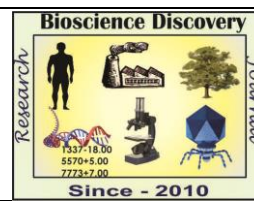


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Research Article



Role of Diet in Formation of Calcium Containing Renal Stone

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Abstract

Urine of most people is supersaturated with stone forming constituents, including calcium, oxalate, phosphate and uric acid. Crystals or foreign bodies can act as nuclei, upon which ions from the supersaturated urine form microscopic crystalline structures. The majority of urinary calculi contain calcium. Calcium stones occur when urine becomes supersaturated with calcium oxalate and phosphate. They form crystals that bind into hardened mineral deposits known as renal stones. The easiest way to manage renal stones is by having a diet that is balanced and proper for a particular age. People can prevent formation of renal stones by making some changes in their lifestyle and dietary habits. In this paper, we will summarize how diet impacts calcium renal stone formation and what diet should be preferred to manage calcium containing renal stones and lead a healthy life.

INTRODUCTION

Renal stones, also known as renal calculi (singular calculus) are the most common chronic disease of the urinary tract affecting about 10% of the global population. Kidney stones develop when some unwanted minerals start collecting in the urine and form crystals in the kidney, ureter or bladder. Upper tract stone disease is associated with affluent lifestyle and diets rich in animal protein while bladder stones are associated with poor socioeconomic status. Generally, the renal stone develops when the urine becomes overly saturated with certain microscopic substances. These substances form crystals that bind into hardened mineral deposits known as renal stones. Out of all these types of renal stones, Calcium stones are the most common type of renal stones. Approximately 85% of the stones in human are calcium stones comprising oxalate and phosphate either alone or combined (Moe, 2008). Calcium plays an essential role throughout the body. Key to the formation of teeth and bones, it's involved in transporting nerve impulses, contracting muscles and supporting other life-sustaining activities. Most individuals get their daily calcium requirements from a healthy diet,

abundant with dairy products, eggs, fish, fruits and green vegetables. Not all of the calcium is needed by the body. After a sufficient amount is absorbed, any excess is normally excreted by the kidneys and flushed out with urine. But in some patients, abnormally high levels collect in the urinary tract, triggering high calcium (hypercalciuria), the most common cause of calcium oxalate stones (Sakhaee, 2008). An excretion of greater than 300mg/24 hr in men and 250mg/24 hr in women has been termed as hypercalciuria. Calcium stones are formed as a result of a combination of various environmental factors like hot climatic conditions, continuous exposure to sunlight etc. and various metabolic abnormalities that change the concentration of ions present in the urine and increases supersaturation of stone-forming calcium salts in the urine.

The incidence of renal stone disease has increased in past two decades. The renal stone formation is a recurrent problem and around half of all people who previously had a kidney stone will develop another one within five years. The recurrence rate without preventive treatment is approximately 10% at 1 year, 33% at 5 years and 50% at 10 years (Coe *et al.*, 2005).

The various risk factors associated with renal stone disease are age, sex, occupation, climate, genetics, fluid intake, dietary intake, family history, hypertension, pregnancy, social class.

The easiest way to manage kidney stones is by taking a balanced diet that is appropriate for that particular age. This is because having a balanced diet would not only ensure all the key nutrients but also assures that one will have lesser chances of developing diseases such as kidney stones as these are directly linked with diet. Eating the right set of foods along with early diagnosis is very crucial in keeping away from kidney stones (Gupta Monika *et al.* , 2011). Kidney stone formers should pay lot of attention towards their diet as diet is one of the factors that can promote or inhibit kidney stone formation (Gupta Monika *et al.* 2012). Certain foods may promote stone formation in people who are at risk, but eating right set of food prevents them from the chances of stone formation. A variety of dietary factors have been associated with calcium stone formation, including low fluid intake, high calcium and low calcium diet, overindulgence in animal protein and excess intake of salt and oxalate-rich foods, refined carbohydrates, sodium, alcohol, caffeine, low urine citrate (Curhan *et al.*, 1993).

Role of Diet in Managing Calcium containing Renal Stones

One can prevent kidney stones by making some changes in their dietary factors i.e. fluid intake and depending on the type of kidney stone, changes in consumption of sodium, animal protein, calcium and oxalate, fiber- rich foods. Recommendations based on the specific type of kidney stone are described in this section.

Calcium- All patients with calcium stones should limit their dietary calcium intake. There is a linear relationship between dietary calcium intake and urinary calcium (Massey *et al.* ,1993). However, dietary calcium restriction may result in higher levels of urinary oxalate, believed to be caused by a decreased oxalate binding with calcium in the intestine. Hence reducing urinary calcium should be the purpose for stone formers, but not by means of dietary restriction (Curhan *et al.*, 1993). While reduced dietary calcium can decrease urine calcium, calcium restriction is no longer desirable for patients who form calcium kidney stones as it increases the risk of bone disease, namely osteoporosis (Gupta Monika *et al.* 2012). People who form calcium oxalate stones should include 800 mg of calcium in their diet every

day, not only for kidney stone prevention but also to maintain healthy bone density.

The type of calcium supplementation, whether from food or supplements, as well as the timing of calcium consumption i.e. with meals or between meals also influences urinary calcium and oxalate excretion. It is found that older women consuming calcium supplements were 20% more prone to form renal stones than those who did not, but that relationship does not hold true in younger women or men. Calcium citrate supplementation in non-stone forming post-menopausal women increased urinary calcium and citrate and reduced urinary oxalate and phosphate without a change in urinary saturation of calcium oxalate or phosphate, suggesting no increased risk of stone formation in healthy post-menopausal women. A high calcium intake may decrease the risk of stone formation in normal subjects or in stone formers with normal intestinal calcium absorption, in patients with absorptive hypercalciuria, normal calcium intake is desirable.

Fluids - The amount of fluid that each person requires to drink depends on the weather and the person's occupation and activity. People who work or exercise in hot climate need more fluid to replace the fluid they lose through sweat. The protective effect of a high fluid intake against stone formation has been attributed to the dilution of urine and hence prevention of crystallization of stone-forming salts in the urine. The risk of stone formation was found to be inversely proportional to fluid intake. If a person consumes enough amount of fluid, it can wash away toxins and flush them out from the body. Increasing fluid intake, especially water, is the simplest and most effective way of fighting kidney stones because it can help oneself to keep hydrated. The ideal water intake should be 8-10 glasses but since people with kidney stones need more to flush out salts and other minerals in the body, 10 to 12 glasses is recommended daily. Some studies suggest citrus drinks like lemonade and orange juice was associated with a reduction in urinary saturation of calcium oxalate stones because they contain citrate, an important inhibitor of calcium oxalate and phosphate stones (Wabner , 1993), which stops crystals from growing into stones. Grapefruit juice and dark colas have been found to increase the risk of stone formation and should be avoided by people who are prone to calcium oxalate stone formation.

Oxalates- Some of the oxalate in urine is made by the body. But eating certain foods with high levels of oxalate can increase the amount of oxalate in the urine, where it combines with calcium to form calcium oxalate stones. There is much less oxalate in the urine than calcium in the urine, urinary oxalate concentration is much more critical to the formation of calcium oxalate crystals than the urinary calcium concentration. Reducing urinary oxalates have a more powerful effect on stone formation than the reduction of urinary calcium (Zimmermann *et al.*, 2005). Patients with calcium oxalate stones should avoid foods high in oxalates. Vitamin C is pioneer to production of oxalates in our body endogenously, so it is recommended to avoid large doses of vitamin C. The main dietary sources of oxalate are green leafy vegetables, chocolate, rhubarb, nuts, wheat bran and tea. Avoiding these foods may help to lessen the amount of oxalate in the urine. Eating foods containing calcium also reduces oxalate in the urine because calcium binds oxalate in the digestive tract so it is not excreted into the urine (Holmes *et al.*, 2001).

Sodium - Sodium is an important dietary element influencing urolithiasis risk. An increase in dietary sodium intake has been associated with hypercalciuria (Ogawa Y, 1994). In addition to promoting hypercalciuria, dietary sodium intake influences calcium stone formation through promotion of epitaxial calcium oxalate crystal growth and reduction of urinary stone inhibitors. As a result, dietary sodium should be limited in those patients who are at risk for calcium stones because it increases the calcium levels present in the person's urine. Doctors advise people with calcium stones to cut down or totally get rid of sodium intake from the foods that they eat. This is because too much salt intake will not only make the condition more complicated but also cause other related diseases. Studies show that dietary sodium restriction in hypercalciuric stone formers has been shown to reduce urinary calcium (Muldowney *et al.*, 1982). Foods that contain high levels of sodium include hot dogs, canned soups and vegetables, processed frozen foods, fast food, baking soda etc. Limiting salt intake to 2400 mg or less is an important step for people having kidney stones. People who are trying to restrict their sodium intake should check labels for ingredients that contain hidden sodium, such as monosodium glutamate, sodium bicarbonate (baking soda), baking powder, which contains

sodium bicarbonate and other chemicals, disodium phosphate etc.

Fiber-rich foods - Fiber is considered advantageous to people with kidney stones because it contains several compounds generally phytate that safeguards the kidney against the formation of stones. People who are suffering from kidney stones and those who would want to be safe from it should increase their calcium intake coming from the foods they eat such as wheat, rice bran and soybeans as it contains a lot of fiber (Grases F *et al.*, 2000).

Proteins - A diet high in animal protein such as eggs and meat is associated with an increased risk of urinary stone formation as they contain purines which break down into uric acid in urine. Epidemiological studies relate a high socioeconomic status with stone formation attributable to diets high in protein (Giannini, 1999). The mechanism by which dietary protein increases the risk of calcium stones is complex and involves changes in calcium metabolism and other ions influencing calcium stone formation. Consumption of large amounts of dietary protein should be avoided in all patients with a history of calcium nephrolithiasis. Dietary protein intake not only increases the risk of calcium stones but also uric acid stones. The type of dietary protein may influence stone risk. The highest risk is associated with a diet high in animal protein i.e. by meats and eggs. Nondairy animal proteins may also increase the risk of calcium stones by increasing the excretion of calcium and reducing the excretion of citrate into the urine, an important inhibitor. Recommended intake of animal proteins for adults are 12 ounces per day.

Maintaining Weight -A relationship between weight, body mass index and risk of calcium oxalate stone formation was recognized in a retrospective study of health professionals (Curhan GC, 2004). Studies have shown that being overweight increases the risk of calcium containing kidney stones. Maintaining an ideal weight through healthy food choices and exercise may reduce the risk of kidney stones.

Conclusion

It is relatively difficult to dissolve calcium stones, and therefore an important aspect of patient management is the prevention of further development of calcium stones formation once stone has been removed. Diet plays a major role in the majority of patients with kidney stones. Eating right set of foods is very important in keeping

one's self away from kidney stones. Dietary modification can reduce and often prevent stone recurrences. A vegetarian diet that is rich in potassium, magnesium, citrate, and fiber and restricted in oxalate-rich foods, limited daily meat (protein) intake and salt intake together with an increased fluid intake can prevent or at least significantly reduce the recurrences of kidney stones in most patients.

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