1 cm lower pole stones has been compared in 2 RCTs.[26,27] Although both studies showed higher stone-free rates for URS than SWL, the difference reached statistical significance in only one of the 2 trials. Few studies have compared PCNL with SWL or URS for the treatment of < 1 cm lower pole stones because of the greater morbidity of PCNL compared to the other treatment modalities.

When deciding on the optimal treatment of patients with < 1 cm lower pole stones, it is important to keep in mind that the goals of care for the patient should be paramount. Thus, the relevant advantages and disadvantages of each of the procedures, including invasiveness, potential complications, anesthesia requirements, likelihood of requiring additional procedures, and the possible need for ureteral stent placement should be discussed.

For adult patients with > 1 cm lower pole or > 2 cm non-lower pole kidney stones, clinicians should not offer SWL as first-line therapy. (*Expert Opinion*)

The studies and meta-analyses informing this statement confirmed that SWL has the lowest stone-free rate among the procedures commonly used to treat kidney stones. In addition, SWL has a significantly higher rate of retreatment and need for salvage procedures compared to URS or PCNL.[28] URS has superior stone-free rates compared to SWL for the treatment of kidney stones.[28-30] However, standard PCNL is the treatment modality associated with the highest overall stone-free rate.[28]

The patient's goals of care should be paramount. Thus, if shared decision-making discussions with the patient reveal that stone-free rate is not the primary consideration, the relevant advantages and disadvantages of each of the potential procedures, including invasiveness, potential complications, likelihood of requiring additional procedures, and the possible need for ureteral stent placement should be reviewed.

For adult patients with > 1 cm lower pole kidney stones, clinicians should inform the patient that PCNL is associated with a higher stone-free rate than SWL or URS. (*Strong Recommendation; Evidence Level: Grade A*)

A meta-analysis undertaken for this Guideline comparing stone-free rates between PCNL and SWL for treatment of patients with > 1 cm lower pole stones found higher stone-free rates with PCNL (refer to full Guideline). However, because of the greater invasiveness of PCNL compared to SWL and URS, patients should be informed about the advantages and disadvantages of PCNL, including the risk of complications.

Multiple variations in PCNL technique have been introduced with the intention of reducing the morbidity of the procedure while maintaining high stone-free rates, including mini-PCNL (defined as procedures with a percutaneous sheath less than 22 Fr), micro-PCNL (sheath size 4.85 Fr) and ultra mini-PCNL (sheath size 11 Fr to 13 Fr).[31-34] The studies informing this statement revealed that, similar to standard PCNL (sheath size 24 to 30 Fr), reduced tract PCNL procedures are associated with higher stone-free rates compared to SWL and URS for the treatment of lower pole stones.[35] However, the data on these reduced tract PCNL procedures have been mixed with respect to complication rates, operative time, and hospital duration compared to SWL or URS.[36,37]

For adult patients with < 2 cm lower pole stones undergoing URS with laser lithotripsy, clinicians should, when feasible, reposition the stone to a more superior location prior to lithotripsy. (*Moderate Recommendation; Evidence Level: Grade B*)

Repositioning lower pole stones to a more superior location (eg, upper pole calyx) produces higher stone clearance rates (95% and 98%) than treating stones in situ in a lower pole calyx (74% and 84%).[38,39] Complications associated with repositioning are low (generally < 10%) and similar to complications associated with treating the lower pole stone in situ. The use of flexible and navigable suction ureteral access sheaths and flexible ureteroscopes with integrated suction may provide an acceptable alternative to repositioning a lower pole stone, although comparative studies have not been performed.[40]

For adult patients with 1 to 2 cm kidney stones, clinicians may offer mini-percutaneous nephrolithotomy (mini-PCNL), when available, over URS because of higher stone-free rates. (*Conditional Recommendation; Evidence Level: Grade B*)

In a meta-analysis prepared for this Guideline, mini-PCNL was demonstrated to have a higher stone-free rate compared to URS for the treatment of 1 to 2 cm kidney stones (refer to full Guideline). However, the data are less clear with regard to differences in complication rates or hospital stay.[41-43] Clinicians should discuss with the patient the advantages and disadvantages of mini-PCNL, including the expected operative time. Of note, emerging data with newly developed suction devices for URS show noninferiority with regard to stone-free rates with suction-assisted URS compared to mini-PCNL.[44] There are currently insufficient high-quality studies comparing these modalities to make a definitive statement regarding efficacy. This Guideline is not meant to imply that standard PCNL cannot be used for the treatment of stones in this size range, particularly when mini-PCNL setups are unavailable.[35]

For adult patients with > 2 cm kidney stones, clinicians should recommend PCNL as first-line therapy. (*Moderate Recommendation; Evidence Level: Grade B*)

PCNL has been shown to have a higher stone-free rate and lower rate of retreatment in patients with large (> 2 cm) stones compared to SWL and URS.[45] In particular, PCNL should constitute the first-line treatment for large, branched stones.[46] Meta-analyses performed for this Guideline comparing stone-free rates for PCNL, URS, and SWL revealed higher stone-free rates for PCNL vs SWL, and for PCNL vs URS (refer to full Guideline).

Shared decision-making discussions may reveal that a patient prefers URS to the more invasive PCNL procedure. These discussions should include the likelihood of needing multiple procedures if URS is selected instead of PCNL. Of note, there are emerging data supporting the use of suction devices for URS, that may eventually improve the efficiency of URS and result in higher single-procedure stone-free rates even for large renal stone burdens. However, at present, the data support superior stone-free rates for PCNL compared to URS.

For adult patients undergoing PCNL for kidney stones up to 3 cm in size, clinicians may offer standard or mini-PCNL. (*Conditional Recommendation; Evidence Level: Grade B*)

Clinicians should inform these patients that mini-PCNL has stone-free rates comparable to standard PCNL but is associated with fewer complications, less pain, and shorter length of stay, but with a longer operative time. (*Moderate Recommendation; Evidence Level: Grade C*)

For patients undergoing PCNL, clinicians should counsel patients that standard (24 Fr to 30 Fr) or mini-PCNL (10 Fr to 22 Fr) offer comparable stone-free rates for stones up to 3 cm in size.[47-55] For patients with stones approaching 3 cm or larger in diameter, several studies have demonstrated that standard PCNL has a higher stone-free rate.[52,54]

Two meta-analyses comparing outcomes for mini-PCNL and standard PCNL, including the treatment of patients with > 2 cm stones, found comparable stone-free rates for the 2 procedures.[47,48] With regard to other outcomes, hospital length of stay was shorter for mini-PCNL compared to standard PCNL.[47] A meta-analysis demonstrated fewer Clavien-Dindo Grade 1 and 2 complications with mini-PCNL compared with standard PCNL, but showed similar complication rates between the 2 techniques for Grade 3 and higher complications.[47]

Mini-PCNL has been shown to be associated with less blood loss and lower transfusion rates compared to standard PCNL.[47] Patients undergoing mini-PCNL experience less pain compared to standard PCNL.[53-55] One parameter that consistently favors standard PCNL is operative time, which is consistently longer for mini-PCNL compared to standard PCNL.[47]

Clinicians may perform PCNL in adult patients without discontinuing daily low dose aspirin. (*Conditional Recommendation; Evidence Level: Grade C*)

Convention has historically dictated that all anticoagulant/antiplatelet (AC/AP) therapy should be stopped prior to PCNL. A systematic review and meta-analysis[56] and a more recent retrospective cohort study[57] demonstrated that the use of low dose aspirin (75-100 mg) during PCNL is associated with no greater bleeding complications and comparable stone-free and complication rates than no aspirin use, leading this Panel to recommend that PCNL can safely be performed in patients taking low dose aspirin at the time of surgery.

For adult patients undergoing PCNL for kidney stones, clinicians may administer systemic tranexamic acid (TXA) at the time of PCNL to reduce blood loss, provided they have no contraindications. (*Conditional Recommendation; Evidence Level: Grade A*)

TXA is a synthetic analog of lysine and serves as an antifibrinolytic by binding to lysine receptors of plasminogen. TXA can be administered via oral or intravenous routes. Clinicians should be aware of the contraindications, relative contraindications, and side effects of TXA. Contraindications include active thromboembolic disease (ie, deep venous thrombosis, pulmonary embolism), history of significant risk of thromboembolic disease, and epilepsy or seizure history. This recommendation is based on a meta-analysis of RCTs performed by Prasad et al that included 6 RCTs composed of 1323 patients (659 in the TXA arm and 664 in the control arm) evaluating the use of TXA during PCNL.[58]

Decisions on the use of TXA may depend on many factors, including but not limited to surgical experience (eg, personal transfusion rates), patient factors and risks (eg, history of thromboembolic disease), stone characteristics (eg, need for multiple accesses), and surgical choices (eg, tract size).

For adult patients undergoing PCNL, clinicians may utilize either prone or supine positioning. (*Conditional Recommendation; Evidence Level: Grade B*)

A meta-analysis by Keller et al comparing prone and supine positioning in patients undergoing PCNL found comparable stone-free rates between groups.[59] An additional 3 RCTs not included in the previous meta-analysis demonstrated no significant difference in stone-free rates between prone and supine PCNL.[60-62]

Keller et al analyzed additional outcomes after PCNL and found a higher incidence of postoperative fever and a 13 minute longer operative time in prone vs supine PCNL.[59] However, no differences in complication rates, transfusion rates, blood loss, and length of hospitalization were observed between groups. For complex stones, a multicenter RCT by Perrella et al demonstrated no difference in stone-free rates with supine or prone positioning.[62]

Surgeon experience and preference, patient body habitus/anatomy, and stone burden may influence the choice of positioning for PCNL.

For adult patients undergoing PCNL for kidney stones, clinicians may utilize intraoperative US, fluoroscopy, or combination image guidance for access. (*Conditional Recommendation; Evidence Level: Grade B*)

PCNL can be performed with US, fluoroscopy, or combination image-guidance for access. Two RCTs comparing fluoroscopic- and US-guided access for PCNL found comparable stone-free rates and no differences in need for additional procedures, organ injury, transfusion rates or bleeding complications between the types of image guidance.[63,64] Likewise, a 3-way RCT comparing fluoroscopic, US or combination access demonstrated no difference in stone-free or retreatment rates, bleeding

complications, or rates of organ injury among the 3 groups.[65]

The Panel assigned this Guideline statement a Conditional Recommendation, acknowledging that heterogeneity among the studies could introduce potential bias.

When performing mini-PCNL in adult patients with kidney or proximal ureteral stones, clinicians may utilize a suction sheath, when available, to improve stone-free rates and reduce the need for secondary procedures. (*Conditional Recommendation; Evidence Level: Grade C*)

Li et al performed a meta-analysis of 4 RCTs and 3 retrospective observational studies comparing the use of a suction sheath vs a traditional sheath in patients undergoing mini-PCNL.[66] Operative time was significantly less and auxiliary procedures were fewer in the suction sheath group compared to the traditional sheath group. Furthermore, use of a suction sheath was associated with a 39% lower likelihood of requiring additional stone-removing procedures. Stone-free rates were also significantly higher in the suction group. Another meta-analysis by Chen et al found no difference in stone-free or sepsis rates between suction or standard sheaths, but use of a suction sheath was associated with less blood loss, fewer postoperative complications, shorter operative time, and lower incidence of fevers compared to the standard sheath group.[67]

Given the heterogeneity of the studies and potential outcome bias, this statement was assigned a Conditional Recommendation. The Panel also recognized that not all surgeons have ready access to suction sheaths in their facility.

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