

A brief review on kidney stone

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ABSTRACT

The development of urinary calculi or kidney stones is known as urolithiasis or nephrolithiasis. It is considered one of the most painful conditions known to man. Over the last few decades the incidence of kidney stones has increased and the age of onset for this condition has decreased. In severe cases kidney stones can cause urinary obstruction, kidney infections, and scarring and damage to the kidneys. Orthodox treatment of kidney stones is somewhat limited, relying on oral (Percocet, Vicodin, Percodan) or IM (Toradol, Demerol) analgesic medications as well as on herbal product to relieve discomfort as smaller stones pass. In an emergency with acute pain, immersion in a hot tub or hot bath or localized warming of the abdomen and lower back can significantly reduce pain and nausea. Larger stones that cannot pass are either broken up with extracorporeal shockwave lithotripsy (ESWL) or are removed via ureteroscopy or using a surgical technique known as percutaneous nephrolithotomy. This study involves comparison between herbal therapy and surgical treatment for kidney stone

Keywords: Struvite Stone, Cystine Stone,

I. INTRODUCTION:

Urinary stone constitute one of the commonest diseases in our country and pain due to kidney stones is known as worse than that of labour pain. Among all the pain, abdominal pain always drags not only patient's attention but also the curiosity of the surgeon. In India, approximately 5-7 million patients suffer from stone disease and at least 1/1000 of Indian population needs hospitalization due to kidney stone disease. Thus, the disease is as widespread as it is old, particularly in countries with dry, hot climate. These are "stone belt regions". The incidence of calculi varies as per geographical distribution, sex and age group. The recurrence rate is 50 to 80%. Males are more

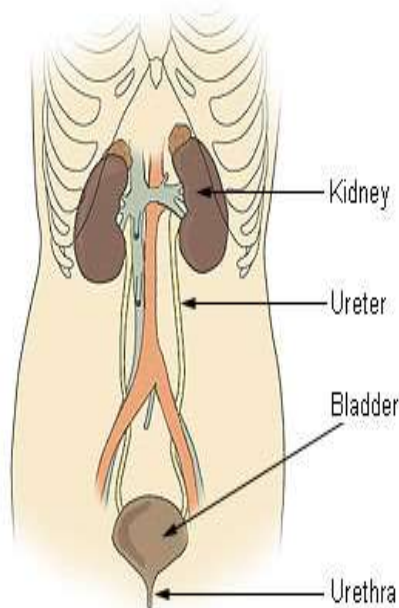
frequently affected than the female. The incidence is still higher in the age group between 30-45 years and incidence declines after age of 50. Changing your diet and using medications can be good ways to stop stones from forming. This guide will go over how stones are diagnosed and treated, and how they can be prevented

Urine contains many dissolved minerals and salts. When urine has high levels of these minerals and salts, it can form stones. Kidney stones can start small but can grow larger in size, even filling the inner hollow structures of the kidney. Some stones stay in the kidney, and do not cause any problems. Sometimes, the kidney stone can travel down the ureter, the tube between the kidney and the bladder. If the stone reaches the bladder, it can be passed out of the body in urine. If the stone becomes lodged in the ureter, it blocks the urine flow from that kidney and causes pain

Anatomy of urinary system

The urinary tract system consists of the kidneys, ureters, bladder and urethra. The kidneys are two bean-shaped organs located below the ribs toward middle of the back. The kidneys remove extra water and wastes from the blood, converting it to urine. They also keep a stable balance of salts and other substances in the blood. Narrow tubes called ureters carry urine from the kidneys to the bladder, a triangle-shaped chamber in the lower abdomen. Like a balloon, the bladder's elastic walls stretch and expand to store urine. They flatten together when urine is emptied through the urethra to outside the body

Components of the Urinary System



Functions of kidney and urinary system

The kidneys are fist-size organs that handle the body's fluid and chemical levels. Most people have two kidneys, one on each side of the spine behind the liver, stomach, pancreas and intestines. Healthy kidneys clean waste from the blood and remove it in the urine. They control the levels of sodium, potassium and calcium in the blood. The kidneys, ureters and bladder are part of your urinary tract. The urinary tract makes, transports, and stores urine in the body. The kidneys make urine from water and your body's waste. The urine then travels down the ureters into the bladder, where it is stored. Urine leaves your body through the urethra. Kidney stones form in the kidney. Some stones move from the kidney into the ureter. The ureters are tubes leading from the kidneys to the bladder. If a stone leaves the kidney and gets stuck in the ureter, it is called a ureteral stone.

Pathophysiology of Urinary Stone

The stone formation requires supersaturated urine. Super-saturation also depends on urinary pH, ionic strength, solute concentration and complexations. Three conditions must coexist for the formation of Struvite calculi:

- Alkaline urine
- The presence of urea or ammonia in the urine
- Higher concentration of minerals in the urine

Urine from healthy humans consists of a large quantity of nitrogenous compounds, including 0.5 M urea as well as inorganic ions. Urine is neutral to slightly acidic, and under these conditions, ammonia becomes protonated with the concomitant generation of hydroxide, which increases urine pH. The alkaline pH causes the precipitation of normally soluble polyvalent cations and anions in urine, leading to the formation of urinary stones.

Kidney stones contain calcium, oxalate, phosphate, magnesium, uric acid and the formation of urinary calculi involves a crystallization process, which includes the followings:

- Nucleation
- Growth
- Aggregation of crystals

Stone formation may be either homogeneous (where the nucleus of stone around which crystals aggregate is the same material as that of the crystal) or heterogeneous.

Nucleation

Nucleation is the formation of a solid crystal phase in a solution. It is an essential step in stone formation. The term super saturation refers to a solution that contains more of the dissolved material than could be dissolved by the solvent under normal circumstances. The point at which saturation of a solution is reached and crystallization begins is commonly known as thermodynamic solubility product (K_{sp}). Urine contains inhibitors of crystallization and can hold large concentrations of solute above the K_{sp} , a metastable state. If the concentration of solute increases further and a point is reached where it cannot be held in solution, this concentration is known as K_F , which is the point of formation of product in urine. The process of nucleation in a pure solution is known as homogeneous nucleation. In secondary nucleation, new crystals deposit on pre-existing crystal surface of similar type. Secondary nucleation results in the mass production of crystals. Epitaxy is a process where by material of one crystal type is precipitated upon the surface of another whose lattice dimensions are almost identical. Epitaxy is clinically important in the formation of calcium oxalate stones. These two processes are closely related to heterogenous nucleation.

Growth

After nucleation, crystal growth is the next major step of stone formation. The driving force of crystallization is a reduction in potential energy of the atoms or molecules when they form bond to each other. Crystal growth is determined by molecular size and shape of the molecule, physical properties of the material, super saturated solution level, pH and defects that may form in the crystals structure. Crystal growth is one of the prerequisites for particle formation.

Aggregation

In this process, crystals in solution stick together and form a large particle. Aggregation of particles in solution is determined by a balance of forces, some with aggregating effects and some with disaggregating effects. A small inter-particle distance increases attractive force and favours the particle aggregation. Furthermore, aggregate may be stabilized by solid bridges formed by crystalline material connecting two particles. The main force that inhibits aggregation is the repulsive electrostatic surface crystal known as Zeta potential. In various steps of stone formation, crystal aggregation is a more important factor than nucleation and growth since aggregation occurs within seconds.

Signs and symptoms of kidney stones

RENAL CALCULI

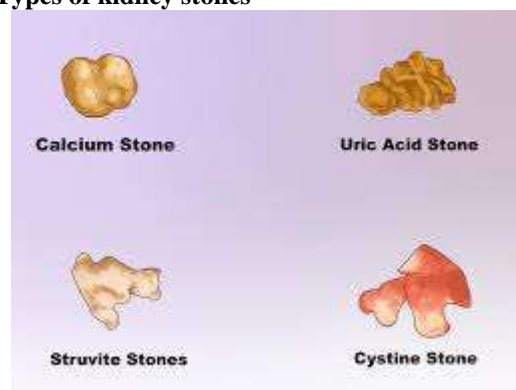


Stones in the kidney often do not cause any symptoms and can go undiagnosed. When a stone leaves the kidney, it travels to the bladder through the ureter. Often the stone can become lodged in the ureter. When the stone blocks the flow of urine out of the kidney, it can cause the kidney to swell (hydronephrosis), often causing a lot of pain.

Common symptoms of kidney stones are:

- A sharp, cramping pain in the back and side, often moving to the lower abdomen or groin. Some women say the pain is worse than childbirth labor pains. The pain often starts suddenly and comes in waves. It can come and go as the body tries to get rid of the stone.
- A feeling of intense need to urinate .
- Urinating more often or a burning feeling during urination.
- Urine that is dark or red due to blood . Sometimes urine has only small amounts of red blood cells that can't be seen with the naked eye.
- Nausea and vomiting.
- Men may feel pain at the tip of their penis

Types of kidney stones



Kidney stones come in many different types and colors. How you treat them and stop new stones from forming depends on what type of stone you have.

1. Calcium stones (80 percent of stones)

Calcium stones are the most common type of kidney stone. There are two types of calcium stones: calcium oxalate and calcium phosphate. Calcium oxalate is by far the most common type of calcium stone. Some people have too much calcium in their urine, raising their risk of calcium stones. Even with normal amounts of calcium in the urine, calcium stones may form for other reasons.

2. **Uric acid stones** (5–10 percent of stones)

Uric acid is a waste product that comes from chemical changes in the body. Uric acid crystals do not dissolve well in acidic urine and instead will form a uric acid stone. Having acidic urine may come from:

- Being overweight
- Chronic diarrhea
- Type 2 diabetes (high blood sugar)
- Gout
- A diet that is high in animal protein and low in fruits and vegetables

3. **Struvite/infection stones** (10 percent of stones)

Struvite stones are not a common type of stone. These stones are related to chronic urinary tract infections (UTIs). Some bacteria make the urine less acidic and more basic or alkaline. Magnesium ammonium phosphate (struvite) stones form in alkaline urine. These stones are often large, with branches, and they often grow very fast. People who get chronic UTIs, such as those with long-term tubes in their kidneys or bladders, or people with poor bladder emptying due to neurologic disorders (paralysis, multiple sclerosis, and spina bifida) are at the highest risk for developing these stones.

4. **Cystine stones** (less than 1 percent of stones)

Cystine is an amino acid that is in certain foods; it is one of the building blocks of protein. Cystinuria (too much cystine in the urine) is a rare, inherited metabolic disorder. It is when the kidneys do not reabsorb cystine from the urine. When high amounts of cystine are in the urine, it causes stones to form. Cystine stones often start to form in childhood.

Causes of kidney stones

▪ **Low urine volume**

A major risk factor for kidney stones is constant low urine volume. Low urine volume may come from dehydration (loss of body fluids) from hard exercise, working or living in a hot place, or not drinking enough fluids. When urine volume is low, urine is concentrated and dark in color. Concentrated urine means there is less fluid to keep salts dissolved. Increasing fluid intake will dilute the salts in your urine. By doing this, you may reduce your risk of stones forming. Adults who form stones should drink enough fluid to make at least 2.5 liters (2/3 gallon) of urine every day. On average, this will take about 3 liters (100 ounces) of fluid intake per day. While water is likely the best fluid to drink, what matters most is getting enough fluid.

▪ **Diet**

Diet can also affect the chance of forming a stone. One of the more common causes of calcium kidney stones is high levels of calcium in the urine. High urine calcium levels may be due to the way your body handles calcium. It is not always due to how much calcium you eat. Lowering the amount of calcium in your diet rarely stops stones from forming. Studies have shown that restricting dietary calcium can be bad for bone health and may increase kidney stone risk. Health care providers usually do not tell people to limit dietary calcium in order to lower urine calcium. But calcium intake should not be too high. Instead of lowering dietary calcium intake, your health care provider may try to reduce your urine calcium level by decreasing your sodium (salt) intake. Too much salt in the diet is a risk factor for calcium stones. This is because too much salt is passing into the urine, keeping calcium from being reabsorbed from the urine and into the blood. Reducing salt in the diet lowers urine calcium, making it less likely for calcium stones to form. Because oxalate is a component of the most common type of kidney stone (calcium oxalate), eating foods rich in oxalate can raise your risk of forming these stones.

A diet high in animal protein, such as beef, fish, chicken and pork, can raise the acid levels in the body and in the urine. High acid levels make it easier for calcium oxalate and uric acid stones to form. The breakdown of meat into uric acid also raises the chance that both calcium and uric acid stones will form.

▪ **Bowel conditions**

Certain bowel conditions that cause diarrhea (such as Crohn's Disease or ulcerative colitis) or surgeries (such as gastric bypass surgery) can raise the risk of forming calcium oxalate kidney stones. Diarrhea may result in loss of large amounts of fluid from the body, lowering urine volume. Your body may also absorb excessive oxalate from the intestine, resulting in more oxalate in your urine. Both low urine volume and high levels of urine oxalate can help to cause calcium oxalate kidney stone formation.

▪ **Obesity**

Obesity is a risk factor for stones. Obesity may change the acid levels in the urine, leading to stone formation.

▪ **Medical conditions**

Some medical conditions have an increased risk of kidney stones. Abnormal growth of one or more of the parathyroid glands, which control calcium metabolism, can cause high

calcium levels in the blood and urine. This can lead to kidney stones. Another condition called distal renal tubular acidosis, in which there is acid build-up in the body, can raise the risk of calcium phosphate kidney stones. Some rare, inherited disorders can also make certain types of stones more likely. Examples include cystinuria, which is too much of the amino acid cystine in the urine, and primary hyperoxaluria, in which the liver makes too much oxalate.

▪ Medication

Some medications, and calcium and vitamin C supplements, may increase your risk of forming stones. Be sure to tell your health care provider all the medications and supplements you take, as these could affect your risk of stone formation. Do not stop taking any of these unless your health care provider tells you to do so.

▪ Family history

The chance of having kidney stones is much higher if you have a family history of stones, such as a parent or sibling.

Diagnosis of kidney stones

“Silent” kidney stones, those that cause no symptoms, are often found when an X-ray is taken during a health exam. Other people have their stones diagnosed when sudden pain occurs while the stone is passing, and medical attention is needed. When a person has blood in the urine (hematuria) or sudden abdominal or side pain, tests like an ultrasound or a CT scan may diagnose a stone. These imaging tests tell the health care provider how big the stone is and where it is located.

A CT scan is often used in the ER when a stone is suspected. It is used because it can make a quick and exact diagnosis.

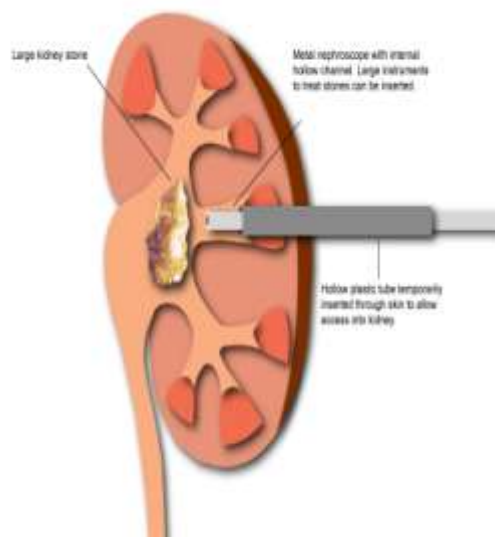
Abdominal ultrasound also gives information about the size and location of kidney stone

Treatment of kidney stones:

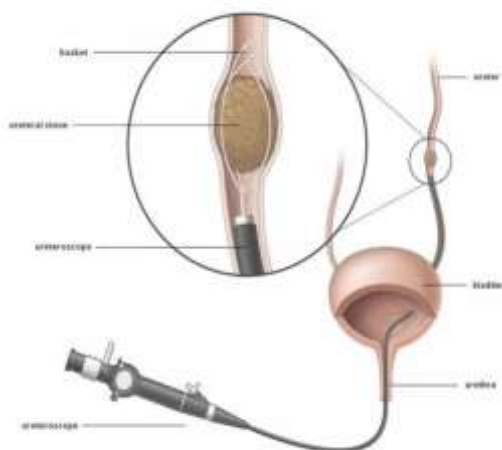
The treatment and removal of renal calculi is often dependant upon the composition and hardness of the stone as well as stone size and placement in the urinary tract. Though the main components of renal stones tend to be calcium oxalate, calcium phosphate (hydroxylapatite) and uric acid, calculi with up to 82 components have been previously analyzed. Treatment options vary depending on the placement of stone in renal system. The most preferable and least invasive

treatment is, of course, natural passing, though this option is often the most uncomfortable for the patient. The option of natural passing is dictated by the size of renal stone, since blockage of urethra will occur with renal stones larger than approximately 6 mm in diameter. Intractable renal stones are treated through several different techniques, two of the well-known methods being extracorporeal shockwave lithotripsy (ESWL) and surgical removal. Unfortunately, ESWL causes renal tissue trauma and hemorrhaging with virtually every treatment, while surgical methods are invasive and require longer recovery times. Extracorporeal shockwave lithotripsy (ESWL), commonly known as lithotripsy is a technique that uses shock waves produced outside the body to hit and break up the stones so that they can pass out of the body.

Percutaneous nephrolithotripsy (the shattering of stones) and **percutaneous nephrolithotomy** (the removal of stones) involve the insertion of a narrow endoscope through back of the patient into the kidney in order to break up or remove the stone, respectively. This procedure is often used when ESWL has failed and is usually attempted prior to open surgery, which is considered a last resort.



Ureteroscopy is similar to percutaneous nephrolithotomy, but in this case, the endoscope is inserted through the urethra instead of through back of the patient.



There are recent concerns as to the long-term side effects of lithotripsy and the damage caused to the renal system. Current research indicates that in addition to soft tissue damage, the development of brushite renal stones is directly related to the treatment by ESWL, where HAP, COM, or UA stones are removed but brushite stones are formed in their place.

In addition to surgical management of the problem, there are certain drugs and other conventional therapies, which are recommended for its control. A few numbers of drugs and some dietary measures have been shown in randomized trials to reduce the rate of stone recurrence. Indeed, a meta-analysis of randomized medical therapy trials showed a 22.6% risk reduction in stone recurrence rates with the initiation of drug and dietary therapy.

Besides, these treatments cause undesirable side effects such as hemorrhage, hypertension, tubular necrosis and subsequent fibrosis of the kidney leading to cell injury and recurrence of renal stone formation. The kidney stone forming patients are prone to its recurrence even after its surgical removal. Recurrence rates are close to 50%, and the cost of urolithiasis to individuals and society is high. Urinary stone is characterized by high recurrence rate, therefore, requiring a preventive treatment by using medicinal plants or phytotherapy. From the above facts, it is clear that there is a need to study herbal plants for the treatment of urinary stones. Moreover, it is also beneficial for human beings for its efficacy, safety and quality.

Herbal therapy

Existence and survival of man is impossible without plant kingdom since plants are the primary procedure and play vital role in sustaining life on earth. Man has used higher plants as a source of drugs to combat diseases since ancient times. Our indigenous systems of medicine namely Ayurveda, Siddha and Unnani have been in existence for several countries. The traditional systems of medicines and the folk fore of various countries depend on medicinal plants for their medicinal preparations. According to WHO estimate, 80% population living in developing countries almost exclusively uses herbal medicines. This means that 3330 million people use medicinal plants on regular basis. Herbal medicines are in great demand in the developed world for primary health care because of their efficacy, safety, lesser side effects and better compatibility with human body. In the traditional systems of medicine, most of the remedies for kidney stone management were taken from plants and they were proved useful, though the rationale behind their use is not well established through systematic pharmacological and clinical studies except for some composite herbal drugs and plants.

There are several options available in the management of ureteral stones. Treatment selection depends on stone size, location and composition, efficacy of each modality and associated morbidity, equipment available, physician skill, patient health and preference and finally costs.

These treatments are relatively costly, painful and require expert hands and availability of appropriate equipments. This has given rise to stimulation in the search for investigating natural resources showing antiurolithiatic activity. In spite of tremendous advances in the field of medicine, there is no truly satisfactory drug for the treatment of renal calculi. Most patients still have to undergo surgery to be rid of this painful disease. Ayurveda, an indigenous system of Indian medicine, offers vast scope for successful treatment of urolithiasis.

Plants and other natural substances have been used as the rich source of medicine. All ancient civilizations have documented medicinal uses of plant in their own ethnobotanical texts. The list of drugs obtained from plant source is fairly extensive. Many remedies have been employed during the ages to treat urolithiasis. Most of the remedies were taken from plants and proved useful, though the rationale behind their use is not scientifically established except for a few plants and some proprietary composite herbal drugs.



Challenges and Future Aspects of Herbals Plants for Urinary Stone Today

Herbals plants are very important for the growth of new drugs for the treatment of urinary stones. People are using herbal drugs because of its safety, efficacy and lesser side effects. Plants and their products have been utilized with varying success to cure and prevent kidney diseases. At present, demand of naturally derived plants products is increasing day by day in global countries. The significance of medicinal plants in national economy and its potential for the rapid growth of herbal products have been emphasizing frequently. At this moment, scientific research on medicinal plants is being carried out most intensely in research institutes, universities and pharmaceutical laboratories as well as in the clinics of many developed countries. This research is oriented mainly in two directions. Firstly, the active ingredients of plants that have long been known for their healing properties are investigated. The second sphere of basic research is directed towards the discovery of new kinds of medicinal plants and new drugs from the more remote regions of the world, which have not been explored so far. Drugs of each traditional medicine, like Ayurveda, Unani and Siddha need to be tested and validated scientifically. Council for Scientific and Industrial Research (CSIR), New Delhi is already involved in this field and validated about 350 formulations for different activities. This is a welcome trend since it attempts to marry traditional practice with modern knowledge for the betterment of health. WHO has emphasized the need to ensure the quality control of herbs and herbal formulations using modern techniques. Several countries have herbal pharmacopoeias and lay down monographs to maintain their quality. Ayurvedic Pharmacopoeia of India recommends basic quality parameters for 80 common herbal drugs.

II. CONCLUSION

Urinary stone is characterized by its high recurrence rate if patients are not treated appropriately. The treatments used are extracorporeal shock wave lithotripsy (ESWL) and drug treatment. Even improved and beside the high cost that imposes, compelling data, now suggest that exposure to shock waves in therapeutic doses may cause renal injury, decrease in renal function and an increase in stone recurrence. In addition, persistent residual stone fragments and possibility of infection after ESWL represent a serious problem in the treatment of stones. Drug treatment

has shown some feasibility in many randomized trials, it is not accomplished without side effect, which is sometimes very serious. Therefore, it is worthwhile to look for an alternative to these means by using medicinal plants or phytotherapy. So far the urinary stones are concerned, acupuncture, herbal medicine, natural products and homeopathy have been used to treat and/or to alleviate symptoms of kidney stone patients. Concerning herbal medicines, there is a large number of species described in many pharmacopoeias of several countries in the world as remedies of urolithiasis. Herbal medicines play a significantly benefits for the treatment of urinary stones because of efficacy, safety, lesser side effects and better compatibility with human body. The undesirable effect of modern medicine has already diverted the attention of people towards herbal medicines. To increase the acceptability and awareness among the people, there is an urgent need to develop trust and faith towards the safer indigenous system by establishing its validity in treatment for various diseases. Health care systems are going to become more and more expensive. Therefore, herbal medicine systems should be introduced in health care centers. It is expected that in future, natural products will be competing modern medicines with added advantages of more safety and lower costs.

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