

DEFINITION

Calculi (stone) in the urinary tract (kidneys, bladder, urethra). Often causes renal colic, a pain produced by the presence and movement of a stone within the ureter or renal pelvis. Some clients are asymptomatic.

IMMEDIATE CONSULTATION REQUIRED IN THE FOLLOWING SITUATIONS

- Solitary kidney
- Known non-functioning kidney
- Hydronephrosis
- Inability to take adequate fluids due to nausea and vomiting
- Pain does not respond to administration of non-steroidal anti-inflammatory drugs (NSAIDs)
- Anuria
- Pregnancy
- Pulsatile mass in abdomen
- Diagnostic uncertainty (a leaking aortic aneurysm/"serious intra-abdominal calamities" may present with identical symptoms)
- Pediatric clients

CAUSES

- Calcium oxalate or calcium phosphate accumulation
- Magnesium ammonium phosphate (struvite stones)
- Uric acid accumulation
- Medications (e.g., indinavir, acyclovir, sulfADIAZINE)
- Enhanced oxalate absorption (e.g., gastric bypass surgery)
- Other genetic disorders (e.g., cystine stones, an inborn error of amino acid metabolism)

PREDISPOSING AND RISK FACTORS

- Anatomical anomalies in the kidneys and/or urinary tract (e.g., horseshoe kidney, ureteral stricture)
- Hypertension
- 20-49 years of age
 - Hypercalciuria is the main risk factor. Hereditary condition in 50% of men and 75% of women with calcium stones.

UROLITHIASIS ADULT & PEDIATRIC

- Personal history of urolithiasis
 - Disorders that increase urinary salt concentration, either by increased excretion of calcium or uric acid salts, or by decreased excretion of urine or citrate.
- Recurrent upper urinary tract infections (UTI)
- Hyperparathyroidism
- Increased bone resorption
- Low fluid intake
- Immobilization
- Relative dehydration
- Metabolic disorders which increase excretion of solutes (e.g., chronic metabolic acidosis, hypercalciuria, hyperuricosuria)
- Deficiency of citrate in the urine
- Cystinuria (an autosomal recessive aminoaciduria)
- Drugs (e.g., calcium/vitamin D supplements)
- More common occurrence in hot climates
- Possible risk factors include diabetes, obesity, gout, excessive physical exercise
- Health history may provide insight into the type of stone
 - Calcium stones (are most common 85%):
 - Hypercalciuria
 - Hypocitraturia
 - Hyperoxaluria
 - Low urine volume
 - Alkaline urine
 - Dietary factors [e.g., low calcium, high oxalate (e.g., spinach), high animal protein, high sodium, low fluid, high vitamin C or D supplementation]
 - Primary hyperparathyroidism
 - Uric acid stones (10%):
 - Acidic urine (e.g., due to chronic diarrhea, gout, diabetes, obesity, metabolic syndrome)
 - High serum uric acid
 - Cystine stones (2%)
 - Struvite stones (magnesium, ammonium, phosphate):

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- Upper UTI due to Proteus or Klebsiella
- Recurrent UTI

HISTORY

- Sudden onset of mild ache to severe, colicky pain in one flank that often increases and decreases in severity, along with nausea and vomiting when stones pass into the ureter, cause obstruction, or both
- Pain may radiate to lower abdomen, flank, groin, labia, or testicle
- Exact location of pain depends on location of stone and level of obstruction (may be vague or acute, abdominal or flank, may change location as the stone moves)
- Hematuria present
- Dysuria, urgency, frequency may develop
- Nausea and vomiting are often present
- Stone or "gravel" in urine may be present

PHYSICAL FINDINGS

- Client appears in acute distress
- Client pale, cool and diaphoretic
- Temperature may be elevated (unusual unless infection is also present)
- Tachycardia may be present
- Blood pressure may be elevated
- Client restless, tossing about, unable to find a comfortable position
- Abdomen may be distended (uncommon)
- Pain anywhere from the costovertebral angle along the ureter and into the pelvis
- Bowel sounds may be decreased (because of reactive ileus)

DIFFERENTIAL DIAGNOSIS

- Abdominal aortic aneurysm (the most important differential diagnosis to rule out, often mimics urinary colic)
- Ectopic pregnancy (important to rule out in any female client of childbearing age with abdominal pain)
- Acute abdomen (cholecystitis, appendicitis, gastroenteritis, diverticulitis, peritonitis)
- Acute pyelonephritis

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- Peptic ulcer disease
- Biliary colic
- Salpingitis, tubo-ovarian abscess
- Ovarian cysts/masses and ruptured ovarian cysts
- Herpes zoster prodromal pain (shingles)
- Pancreatitis
- Low back pain
- Renal carcinoma/masses
- Attention or drug-seeking client

COMPLICATIONS

- Renal abscess
- Ureteral perforation
- Ureteral stenosis and scarring
- Urinary fistula formation
- Recurrent stones
- Chronic renal failure secondary to obstruction
- Recurrent infection of the lower urinary tract
- Hydronephrosis (asymptomatic obstruction of the kidney leading to decreased renal function or renal failure)
- Pyelonephritis
- Sepsis (e.g., fever, tachycardia, hypotension, tachypnea, altered mental status)
- Complete blockage of the urinary flow from a kidney decreases glomerular filtration rate (GFR). If it persists for > 48 hours it may cause irreversible renal damage.
- If ureteric stones cause symptoms after 4 weeks, there is a 20% risk of complications, including deterioration of renal function, sepsis and ureteric stricture.

INVESTIGATIONS AND DIAGNOSTIC TESTS

- Obtain urine for urinalysis (routine and microscopic and for culture)
 - Red cells (hematuria is suggestive of urolithiasis)
 - White cells and nitrites suggest infection

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- pH > 7 suggests urea-splitting organisms, such as Proteus
- pH < 5 suggests uric acid stones
- Pregnancy test to rule out pregnancy, if female client is of childbearing age
- Serum for complete blood count, renal panel, uric acid, ionized calcium, and phosphate
- Strain all urine and analyze stones in the following clients:
 - All first time stone formers
 - All clients with recurrent stones who are on pharmacological preventing therapy
 - Clients who have had early recurrence after complete stone clearance
 - Late recurrence after a long stone free period (stone composition may change)

Referral is mandatory:

- In clients with a fever, solitary kidney, or in cases of diagnostic uncertainty, where immediate imaging is indicated. Non-contrast enhanced computed tomography (NCCT) should be used to confirm stone diagnosis in clients with acute flank pain because it is superior to intravenous urography.
- For ultrasound scanning to differentiate radio-opaque from radiolucent stones and in detecting evidence of obstruction.
- For plain x-rays of the kidney, ureter, and bladder (KUB) if these will be used to watch the passage of radio-opaque stones (around 75% of stones are of calcium and so will be radio-opaque).
- For pediatric clients.

MAKING THE DIAGNOSIS

- The diagnosis is usually made clinically based on the characteristic cramping and intermittent abdominal and flank pain that occur as the kidney stone(s) travel within the urinary tract. The pain is often accompanied by hematuria, nausea or vomiting, and malaise; fever and chills may also be present.
- If symptoms are **mild**, client is afebrile and able to tolerate oral fluids and medication, and the diagnosis is clear, the client can be treated on an outpatient basis.

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- If symptoms are uncontrollable or **severe**, client is unable to tolerate oral fluids, or the diagnosis is questionable, consultation with a physician/RN(NP) and possible inpatient treatment will be needed.

MANAGEMENT AND INTERVENTIONS

Goals of Treatment

- Analgesia/control pain
- Facilitate stone passage
- For persistent and infection-causing stones, refer for removal
- Maintain hydration
- Identify complications

Appropriate Consultation

- Presentation consistent with those identified in the Immediate Consultation Required in the Following Situations section.
- Any client:
 - whose pain, nausea, vomiting or fever persists or are not controlled.
 - showing signs of urosepsis (high fever, chills, rigors).
 - with acute renal failure or who is anuric.
- Requires parenteral hydration, parenteral narcotics, and parenteral antiemetics.
- Clients who may benefit from medical expulsive treatment with calcium-channel blockers (e.g., NIFEdipine) or alpha-blockers (e.g., tamsulosin).
- Pediatric clients who have recurrent episodes should be investigated for metabolic conditions, developmental abnormalities of the urinary tract, urinary obstruction, urinary stasis, and infection with urea-splitting microorganisms.
 - Urolithiasis during childhood can have important lifelong implications related to the damage that can occur to the renal parenchyma and subsequent loss of kidney function.

Non-Pharmacological Interventions

- Lifestyle measures
 - Increase fluid intake to maintain urine output at 2-3 L per day

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- Reduce salt intake
- Dietary restrictions based on stone analysis
- Strain urine for stones

Pharmacological Interventions

- NSAIDs are first-line for the relief of pain related to renal colic. They are more effective than opioids and have fewer tendencies to cause nausea.
- Adults
 - Naproxen 500 mg orally bid for 14 days
 - Or
 - Ibuprofen 600-800 mg tid for 14 days
 - Or
 - Toradol (Ketorolac) 30 mg IM q6-8h for the first 24 hours
- Children
 - Ibuprofen (Motrin) 10 mg/kg/dose orally q6-8h (maximum dose 40 mg/kg/day)
- Consultation with a physician/RN(NP) is required for clients:
 - with severe pain, nausea and vomiting as they will require hydration, parenteral pain management, and antiemetic medications (e.g., morphine for pain).
 - who will receive medical expulsive therapy to facilitate the passage of the stone.
 - who may benefit from preventative therapy. Depending on the composition of the stone, medication to prevent further stone formation is sometimes given (e.g., thiazide diuretics for calcium stones, allopurinol for uric acid stones and calcium citrate for oxalate stones).

Client and Caregiver Education

- Counsel client/caregiver about appropriate use of medications (dose, frequency, compliance, etc.).
- Encourage the client to try to catch the stone for analysis. This may mean urinating through a tea strainer, filter paper such as a coffee filter, or gauze.

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- The majority of stones will pass spontaneously but may take 1-3 weeks. Clients who have not passed a stone or who have continuing symptoms should have the progress of the stone monitored at a minimum of weekly intervals to assess progression.
- Conservative management may be continued for up to 3 weeks unless the client is unable to manage the pain, or if he or she develops signs of infection, or obstruction.
- Recurrence of renal stones is common, therefore clients who have had a renal stone should be advised to adapt and adopt several lifestyle measures which will help to prevent or delay recurrence:
 - Increase fluid intake to maintain urine output at 2-3 L per day
 - Reduce salt intake
 - Reduce the amount of meat and animal protein
 - Reduce oxalate intake (e.g., foods rich in oxalate include chocolate, rhubarb, nuts) and urate-rich foods (e.g., offal and certain fish)
 - Drink regular cranberry juice as it increases citrate excretion and reduces oxalate and phosphate excretion
 - Maintain calcium intake at normal levels (lowering intake increases excretion of calcium oxalate)

Monitoring and Follow-Up

Mild Condition

- Client may be discharged home once pain and nausea are controlled.
- Instruct client to collect and strain all urine for stones and save any stones that are passed and then bring them to the clinic so they can be sent for analysis.
- Follow-up 48 hours after discharge or sooner if pain is uncontrollable or fever develops.

Severe Condition

- Monitor urine output.
- Strain all urine for stones.
- Send all stones for laboratory analysis.
- Client may be discharged home once pain and nausea are controlled.

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- Instruct client to collect and strain all urine for stones and save any stones that are passed and then bring them to the clinic so they can be sent for analysis.
- Encourage fluid intake to produce 2 L of urine daily.
- Follow-up 12-24 hours after discharge.

Referral

- Presentation consistent with those identified in the Immediate Consultation Required in the Following Situations section.
- Referral to a physician/RN(NP) is required if:
 - the stone does not pass.
 - Approximately 1 in 5 stones will not pass spontaneously and will require some form of intervention.
 - Stones that have not passed in 6-8 weeks will likely not pass spontaneously and will have to be removed if they cause ongoing symptoms, obstruction, or other complications.
 - the client is pregnant.
- Pediatric clients should be referred.

DOCUMENTATION

- As per employer policy

REFERENCES

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RNs WITH ADDITIONAL AUTHORIZED PRACTICE
CLINICAL DECISION TOOL
DECEMBER 1, 2016

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Qaseem, A., Dallas, P., Forciea, M. A., Starkey, M., & Denberg, T. D. (2014). Dietary and pharmacologic management to prevent recurrent nephrolithiasis in adults: A clinical practice guideline from the American College of Physicians. *Annals of Internal Medicine*, 161(9), 659-667. doi: 10.7326/M13-2908

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