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Review Article

A Synopsize Report of the Various Perspectives of Urolithiasis and its Ethno-Medical Future

Sarita Sharma[1]*, Amit J. Raval[2], Raju Koneri[3], Gaurav Kumar Sharma[4]

[1] *PhD Research Scholar, Pacific Academy of Higher Education and Research University, Udaipur, India*

[2] *Professor, Pacific Academy of Higher Education and Research University, Udaipur, India*

[3] *Professor and Dean, Karnataka College of Pharmacy, Bangalore, India*

[4] *Associate Professor, Mewar University, Gangrar, Rajasthan, India*

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*Address for Correspondence:

Ms Sarita Sharma, Research Scholar & Assistant Professor, Department of Pharmacy, Mewar University, NH – 79, Gangrar, Chittorgarh, Rajasthan-312 901, India

Abstract

Kidney stone formation or urolithiasis is a complex process that results from a series of physicochemical events, including supersaturation, nucleation, growth, aggregation, and retention in the kidney. Urolithiasis affects about 10% of people in the Western world in their 70s. Epidemiological data show that calcium oxalate is the major mineral in most kidney stones.

To date, great progress has been achieved in identifying metabolic risk factors that predispose to this complex condition, the most prominent of which is hypercalcemia. The unique genetic and epigenetic elements concerned in urolithiasis have remained largely unknown, thanks in part to the candidate gene and linkage techniques that have been available to date, which are inherently low in terms of their decision-making power and ability to assess modest outcomes in complicated traits.

However, when combined with studies of rare Mendeliantypes of urolithiasis linked to various metabolic danger factors, those methodologies have shown organic pathways that appear to underpin the improvement of stones in the urinary system. Furthermore, despite substantial improvements in research into the biochemical and physical signs of kidney stones, therapeutic therapy medications are in short supply. Phytotherapy may be effective as an alternative or adjunctive therapy in the treatment of urolithiasis, according to data from in vitro, in vivo, and clinical investigations. This article discusses the various varieties of stones, as well as their characteristics.

The varieties of stones, their composition, clinical evaluation, various surgical procedures for removal, treatment downsides, and several herbal medicine details giving therapeutic effects are all included in this review.

Keywords: Urolithiasis, Epidemiological data, Diagnosis, Herbal drugs, Ethno medicines.

Introduction

The presence of one or more stones in the urinary tract is known as urolithiasis. Urolithiasis is derived from the Greek words ouron (urinary system) and lithos (skin) (stone). Urinary stones are the third most frequent urinary tract ailment, with common urinary tract infections and benign prostatic hyperplasia ranking first and second, respectively. According to epidemiological research, nephrolithiasis is more common in males (12%) than in women (6%), and it is more common in men and women between the ages of 20 and 40.[1] Urinary calculi are more common in mountainous, desert, and tropical environments. The prevalence of urinary calculus disease in the United States is extremely high for its population.[2] In people who are prone to the disease, increased water consumption and increased urine output reduce the prevalence of urinary calculi. This disease has a complex aetiology that is strongly linked to nutritional lifestyle behaviours or practices.[3] Increased rates of hypertension and obesity, both of which may be linked to nephrolithiasis, also play a role in stone formation.[4]

Pathophysiology of Urolithiasis:

Renal stones are a common cause of blood in the urine and can cause severe abdominal, flank, or groyne pain. Renal calculi are another name for kidney stones. Chemical composition is used to classify kidney stones. To produce crystals, urine must be supersaturated in relation to the stone. That is, the concentration exceeds the substance's thermodynamic solubility.[5] When urine is overly concentrated, kidney stones are common. Calcium, oxalate, phosphate, and other compounds in the urine crystallise on the inside of the kidney as a result of this. These crystals can be linked to stones, which are small, hard masses. Supersaturation of urine with certain urinary salts, such as calcium oxalate, causes kidney oxalate stones.

Figure 1: Kidney Stone[6]

Types of Stones:

• The most prevalent types of stones are calcium oxalate stones. When the urine is acidic, they are more likely to develop.

• Calcium phosphate stones are quite uncommon. When urine is alkaline, calcium phosphate stones are more likely to develop. • Uric acid stones are more prone to form if urine is consistently acidic. This could be related to a high-purine and animal protein diet.

• Kidney infections cause struvite stones.

• Cystine stones are caused by a rare hereditary condition in which cystine — an amino acid – is produced in excess.

Figure 2: Types of Kidney Stones[7]

Table 1: Causes of Stone formation

S.No.	Condition	Causes of stone formation
1.	Hypercalciuria	↑GI calcium absorption impaired renal Ca absorption resorptive hypercalciuria
2.	Hyperoxaluria	Excessive dietary intake enteric hyperoxaluria:↑GI oxalate absorption
3.	Hypocitraturia	Distal renal tubular acidosis is characterized by a decrease in renal tubular acid excretion.
4.	Hyperuricosuria	Excess dietary purine, uric acid overproduction, or uric acid excretion
5.	Hypomagnesuria	Magnesium-rich meals are consumed infrequently.

Hypercalciuria, hypocitraturia, hyperoxaluria, hyperuricosuria, and gout susceptibility can change the composition or saturation of the urine, which can lead to stone formation. CaOxsupersaturation and crystallisation in the kidneys can be influenced by any cellular malfunction that affects numerous urine ions and other chemicals.[8]

Symptoms and Signs[9]

• Flank discomfort (abdominal and back pain)

• Infections of the urinary tract

• Hematuria — blood in the urine • Obstructive uropathy — urinary tract disease caused by obstruction

Stone Composition: Calcium oxalate (CaOx) is the most common component of maximal stones, accounting for more than 80% of all stones.[10] The remaining 20% is made up of struvite, cystine, uric acid, and other stones.[11]

Diagnosis: There are a number of diagnostic tests that can be used to determine whether or not you have kidney stones.

• Complete blood count for the presence of increased white cellular matter (Neutrophilia), among other things.

• Urine test- shows proteins, pink blood cells, bacteria, cell casts, and crystals under a microscope.

• A urine sample is cultured to rule out infection.

• 24-hour urine collection test – calculates overall urinary volume, magnesium, salt, uric acid, citrate, calcium, oxalate, and phosphate over a 24-hour period.

Additional Diagnostic Tests

KUB (kidney ureter bladder), X-ray kidney ultrasonography, IVP (intravenous pyelogram), and CT scan (computed tomography)[12]

Treatment:

Stone illness is treated in a variety of ways, from observation (close monitoring) through surgical removal of the stones. Smaller stones (less than 5 mm) are more likely to pass spontaneously, taking up to 40 days.[13]

Patients might be treated with drinks and analgesics during the observation period. Interventional methods are used to treat stones greater than 5 mm and stones that do not pass.[14]

1. Extracorporeal shock wave lithotripsy (ESWL) is a non-invasive procedure that fragments stones using shock waves. This is the most commonly utilised approach for treating kidney and ureter stones. Acute renal bleeding is the most common lesion, but its real incidence is uncertain and poorly defined. Extracorporeal shock waves are used in ESWL to penetrate through the skin and bodily tissues until they contact thick stones. The stone decomposes into sand and is carried away.[15]

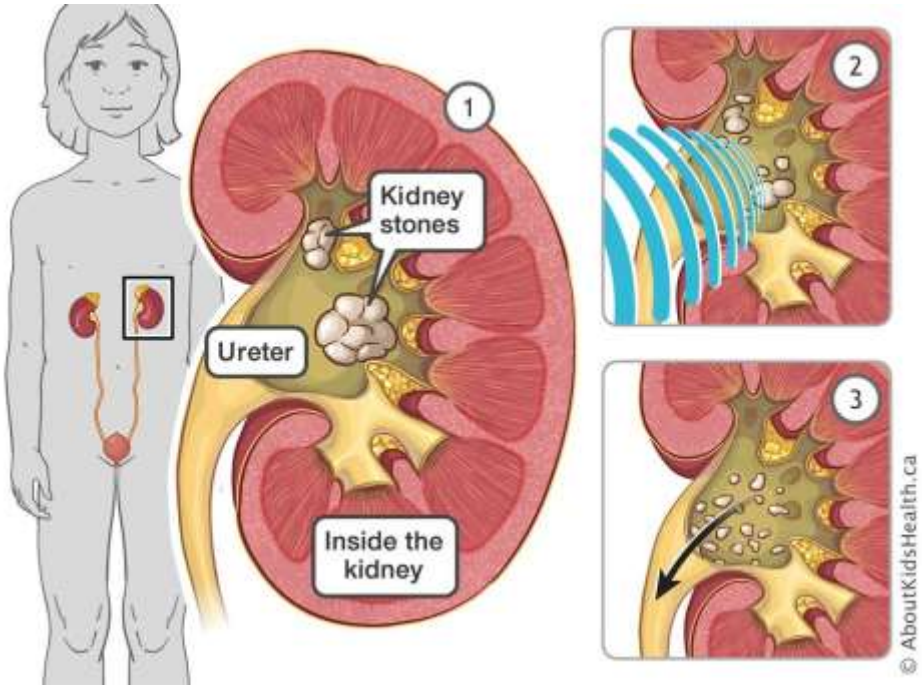

Figure 3: Extracorporeal shock wave lithotripsy (ESWL)[16]

2. Percutaneous Nephrolithotomy (PCNL): Percutaneous nephrolithotomy (PCNL) is a technique that removes large or medium kidney stones from a patient's urinary tract. PCNL necessitates the use of general anaesthesia. PCNL entails cutting a half-inch cut in the back or side of the kidney, just large enough to allow a rigid telescope (nephroscope) to be introduced into the hollow centre region of the kidney where the stone is located.[17] The goal of PCNL is to remove renal calculi in order to reduce pain, bleeding into the urinary tract, and blockage.[18]

Figure 4: Percutaneous Nephrolithotomy (PCNL)[19]

3. Incisional (open) surgery: The afflicted area is opened and the stone is removed via open surgery (s). A solution containing calcium chloride, cryoprecipitate, thrombin, and indigo carmine is injected into the kidneys during this operation. This material is injected into the body, forming a jelly-like blood clot that traps the stones inside. The stone is removed with tweezers through an incision in the kidney.

To avoid the creation of new stones, you can create a specific treatment plan that includes dietary changes, supplements, and medications. The calcium salts that create the stones diminish urine saturation and dilute the promoter of CaOx crystallisation in the distal tubules when you drink a lot of water. Thiazide diuretics are the most effective hypocalciuricagents because their hypocalciuricaction increases calcium absorption in the distal renal tubules.

Fatigue, disorientation, impotence, musculoskeletal issues, and gastrointestinal complaints are some of the negative effects. Thiazide-induced potassium depletion, which produces intracellularacidosis and can lead to hypokalemia and hypocitraturia,[20] is another consequence.

Major drawbacks of ESWL, PCNL:

In addition to future advancements and associated high expenditures, substantial evidence suggests that therapeutic doses of shock waves can cause acute renal damage, impaired renal function, and increased stone recurrence. Furthermore, stone management is complicated by the presence of remaining stone debris and the risk of post-ESWL infection. Despite significant advances in the research of the biochemical and physical symptoms of kidney stones, no effective medicine for clinical treatment exists.

Stones are treated differently depending on their size and placement. Extracorporeal shock wave lithotripsy (ESWL), ureteroscopy (URS), or percutaneous nephrolithotripsy (PNL) should be used to treat stones greater than 5 mm or that do not pass through.[21]

Unfortunately, ESWL excision of the stone has no effect on the likelihood of stone recurrence, and stone recurrence remains at 50%.[22] Furthermore, kidney injury, ESWL-induced hypertension, and renal failure are all possible side effects of ESWL.[23]

Despite some recent findings on the beneficial benefits of medical treatments on the removal of stones in the distal ureter,[24] there is still no satisfactory medicine to use in clinical therapy, particularly for the prevention or recurrence of stones. Many herbs have been used to treat kidney stones in the past and have been proven to be beneficial.

Alternative therapy: herbal treatment

Traditional medicine is believed to be used by 80 percent of the world's population for illness treatment.[25] Medicinal herbs have been used for a long time and are generally considered to be safer than manufactured drugs.[26] They are a reliable source of drug discovery information.[27] Researchers are now concentrating their efforts on finding medicines in medicinal plants.[28] Plants are thought to be the source of at least one-third of all medicines.[29] Pharmaceutical companies consider medicinal plants to be an acceptable, low-cost, readily available, and safe source of active chemicals.[30] Medicinal plant therapeutic effects on renal and urinary tract illnesses have been examined extensively, and their efficacy has been established.[31]

Table 1: of plants which have been used for treatment of urolithiasis[32]

LIST OF PLANTS WHICH HAVE BEEN USED FOR THE TREATMENT OF UROLITHIASIS

Phytotherapeutic agent	Type of study	Mechanism of action
Herniaria hirsute	*in vitro*, cell culture, *in vivo*	Decrease crystal size & increase COD, diuretic
Amni visnaga	*in vivo* animals, cell culture	Potent diuretic, khellin & visnagin prevent renal epithelial cell damage caused by oxalate & COM
Tribulus terrestris	*in vitro*, cell culture, *in vivo* animals	COM, Decrease oxalate
Bergenia ligulata	*In vitro, in vivo* animals	COM, Decreases calcium
Dolichos biflorus	*In vitro*	oxalate crystals
Aerva lanata	*in vivo* animals	Decrease crystal ppt
Vediuppu chunnam	*in vivo* animals	Decrease urinary calcium oxalate, uric acid & Diuretic
Raphanus sativus	*in vivo* animals	Diuretic
Achyranthus Aspera	*In vitro*, cell culture, animals *in vivo*	Prevent renal epithelial damage, Diuretic
Quercus salicina	cell culture	Reduction in oxalate induced renal epithelial cell injury
Phyllanthus niruri	*In vitro, in vivo* animals	Antispasmodic & relaxant
Cranberry juice	Humans *in vivo*	Decrease urinary oxalates
Cynodon dactylon	*In vivo* animals	Increase COD as compare to COM
Grapefruit juice	Humans *in vivo*	Increases urinary excretion
Paronychia argentea	*In vivo* animals	Antioxidant activity
Lemonade juice	Humans *in vivo*	Increases urinary excretion
Pyracantha crenulated	*In vivo* animals	Increase diuresis and lowering of urinary conc. of stone forming constituents
Trachyspermum ammi	*In vivo* animals	Maintain renal functioning; Reduce renal injury and decrease crystal excretion in urine and retention in renal tissues
Moringa oliefera	*In vivo* animals	Diuretic, improved renal function
Costus spiralis	Animals *in vivo*	Decrease stone size

Table 2: of plants which have been used for treatment of urolithiasis: In-Vitro

Phytotherapeutic agent	**Type of study**	**Mechanism of action**
Kampou medicine /traditional Chinese medicines (TCM)	In-Vitro	Calcium oxalate crystallisation is inhibited.[33, 34]
Epigallocatechingallate (EGCG) from green tea	In-Vitro	Oxalate-induced free radical generation is inhibited.[35]
Rosa canina L.	In-Vitro	Increased citrate excretion[36]
Takusha (Alismaorientale [Sam]. Juz),	In-Vitro	Stone formation was prevented by reducing CaOx aggregation.[34, 37] The pH of cat urine was lowered and the production of struvite crystals in cat urine was reduced in cats fed a diet containing Takusha.[38, 39]
Pomegranate juice (Punicagranatum L.)	In-Vitro	Decreased urinary Ox excretion and CaOx deposit formation[40]
Andrographis paniculata	In-Vitro	Diuretic effect[41]
Solidagovirgaurea L.	In-Vitro	Diuretic effect[42]
Sambucusnigra L.	In-Vitro	Diuretic effect[43]
Hibiscus sabdariffa L.	In-Vitro	An increased uric acid excretion and clearance[44,45]
O. grandiflorus	In-Vitro	Diuretic effect[46]
Methoxyflavonoids from Orthosiphon	In-Vitro	Adenosine A1 receptor antagonists. Adenosine A1 receptor antagonists have been shown in several trials to cause diuresis and salt excretion[47, 48]

Dietary Changes to Prevent Calcium Oxalate Stones are part of a lifestyle change to prevent calcium oxalate stones.

• Drink More Water: By increasing the amount of water in your diet, your urine will become less concentrated in calcium and oxalate.

• Limit Protein: Too much protein in the diet might cause calcium and oxalate to build up in the urine.

• Limit Oxalate-Rich Foods: Limiting oxalate-rich foods lowers oxalate levels in the urine.

• Lower your sodium intake: Too much sodium in the diet might cause calcium to build up in the urine.[49]

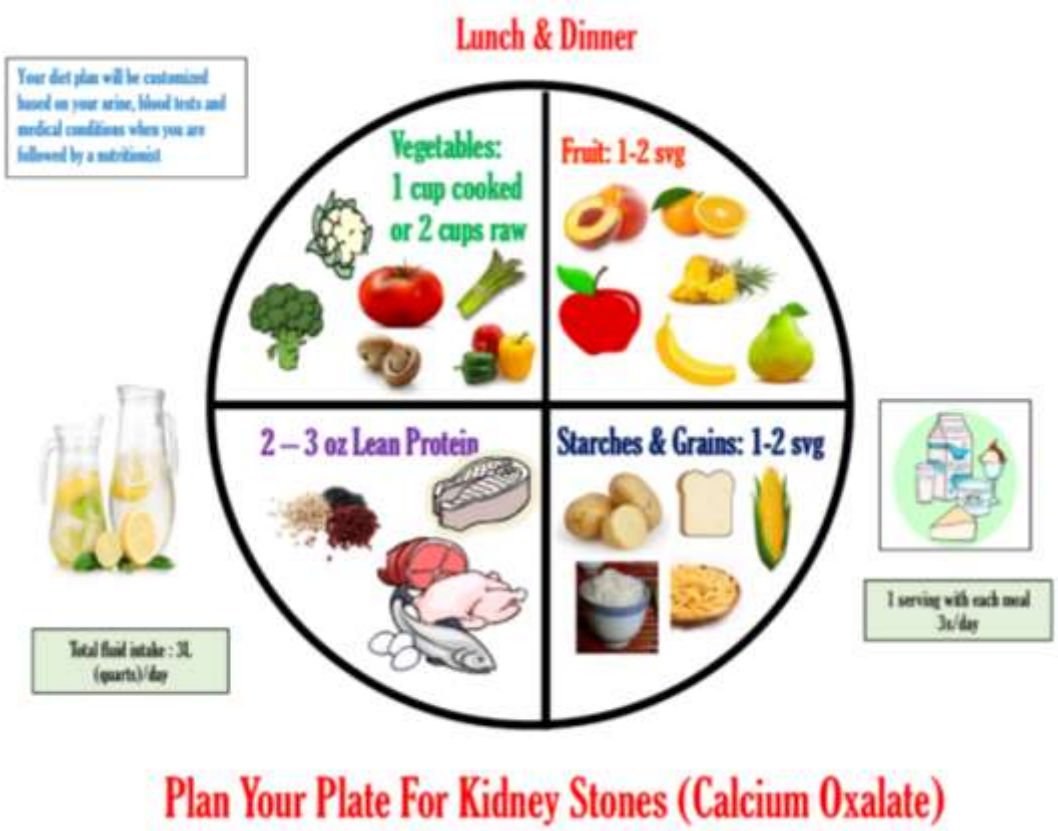

Figure 5: Diet Modification[50]

Conclusion

In vitro, in vivo, and clinical investigations suggest that phytotherapeutic agents could be used as an alternative or adjuvant therapy for urolithiasis treatment. However, because the number of clinical trials on these plants is so small, the overall benefits are still unclear, and further study is needed to confirm the stated results.

Some probable mechanisms of action of plant extracts, according to the reviewed studies, include increased urine citrate excretion, decreased urinary calcium and oxalate excretion, or diuretic, antioxidant, or antibacterial properties.

The development of effective, safe, and standardised herbal preparations for the treatment of urolithiasis has been a priority for hours. Plants must be investigated as an alternative and/or supplemental medicine for the treatment of urolithiasis in systematic investigations.

In conclusion, additional multidisciplinary study among pharmacognosists, pharmacologists, and clinical researchers is needed to produce new plant-derived, high-quality natural products for kidney stone treatment and prevention.

Abbreviations

CaOx : Calcium oxalate
CaP: Calcium phosphate
ESWL: Extracorporeal shock wave lithotripsy
URS: Ureteroscopy
PCNL: Percutaneous nephrolithotripsy
IVP: Intravenous pyelogram
CT Scan: Computed Tomography (CT) scan

Conflicts of interest

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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