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REVIEW ARTICLE

Urolithiasis: An Overview

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ABSTRACT

Kidney stone formation or urolithiasis is a complex process that results from a succession of several physicochemical events including supersaturation, nucleation, growth, aggregation, and retention within the kidneys. Urolithiasis affects approximately 10% of individuals in Western societies by the seventh decade of life. Epidemiological datahave shown that calcium oxalate is the predominant mineral in a majority of kidney stones.Till date, considerable progress has been made in identifying the metabolic risk factors that predispose to this complex trait, among which hypercalciuria predominates. The specific genetic and epigenetic factors involved in urolithiasis have remained less clear, partly owing to the candidate gene and linkage methods that have been available until now, being inherently low in their power of resolution and in assessing modest effects in complex traits. However, together with investigations of rare, Mendelian forms of urolithiasis associated with various metabolic risk factors, these methods have afforded insights into biological pathways that seem to underlie the development of stones in the urinary tract. Furthermore, in spite of substantial progress in thestudy of the biological and physical manifestations of kidney stones, there is no satisfactorydrug to use in clinical therapy. Data fromin-vitro, in-vivo and clinical trials reveal that phyto-therapeutic agents could be useful as either an alternative or an adjunctive therapy in the managementof urolithiasis. In this Review, we will discuss about types of stones, their composition, clinical investigation & possible surgical procedure for removal and a few herbal market formulation.

Key words: Urolithiasis, physicochemical events, Epidemiological data, complex traits.

INTRODUCTION

Urolithiasis is defined as the presence of one or more calculi in any location within the urinarytract. Urolithiasis is derived from the Greek words ouron (urine) and lithos (stone). Urolithiasis is the third most common disorder of the urinary tract, the others being frequently occurring urinary tract infections and benign prostatic hyperplasia.Epidemiological studies revealed that nephrolithiasis ismore common in men (12%) than in women (6%) and are more prevalent between the ages of 20 to 40 in both sexes[1]. The prevalence of urinary calculi is higher in mountainous, desert or tropical areas. Incidence of urinary calculus disease in the United States is relatively high for its population [2]. Increased water intake and increased urinary output decrease the incidence of urinary calculi in those patients who are predisposed to the disease.The etiology of this disorder is multifactorial and is strongly related to dietary lifestyle habits or practices [3]. Increased rates of hypertension and obesity, which are linked to nephrolithiasis, also contribute to an increase in stone formation [4].

Pathophysiology of Urolithiasis

Kidney stones are a common cause of blood in the urine and often severe pain in the abdomen, flank, or groin. Kidney stones are sometimes called renal calculi. Kidney stones are classified according to their chemical composition. For crystals to form, urine must be supersaturated with respect to the stone material, meaning that concentrations are higher than the thermodynamic solubility for that substance [5].Kidney stones often occur when

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urine becomes too concentrated. This causes calcium, oxalate and phosphate or other chemicals in the urine to form crystals on the inner surfaces of kidneys. These crystals may combine to form a small, hard mass called as stones.Kidney oxalate stone is the result of super saturation of urine with certain urinary salts such ascalcium oxalate.

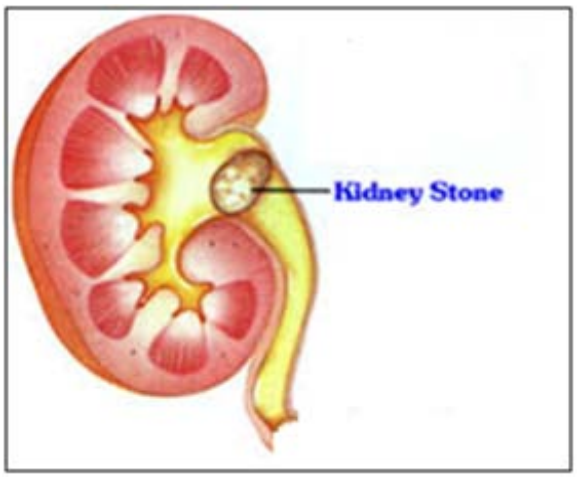

Figure 1: Kidney Stone

Types of Stones

- Calcium oxalate stones are the most common. They tend to form when the urine is acidic
- Calcium phosphate stones are less common. Calcium phosphate stones tend to form when the urine is alkaline
- Uric acid stones are more likely to form when the urine is persistently acidic, which may result from a diet rich in animal proteins and purines
- Struvite stones result from infections in the kidney
- Cystine stones result from a rare genetic disorder that causes cystine—an amino acid

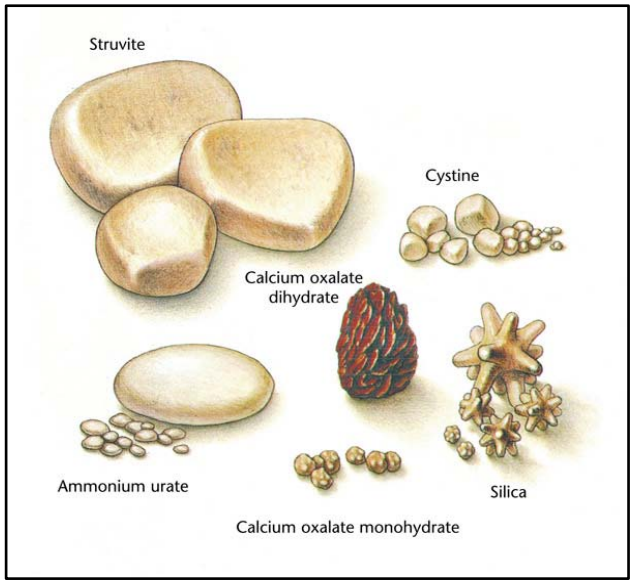

Figure 2: Types of Kidney Stones

Causes of Stone formation

Table 1: Causes of stone formation

Condition	Causes
Hypercalciuria	↑GI calcium absorption impaired renal Ca absorptionresorptivehypercalciuria
Hyperoxaluria	Excessive dietary intakeenteric hyperoxaluria:↑GI oxalate absorption
Hypocitraturia	Distal renal tubular acidosis: impaired renal tubular acidexcretion
Hyperuricosuria	Dietary purine excess, uric acid overproduction or overexcretion
Hypomagnesuria	Limited intake of magnesium-rich foods

Metabolic abnormalities such as hypercalciuria, hypocitraturia, hyperoxaluria, hyperuricosuria, and gouty diathesis can change the composition or saturation of the urine so as to enhance stone formation. Any cellular dysfunction that can affect various urinary ions and other substances can also influence CaOxsuper saturation and crystallization in the kidneys[6].

Signs and Symptoms [7]

• Flank pain –pain in upper abdomen and back
• Urinary tract infections
• Obstructive uropathy -- urinary tract disease due to obstruction
• Hematuria -- blood in the urine

Composition of Stones

Calcium oxalate (CaOx) is the predominant component of most stones accounting for more than 80% of stones [8]. The remaining 20% are composedof struvite, cystine, uric acid, and other stones [9].

Diagnosis

A number of diagnostic tests to diagnose kidney stones they are,

- Blood tests- full blood count for presence of a raised white cell count (Neutrophilia) etc.
- Urine test- Microscopic study of urine- show proteins, red blood cells, bacteria, cellular casts and crystals.
- Culture of a urine sample to exclude urine infection.
- 24-hour urine collection test.–measures total daily urinary volume, magnesium, sodium, uric acid, citrate, calcium, oxalate and phosphate.

Other Diagnostic Tests

Kidney ureter bladder (KUB), X-ray kidney ultrasound, Intravenous pyelogram (IVP) and Computed Tomography (CT) scan [10].

Treatment

The accepted management of stone disease ranges from observation (watchful waiting) to surgical removal of the stone. Stones which are smaller than 5mm have a high probability of spontaneous

passagewhich can take up to 40 days [11]. During this watchful waiting period, patients can be treated with hydration and pain medication [12]. However, stones larger than 5mmor stones that fail to pass are treated by interventional procedures [12].

1. Extracorporeal Shockwave Lithotripsy (ESWL)

ESWL is a non-invasive procedure which uses shock waves to fragment calculi. This technique is the most widely used method for managing renal and ureteral stones. The most common injury is acute renal hemorrhage although its true incidence isunclear and poorly defined. ESWL uses non-electrical shock waves that are created outside of the body to travel through the skin and body tissues until the shockwaves hit the dense stones. The stones become sand-like and are passed[13].

2. Percutaneous Nephrolithotomy (PCNL)

Percutaneous nephrolithotomy, or PCNL, is a procedure for removing medium-sized or larger renal calculi (kidney stones) from the patient's urinary tract by means of a nephroscope passed into the kidney through a track created in the patient's back. The purpose of PCNL is the removal of renal calculi in order to relieve pain, bleeding into or obstruction of the urinary tract [14].

3. Open (incisional) Surgery

Open surgery involves opening the affected area and removing the stone(s). This procedure involves the injection of a liquid containing calcium chloride, cryoprecipitate, thrombin and indigo carmine into the kidney. This injection of substances forms a jelly like clot that traps the stones inside. Through an incision made in the kidney, the doctor extracts the stone with forceps.

An individualized treatment plan incorporating dietary changes, supplements, and medications can be developed to help prevent the formation of new stones.A high fluid intake reduces urinary saturation of stone-forming calcium saltsand dilutes promoters of CaOx crystallization.The most effective hypocalciuric agentsare thiazide diuretics which hypocalciuricaction enhances calciumreabsorption in the distal renal tubules. It has side effectssuch as fatigue, dizziness, impotence, musculoskeletal symptoms, or gastrointestinal complaints. Another complication is thiazide-induced potassium depletion, which causes intracellularacidosis and can lead to hypokalemia and hypocitraturia[15].

Dietary Changes to Prevent Calcium Oxalate Stones

- Drink More Water

By increasing the water in diet, urine will be less concentrated with calcium or oxalate.

- Limit Protein

Excessive protein in your diet can increase both the calcium and oxalate in urine.

- Limit Foods High in Oxalate

By avoiding foods very high in oxalate, reduces the oxalate in urine.

List of high oxalate foods

Protein Foods: Nuts, Peanut butter,Soy protein, Tofu

Beverages: Cocoa,Tea, Cola,Cranberryjuice

Fruits: Grapes, Lemon Peel, Orange, Plums

Vegetables: Carrots,Cauliflower, Celery,Green Beans[16].

- Reduce Sodium

Too much sodium in diet can result in more calcium in urine[17].

MARKETED PRODUCTS

1. Cystone

CYSTONE prevents the formation of kidney stones and dissolves kidney stones. It prevents the deposition and super saturation of oxalic acid and calcium hydroxyproline in urine. This action inhibits the formation of kidney stones. CYSTONE dissolves mucin and is also a diuretic that flushes out small stones from the kidneys[18].

2. Ural

It breaks down renal stones and flushes out gravel, prevents recurrence of calculi by promoting stone inhibitors and checking stone precipitation agents. It helps flush out pus cells and hence useful in UTI and burning micturition [19].

3. K4

It is indicated for urinary tract infections, urethritis, burning micturition and calculi [20].

4. GokharuKadha

It has diuretic, lithotriptic, anti-inflammatory analgesic action. It breaks stones into very small pieces and then flushes them out. It gives relief from the symptoms of dysuria, hematuria, frequency and burning micturition. It also prevents recurrence of stone if used regularly. It also relieves pain associated with calculus[21].

5. Cacury

It is indicated for Urinary calculi renal colic and Dysuria associated with renal calculi[22].

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