International Journal of Current Innovations in Advanced Research
(International Multidisciplinary Tri-annual Research Journal)
Content Available at www.ijciar.com ISSN (O) 2636-6282 ISSN (P) 2659-1553

REVIEW ON CLINICAL PRESENTATION AND MANAGEMENT ON UROLITHIASIS

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DOI: https://doi.org/10.47957/ijciar.v8i1.193

Received: 11 Oct 2024 Revised: 28 Oct 2024 Accepted: 16 Dec 2024

Abstract
Observational studies suggest that there is increasing prevalence rate through worldwide and it has an estimated recurrence risk of 50% probably due to modern life styles and dietary habits. Urolithiasis is a condition of formation of stones (or)caliculi in urinary bladder and or urethra which is characterized by extreme pain in ureter that radiates from flank to the groin or to the genital area and inner thigh. The renal or ureteral stones are of different types based on its mineral composition. The most common stones are struvite, calcium oxalate, urate, cystineand silica. Depending on the type and size of stones physician conclude the type of surgery. An in-depth comprehension regarding urolithiasis is required to provide treatment to the patient. There are several pharmacological and surgical management methods to treat the urolithiasis. Surgical methods include ureteroscopy, SWL (shock wave lithotripsy), ESWL (extracorporeal shockwave lithotripsy), PCNL(percutaneous nephrolithotomy) and Pharmacological treatment includes Analgesics, Alpha-1 adrenergic receptor antagonists.

Keywords: Urolithiasis, Struvite, Ureteroscopy, ESWL, SWL, PCNL, Analgesics

Introduction

Urolithiasis is the condition of forming stones in the urinary system i.e., in the kidney, ureter, urinary bladder or in the urethra. 'Urolithiasis'= ouron (urine) and lithos (stone). The major causes of forming stones are due to low urinary volume than normal (due to restricted fluid intake), Increased fluid loss from body, increased metabolic products forming stones, bacterial infection, precipitation of salts at different pH. Regardless of the region, white Caucasians are more likely than Blacks to suffer from idiopathic stone disease. The same 4 to 1 Caucasian-to-Black ratio of stone formers was reported in Brazil and the United States. These disparities most likely cannot be explained by innate racial characteristics alone. In fact, once Black Americans started eating like Caucasians, the prevalence of urolithiasis significantly increased. In terms of gender distribution, White populations seem to have a higher male-to-female ratio than Black and Hispanic populations [1-2]. The patophysiology of urolithiasis is undoubtedly influenced by diet, if not the most so. There is substantial evidence that the prevalence of stone disease in a particular population is closely linked to the amount of animal protein consumed, and that the chemical makeup of urinary calculi and the overall risk of stone formation are greatly influenced by animal protein intake [3-4].

Clinical Presentation

Children under the age of 5 are less likely to experience acute, severe flank discomfort radiating to the groin, unlike adults. Younger children may report with nonspecific discomfort in the belly, flank, or pelvis, whereas adolescents may exhibit identical symptoms to adults. In newborns, stone symptoms can be confused with colic pain. Up to 90% of children with urolithiasis may develop haematuria, either macroscopic or microscopic [5]. Ureteral stones are

more prone to cause blockage and pain. Renal stones can be discovered accidentally and remain present for years without causing symptoms. Approximately 10% of calculi cause dysuria and urine frequency, and are typically seen in the lower urinary tract [6-7].

Signs and symptoms include pain. Pain is majorly occurred due to local mechanisms such as inflammation, oedema, hyper peristalsis and mucosal irritation that may contributes the perception of pain. Haematuria, fever, nausea, vomiting, infections associated with *proteus, pseudomonas, klebsiella, staphylococcus, Providencia and rarely due to E.coli infections.* Risk factors include Diabetes, gout, Cystic fibrosis, IBD, Obesity, osteoporosis, hyper calciuria, UTI,CKD, Hypertension, Hemiplegia, Hydronephrosis, Pyelonephritis.

Classification of Stones:

1. Calcium caliculi

Calcium is a component of calcium oxalate, the most frequent kind of human kidney stones. Dietary calcium, unlike supplementary calcium, may prevent kidney stones from forming.Calcium may help bind ingested oxalate in the gastrointestinal tract. As calcium intake declines, oxalate absorption increases. The kidneys expel more oxalate into the urine. Oxalate in urine promotes calcium oxalate precipitation at a rate 15 times higher than calcium [8-9].

Non calcium caliculi:

Struvite stones

Approximately 10-15% of urinary calculi include struvite ($NH_4MgPO_4 \bullet 6H_2O$). Struvite stones, often called "infection stones," urease or triple-phosphate stones, are typically caused by urea-splitting bacteria. These organisms use the enzyme urease to convert urea into ammonia and carbon dioxide. This alkalises urine, creating favourable conditions for the production of struvite stones. The most commonly isolated organisms are Proteus mirabilis, Proteus vulgaris, and Morganella morganii. Other less frequent organisms include Ureaplasma urealyticum, and several species of Providencia, Klebsiella, Serratia, and Enterobacter [10]. These symptoms are often associated with metabolic illnesses such idiopathic hypercalciuria, hyperparathyroidism, and gout. Infection stones can quickly grow into massive calyceal staghorn-shaped calculi, necessitating invasive surgery like percutaneous nephrolithotomy for therapy [11].

Uric acid stones

Uric acid accounts for around 5-10% of all stones [12]. Metabolic disorders, such as obesity, can lead to uric acid stones [13]. These disorders may be associated with hyperuricosuria (excess uric acid in urine) or hyperuricemia (excess uric acid in serum). Urinary acid/base metabolism problems can lead to the formation of uric acid crystals due to low pH levels. Diagnosis of uric acid urolithiasis is based on the presence of a radiolucent stone and uric acid crystals in fresh urine samples [14].

Cysteine stones

Cystine kidney stones are caused by cystinuria, an inherited genetic condition that disrupts the transport of cystine, resulting in an excess of cystine in urine and the production of cystine stones.The most prevalent amino acid transporter deficiency is cystinuria. Cysteine is not the sole amino acid excreted excessively in cystinuria, but it is the least soluble among naturally occurring amino acids.Cystine can precipitate out of urine and form stones (calculi) in the urinary system. Small stones are excreted in urine. Large kidney stones (nephrolithiasis) can hinder urine outflow, whereas medium-sized stones can lodge in the ureter and stop the flow (urinary blockage).Obstruction in the urinary tract increases strain on the ureter and kidneys [15].

The stone are responsible for all the signs and symptoms
of cystinuria, including:

- Hematuria -- blood in the urine
- Flank pain -- pain in the side, due to kidney pain
- Renal colic - intense, cramping pain due to stones in the

urinary tract

- Obstructive uropathy -- urinary tract disease due to

obstruction

- Urinary tract infections

Other stones

There is no solid evidence linking alcohol use with kidney stones. Frequent and binge drinking may cause dehydration, perhaps leading to kidney stones, according to some theories. The American Urological Association predicts that rising global temperatures would increase the prevalence of kidney stones in the US, enlarging the "kidney stone belt" across the southern states [16-17].

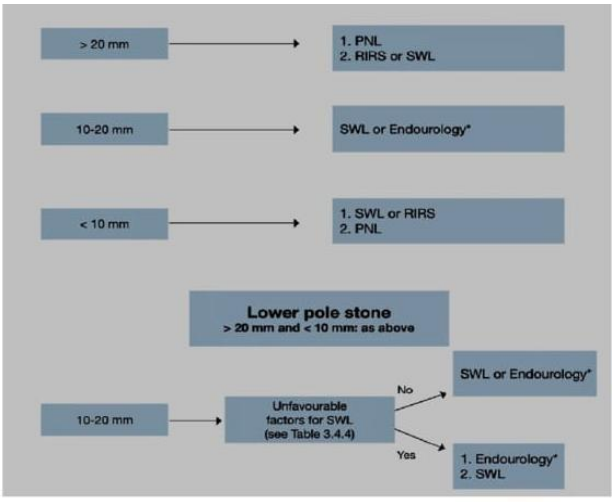

Fig 1: Treatment Algorithm of Urolithiasis

Diagnosis

- Plain radiograph
- Ultrasonography
- Computed tomography
- Excretory urography
- Retrograde pyelography
- Magnetic resonance imaging

Patophysiology

The complicated process of calculus production involves metabolic disruptions of the urine that promote crystal nucleation, aggregation, and most likely adhesion. In reality, hypovolemia and low urine levels, persistently low urine pH (the primary cause), and hyperuricosuria (defined as daily urinary uric acid above 750 mg/d in females and 800 mg/d in males) are all urinary abnormalities that contribute to the development of uric acid calculi [23-24].

Low Urinary Volume

Increased urinary concentrations of lithogenic solutes are the result of decreased urine production. Due to uric acid's limited solubility, high urate concentrations may cause uric acid and monosodium urate to precipitate. As a result, uric acid calculi are common in hot climates and tropical regions [18-19].

Hyperuricosuria

Mixed calculi composed of calcium oxalate and urate can also occur in hyperuricosuria with normal urine pH. Despite the fact that urate is typically more soluble than uric acid, this is not always the case. High concentrations of monosodium urate precipitate out of solution and are thought to cause calcium oxalate crystallization by either salting-out, heterogeneous nucleation, or the attenuation of macromolecular inhibitors of lithogenesis. Although congenital renal hypouricemic hyperuricosuria may develop from mutations in the URAT1 channel, hyperuricosuria typically results from dietary indiscretion [20-21].

Increased Purines in Diet

Because of the higher purine load and acid-ash content of animal protein, people who eat a lot of meat are at risk of developing uric acid calculi. This causes a slight metabolic acidosis and hyperuricosuria, which lowers the pH of the urine. Therefore, dietary measures may help prevent the development of uric acid calculus [22].

Management

Generally, there is no drug treatment for urolithiasis. But some medications will relieve the pain.

- Alpha blockers such as Tamsulosin and the combination of Dutasteride and Tamsulosin relax the muscles of ureter, helping the patient pass the stone more quickly with less pain [27].
- Calcium channel blockers like nifedipine and Phosphodiesterase-5 inhibitors like Tadalafil are used to relax ureter smooth muscle [26].

- Diuretics like Hydrochlorthiazide, Chlorthalidone or Indapamide, all of which help to prevent stones from returning, especially in people who have high levels of calcium in the urine [28-29].
- For severe pain, IV Narcotics, Anti-inflammatory agents may be used in emergency department.
- For less pain it can be managed with ibuprofen [25].

Drainage/ stone removal can be performed if the analgesic treatment is failed.

The Surgical Procedures involved in managing urolithiasis vary based on size, location, and types of stone.

(1) Extracorporeal Shock Wave Lithotripsy:

Procedure: It is a non-invasive procedure where shock waves are generated outside the body and directed at the stone. The waves break the stone into smaller fragments, which can then be passed naturally through the urinary tract.

Indication: It is typically used for stones location in the kidneys or upper ureter, especially if they are less than 2 cm in size.

Advantages: It is minimally invasive, does not require an incision, and generally has a short recovery time [31].

(2) Uretheroscopy with Laser Lithotripsy:

Procedure: A thin, flexible tube (ureteroscope) is inserted through the urethra into the bladder and then into the ureter or kidney. Once the stone is locked, a laser fiber is used to fragment the stone into smaller pieces, which can then be removed or passed out of the body.

Indication: This is typically used for stones in the ureter or kidneys,especially when they are too large for ESWL or in cases where ESWL was ineffective.

Advantages: It allows for direct visualization and removal of stones, especially those located in the ureter or lower pole of the kidney [30].

(3) Percutaneous Nephrolithotomy (Pcnl):

Procedure: A small incision is made in the back, and a nephroscope is inserted directly into the kidney. This procedure is used for larger stones (generally larger than 2 cm) that cannot be treated with ESWL or ureteroscopy. The stone is either broken up with a laser or removed in pieces.

Indication: Large kidney stones, staghorn calculi (stones that fill the renal pelvis),and stones that are difficult to remove with less invasive techniques.

ADVANTAGES: Highly effective for large or complex stones, and provides direct access to the kidney [32].

(4) Open Surgery:

Procedure: Open surgery involves making a large incision in the abdomen or flank to directly access the kidney or urinary tract and renal the stone. This is now rarely used due to the effectiveness of minimally invasive techniques, but it may be necessary in some cases where other methods fail or in the presence of complex anatomical issues.

Indication: Reserved for very large stones, staghorn calculi, or when other procedures are not possible (e.g., when other organs obstruct the stones or when there are anatomical abnormalities).

Advantages: Provides direct access to the stone, ensuring complete removal [33].

(5) Laparoscopic surgery:

Procedure: Laparoscopy involves making small incisions in the abdomen through which a camera and specialized surgical instruments are inserted. The surgeon can remove the stone under direct visualization.

Indication: Often used for stones in the kidney or ureter that is difficult to remove through less invasive techniques. It is less commonly performed than PCNL and open surgery.

Advantages: Minimally invasive with smaller incisions, leading to a faster recovery time compared to open surgery [33].

Post-Surgical considerations

Follow-Up: After surgery, patients may need imaging to confirm stone clearance and ensure there are no remaining fragments.

Pain Management: Pain relief and hydration are critical, particularly after procedures like PCNL or open surgery.

Risk of Recurrence: Patients are often given advice on diet, hydration, and medications to prevent future stones formation.

Conclusion

From above it is concluded that based on the clinical presentation and size of the caliculi the type of the surgery is recommended. KUB is the simplest imaging tool to diagnose urinary calculi but is not always reliable. Nonenhanced CT is rapid, specific, and accurate in assessing urolithiasis with the limitations of higher costs and irradiation exposure.

Funding
Own funding

Acknowledgement
Not Declared.

Conflict of Interest
No

Informed Consent
Not Applicable.

Ethical Statement
Not Applicable.

Author Contribution
All authors are contributed equally.

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