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A Review of Kidney Stone and Its Risk Factors Along With Diagnostic Methods.

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ABSTRACT

Kidney stone is a piece of solid material produced inside kidney besides urine constituents. Big stones can block urethra, bladder or urinary track. This could block and prevent the excretion of urine. Generally speaking, there are 4 types of kidney stones. The most prevalent type contains calcium. In the majority of people, kidney is capable of washing out extra calcium in urine. In some others, however, calcium would sediment inside kidneys. This calcium is then mixed with other compounds and, therefore, forms stones. Struvite stones are secondary to Urinary Tract Infections (UTIs). They contain magnesium and ammonia. Uric acid stones are created especially when urine is over-acidic. In case such stones are formed, patient is advised not to consume meat. Cysteine stones which are very rare. Cysteine is primarily produced in muscles and some other organs naturally. This molecule can also be accumulated in urine and can form a stone. A disease which could make cysteine stones is usually of a family type. Kidney stones could be as little as sand. Occasionally, they grow as big as a Ping-Pong ball. Stones can be either smooth or unsmooth. They are often yellow or brown in color. If there is a stone which cannot be excreted by itself, then the physician takes a series of gradual steps to force it to be finally excreted. In the past, the only way of getting rid of stones was surgery. Today, however, there are other ways requiring no surgery. They include ESWL and a particular surgical method which has the least side effects. Urine or blood test can help to identify the type of stone. For the former, urine should be collected within 24 hours' time. The therapeutic method the physician uses to treat the stone depends on the stone type. Therefore, for an effective treatment, there is a need for a precise testing and analysis of the stone. A daily consumption of 12 glasses of water helps to wash the contents of urine and prevent their sedimentation. Moreover, lime juice or fruit juice can be used. But water is the most effective of all. Attempt should be made to cut down on consuming tea or coffee.

Keywords: kidney stone, calcium, urine, UTI

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INTRODUCTION

Generally speaking, the occurrence of kidney stone in the world especially among women is on the rise. It is also positively correlated with age [1]. Kidney stones are correlated with kidney chronic diseases. Preventing stone recurrence is to a great extent dependent on the primary stone type [e.g. calcium oxalate stones, calcium phosphate, cysteine, Struvite (ammonium magnesium phosphate) or uric acid] [2]. Nevertheless, even when the analysis of the stone is not possible, urine pH and a 24-hour urine examination would provide the required information about the factors involved in stone formation [3]. Such information is useful in preventing stone recurrence. Such drugs as protease inhibitors, antibiotics and some diuretics increase the probability of creating some types of kidney stone [4, 5]. Therefore, patients should get informed about the probable hazards of taking these drugs. Adjustment of diet, drugs and supplements can help to prevent stone formation [5]. Obesity would increase the probability of kidney stone formation. Nevertheless, if loss of weight is accompanied by a diet rich with high loads of animal protein, abusing laxatives, rapid loss of fatless tissues or inadequate intake of liquids, it will not prevent kidney stone formation [6]. In order to prevent the formation of oxalate calcium stones, cysteine and uric acid, urine should become alkaline with the help of a diet rich with fruits and vegetables, consuming citrate supplements prescribed by a physician or drinking alkaline mineral water [7]. In order to stop the formation of calcium phosphate and Struvite stones, urine should become acidic. Today in the treatment of acute kidney stone, besides fluid therapy and pain controlling drugs, they take an ever-increasing advantage of anti-spasm drugs, ureteroscopy and metabolic tests [2, 8].

The prevalence of nephrolithiasis (kidney stone) among women rises with an increase of age. The probability of affliction with kidney stone in the U.S. has been estimated to be 10-15. And this rate is still growing [2]. Risk factors involved in the formation of kidney stones are: obesity, resistance to insulin, intestine inflammatory diseases, living in hot areas, dehydration, specific drugs, urinary infections and particular nutritional diets [3].

Kidney stone

Kidneys purify blood through taking out extra amounts of sodium (salt) and other waste materials soluble in water. Saturation and density of urine would sediment its content in kidneys. Therefore, a kidney stone is formed that is not soluble in urine [9]. The insoluble constituents gather together and form a hard stone. Acidic or alkali urine *does* also lead to stone formation. The majority of patients afflicted with kidney stone are at the outset of puberty [10]. The maximal age for the prevalence of kidney stone is about 28 years. The other age peak is 55 years of age which is usually specific to women's infectious stones. Broadly speaking, kidney stones in men are 4 times as high as women. If we only consider infectious stones, the ratio of male to female is 2 to 3 [7].

Kidney stone is often formed in kidneys. But it can also occur anywhere related to urine for example in ureters that are joined to bladder [8, 10].

Stones can differ in size. 80% of them are less than 2 centimeters wide. If a stone is too small, it might be unobservable and could be excreted by itself. Sometimes due to excessive growth, it is not excreted easily. Sometimes it has sharp and rigid edges which makes it hard or painful to be excreted. In color, they are yellow or brown [9].

About 80% of stones are made of calcium mixed with other elements. Stones are of calcium and oxalate type but most of them are made of calcium carbonate. Other types include Struvite, oxalate, cysteine and uric acidic. Stones are observed inside hydronephrosis, ureter, bladder and urinary tract [11]. The following are involved in stone formation: a diet rich with calcium, sodium and protein, inactiveness of people afflicted with type-II hypercalciuria, affliction with metabolic diseases such as intestine inflammation or ileostomy, a background of affliction with urinary infection and gout [9, 10].

Symptoms

Symptoms appear only when the stone is moved. They mainly involve severe pain similar to that of a childbirth [initially it is weak and gradually it gets strong]. The sore area is below abdomen and might be extended to hips too [12]. An acute pain is usually the result of a stone blocking the urinary tract. Otherwise,

the stone itself possesses no sign [5]. Within a few hours or days, the pain begins to move along with the movement of stone from uteri to hips. Once the stone is excreted, all pain is gone too. Stones residing in hydronephrosis mostly occur in one's back and sides. Ureters' pains can reach McBurney's area. In men, it can even reach the penis and scrotum [12]. In women it can reach their major labia. Even in a big size, kidney stones could show to have no symptoms. However, these stones would increase the risk of bladder malignancy. Therefore, these stones need to be taken into great care [11].

The pain would start slowly at the back and pelvis. This could be the primary symptom. It can be constant or colic. Hardly ever is the pain entirely gone [13].

Besides a backache, patients feel fatigue too. Fever can also accompany as well as severe nausea and vomiting. Patient might also suffer from dysuria, urinary frequency, urine discoloration and even hematuria. Some patients may suffer from dribbling, urinary hesitancy or retention [9, 11].

Underlying factors of kidney stone

1. Inactiveness: one underlying factor for the occurrence of kidney stone is lack of activity. It usually occurs during an illness or disability. It could lead to a further reduction of calcium in bones and an increase in its concentration in urine [8].
2. Hyperthyroidism: primary hyperthyroidism would lead to an excessive calcium excretion. About two-third of people who suffer from an illness in endocrine glands get afflicted with kidney stone too. Nevertheless, this disorder would only comprise 5% of calcium stones [14].
3. Renal tubular acidosis: It is considered as one underlying factor for the occurrence of kidney stones. It is created as a result of ammonia production in kidneys and an excessive excretion of calcium.
4. Excessive consumption of salt: according to research findings, an excessive consumption of salt would increase calcium excretion in urine [15].
5. Increased urinary calcium due to unknown reasons: some individuals consume less calcium in their diet but yet excrete up to a daily amount of 500 milligrams of calcium for unknown reasons [7, 12].
6. Increased oxalate in urine: about half of calcium stones are attached to this compound. Naturally, oxalate exists in only a few foods including spinach, cocoa and vitamin C. body's access to oxalate depends on the degree of in-take and excretion which is not the same in all people [14].
7. Animal protein: a diet rich with protein is followed by an increased calcium, oxalate and urate excretion. In fact an excessive consumption of animal protein with its acidic load would raise calcium excretion. Therefore, some researchers prescribe vegetarian diets to those prone to kidney stones [5, 16].
8. Dietary fiber: an increased dietary fiber would decrease underlying risk factors of stone formation especially calcium stones [10].

A number of diseases such as pancreas failure, intestine surgery, Crohn's disease, hyperthyroidism, sarcoidosis, and even diabetes are accompanied by an increased kidney stone formation. Gout, chronic urinary infections and anomalies of excretory system are also followed by a raised stone formation [11, 15].

Prevention:

A daily consumption of about 3 liters of liquids especially water and so much perspiration can, to a great extent, stop the formation of urinary stones. Diet adjustment, use of supplements and drugs are steps taken to prevent stone formation depending on stone type and patient's urinary traits. A number of general aspects which help to prevent kidney stone formation are introduced in the following [15].

Diagnosis

The first assessment in a patient suspected of kidney stone is urine test in terms of (non) existence of blood in it. Urine sample cultivation is essential if the patient has had a fever or white globules have been found in his/her urine. Sometimes diagnosis is made through observing the stone in a simple abdominal radiography [13]. Uric acid stones and those pertaining to the consumption of protease in radiography are not observable. Sonography or spiral CT can detect all types of kidney stones. If the diagnosis is not yet definite, they should be conducted [1].

In case there is more than one stone, the patient has a fever. His/her kidney begins to malfunction and stone excretion is delayed. Hydronephrosis diagnosis is done through radiography[17]. If the patient is pregnant or the diameter of the stone is more than 5 millimeters, the patient needs to visit a urologist. 90% of smaller stones are automatically excreted. In order to take out the stone and assess the changes which have occurred in the epithelium tissue, arthroscopy is used [16].

KUB radiography

This method is used to obtain an image of kidneys, ureters and bladder in terms of the presence/absence of a stone[17].

Sonography

In this method, ultrasonic rays are used along with computer-based processing to examine internal organs such as kidneys, urinary tract and bladder. This method is absolutely safe, painless and non-aggressive. However, little stones might not be diagnosed in this method[18].

IVU [Intravenous Uretrogram]

This test helps the physician to look for stones not detectable in a simple X-ray radiography. Once the contrast agent is injected into arm veins, in certain intervals while this agent is excreted gradually, X ray is used to provide images which help to examine the size and location of kidneys, urinary tract and [non]existence of stone. In case anything unnatural is detected, then the doctor might ask for a CT scan for further evaluation [14].

CT scan

Spiral CT scan helps to provide a proper image from all sides of kidneys and uterus.

Simple urine test

This test serves the purpose of examining the pH of urine, existence of red globules in urine, existence of crystals in urine and urinary infections [18].

Kidney stone treatment

Oral fluid therapy (ORT) and pain control are part of an acute treatment of all kidney stones. In the case of stones whose diameter is less than 10 millimeters, anti-spasm drugs are used such as calcium channel blockers and alpha-blockers [1]. These can help to loosen the straight muscle of ureters. They have proved to speed up stone excretion for 5-7 days. Patients who are unable to take oral drugs or liquids, or those who have low blood pressure and other primary symptoms of hemodynamic instability need intravenous treatment[8]. If there is any evidence of infection (e.g. fever or pyuria), empiric antibiotics which cover gram-negative bacillus [e.g. enterobacteriaceae types] and gram-positive cocci [e.g. staphylococcus and enterococcus] should be added to their primary treatment according to local resistance patterns. If the radiological evidence shows urinary blockage [hydronephrosis] the patient should immediately visit a urologist [16, 19].

As for bigger stones which are not naturally excreted and cause side effects, infection or sharp pain, there is a need for medical steps taken in order to remove them[20]. Different therapeutic methods are: solving the stone chemically, removing stone through endoscopy, removing it through skin, breaking stone using ultrasonic rays outside the body (ESWL), rare cases of open surgery and other new therapies which are yet being developed [18].

Stones produced due to an overload of calcium in body might require a surgery on the unnatural parathyroid tissue.

CONCLUSION

Kidney stone often afflicts adults above 30 years of age in both sexes. It is, however, more common among white male above 40 years of age as compared to all other groups [21]. In women, the affliction risk is raised after 50 years of age. Moreover, if there is a family background of kidney stone, the affliction risk is raised [20]. The probability of forming a stone made of calcium phosphate is two times as high in pregnant women than non-pregnant women of the same age [6]. High rate of stone formation among children is due to an increased diabetes, obesity and high blood pressure. Considering the fact that rising age is a key risk factor of stone formation, the probability of stone formation is higher in teenagers than children [19].

Sharp and intermittent pains with intervals of a few minutes usually occur at the back and lower ribs. Within a few hours or days, the sore area would follow a track from ureter to hips. Once the stone is excreted, the pain is stopped. Another symptom of kidney stone is recurrent nausea [21].

Excretion of a little blood in urine is another symptom of kidney stone. Urine can become unclear or dark in color.

In inquiring about patient's medical background those diseases which usually increase the probability of kidney stone formation should be included, e.g.: intestine inflammatory disease, intestine surgery, gout, diabetes, obesity, recent weight change, metabolic syndromes, diseases concomitant with hyperparathyroidism, recurrent urinary infections, kidney chronic diseases. Patient's family background in terms of the disease should be investigated too [22].

In patient's medical description, these issues should be taken into account: time relationship of the drugs taken, drugs which have recently been given up, taking drugs for unapproved reasons, taking herbal medication and supplements and screening for illegal drugs [20]. Through various mechanisms, these drugs play a role in stone formation: forming urinary crystals, modifying urine traits (pH or loss of urine weight) [6]. As an instance, carbonic anhydrase inhibitors are involved in forming calcium phosphate stones through: creating a mild systematic acidosis, raising urine pH, raising calcium excretion through urine, and decreasing urine citrate. Some antibiotics increase urine oxalate through decreasing intestinal oxalate bacterium analyzers [13, 21].

Treatment and prevention are to a great extent dependent on stone type. Nevertheless, in the majority of cases despite a complete collection of urine, stones are not accessible [20]. With regard to an increasing prevalence and occurrence of kidney stone and kidney chronic diseases, further evaluations are needed after the first kidney stone attack in all patients. Risk factors of kidney stone are accessible even after excretion through urine and blood assessment [22].

Kidney stone is a risk factor of kidney chronic diseases and advancement to a final phase (ESRD). In people who have a kidney stone, the probability of common and uncommon risk factors are higher [6]. Examples of the former include: black race, previous kidney disease, diabetes, proteinuria and albuminuria. Instances of the latter are: interstitial nephritis, chronic pyelonephritis and female gender [22]. If the glomerular purification level is equal or less than 60 milliliter per minute for each 1.73 squared meter of body level [third phase of kidney chronic disease] or if there is a micro albuminuria, as suggested by the U.S. association of nephrology, patient should visit a nephrologist [19].

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