Assessment of kidney stone and prevalence of its chemical compositions

A Pandeya,[1] R Prajapati,[2] P Panta,[3] and A Regmi,[4]

[1]Department of Biochemistry, [2]Department of Physiology, [3]Department of Community Medicine, Nepal Medical College, Jorpati Kathmandu, [4]Department of Biochemistry, National College for Advanced Learning , Kathmandu, Nepal

Corresponding author: Arun Pandeya, Department of Biochemistry, Nepal Medical College, Kathmandu, Nepal; e-mail: arnpandey@gmail.com

ABSTRACT

Kidney stone analysis is the test done on the stone which cause problems when they block the flow of urine through or out of the kidneys. The stones cause severe pain and are also associated with morbidity and renal damage. There is also no clear understanding on the relative metabolic composition of renal calculi. Hence, the study is aimed to find out the chemical composition of it which can guide treatment and give information that may prevent more stones from forming. The study was carried out on the stones that had been sent to the department of Biochemistry (n = 99; M = 61; F = 38; Mean age: 33.6±14.4 years) Approximately 98.9% of stones were composed of oxalate, 95.9% of Calcium, 85.8% of phosphate, 62.6% of Urate, 46.4% of Ammonium and very few percentages of Carbonate.

Keywords: Kidney stones, renal calculi, diet, pH, urinary tract.

INTRODUCTION

Kidney Stones also called a or urolith (nephrorefers to the kidney, urorefers to urine, and -lith means stone and the condition is known as nephrolithiasis or urolithiasis)or renal calculi, are the extra chemicals that are not flushed out of the system through urine and get collected in the kidneys. These collected solid accumulations/chemicals form crystals and harden into stones. The basis of formation of these accumulations is the change in the normal balance of water, salts, minerals, and other substances found in urine. The main factor that change urine balance is water, the deficiency of which causes stick together of the salts, minerals, and other substances in the urine forming a stone.[1] Stones cause problems when they block the flow of urine through or out of the kidneys. When the stones move along the ureter, they cause severe pain and are also associated with morbidity and renal damage. This study may reveal useful information about the chemical nature of kidney stone in our general population and possible association of urinary tract infection which will be helpful in adopting preventive strategies to minimize stone formation and their recurrence.

Kidney stones have multifactorial causes, but some predisposing conditions are: Environmental factors, especially diet[2,3] play an important role in expression of the tendency to stone formation.

Diet rich in oxalate or purines and high content of calcium in water can lead to excessive excretion of calcium, oxalate and uric acid in urine. Water deprivation causes stasis in the tubules and concentrates the solutes there. Absence of some dietary substances such as and citric acid can lead to excessive amounts of oxalate and phosphate. Some drugs such as are poorly soluble and may precipitate forming stones or become part of the stone matrix. Also some metabolic and genetic disorders may contribute to stone formation. Beside these, pH is one of the most potent causes for stone formation as most solutes are only soluble within a finite pH range, for example, phosphates and carbonates are insoluble at an alkaline pH. Uric acid and calcium oxalate are insoluble at an acidic pH.[4]

Eighty percent of patients with nephrolithiasis form calcium stones, most of which are composed primarily of calcium oxalate or, less often, calcium phosphate.[5,6] The other main types include uric acid, struvite (magnesium ammonium phosphate), and cystine stones. The same patient may have more than one type of stone concurrently (eg, calcium oxalate and uric acid). [6]

A person with a family history of kidney stones may be more likely to develop stones. Urinary tract infections, kidney disorders, certain metabolic disorders and people with renal tubular acidosis are also linked to develop kidney stones.

The first symptom of a kidney stone is extreme pain, which begins suddenly when a stone moves in the urinary tract and blocks the flow of urine causing a sharp, cramping pain in the back and side in the area of the kidney or in the lower abdomen and the pain may spread to the groin. Sometimes nausea and vomiting occur.[7]

MATERIALS AND METHODS

The study was carried out on 99 stone samples (61 males

Table-1: Prevalence of stones according to genders

Sex	Frequency	%
Males	61	61.6
Females	38	38.4
Total	99	100

and 38 females), that had been sent/ received to the Department of Biochemistry, Nepal Medical College, Kathmandu, Nepal, during the period of two years (2008- 2010). The age of subjects having stones were ranging from 5 to 72 years with the mean age of 33.

The stones were first examined for physical characteristics. Since the most stones are mixtures and may consists of several layers hence the stones were cut into two halves or were powdered for analysis of chemical compositions.[8]

Table-2: Prevalence of stones among different age groups

Age group	Males (%)	Females (%)	Total (%)
Up to 20	12 (80.0)	3 (20.0)	15 (15.1)
21-40	28 (53.8)	24 (46.1)	52 (52.5)
41-60	16 (64.0)	9 (36.0)	25 (25.2)
More than 61	1 (20.0)	4 (80.0)	5 (5.0)

RESULTS

A total of 99 kidney stones were analyzed in which male dominancy is seen among stone formers i.e. 61 are males (61.6%) and only 38 are females (38.4%) which is shown in Table-1. The highest number of cases, 52.5% of the total case is present in age group of 21-40 years followed by 25.2% in age group of 41-60 years. The least number of stone formers are present beyond their 60s, which is shown in Table-2. The composition of most of the stones analyzed were oxalate (98.9%) followed by uric acid (62.6%) as an organic constituents while as an inorganic constituents, stones were composed of calcium (95.9%), phosphate (85.8%), ammonium (46.4%) and very few number of stones were composed of carbonate (5.0%), which is shown in Table-3.

DISCUSSIONS

In present study, kidney stones were found to be more common in men than in women which is in accordance with the study by *Stapleton FB*[9] this may be because of the larger muscle mass of men as compared to women. Thus, the daily breakdown of the tissue results in increased metabolic waste and a predisposition of stone formation. The other more significant cause may be because of the male urinary tract being more complicated than the female urinary tract. The study showed the higher prevalence of stone formers ranging from 21- 40 years of their age which is supported by the study of Asplin *et al*.[10] However, some study have stated the increased prevalence of stones when men enter into their 40s and continues to rise into their 70s. For women, the prevalence peaks in their 50s.[7]

The study could not find the living standard of stone formers though stone formation depends upon the standards of living and is strongly associated with race or ethnicity.[11] The chemicals most commonly present in kidney stones included oxalate as an organic constituent whereas calcium and phosphate were present as inorganic constituents. Other compounds such as uric acid, ammonium and carbonate were also present as a constituent of stones.

Kidney stones result when urine becomes too concentrated and substances in the urine crystallize to form stones. Besides dietary factor, the most common cause of kidney stones is not drinking enough water. Excessive consumption of meat protein leads to a marked increase in kidney stones because meat causes the over acidification of urine causing the increased excretion of oxalate, calcium and uric acid, whereas the excretion of citrate - which provides protection against stone formation is decreased. Overly acidic urine is the main risk factor for the formation of uric acid stones.

Dietary oxalate contributes to about half of the urinary oxalate. Spinach, rhubarb, beets, chocolate, nuts, tea, wheat bran, strawberries, and soya foods are known to increase urinary oxalate concentrations.[12] Vitamin C supplementation may increase urinary oxalate excretion and the risk of calcium oxalate crystallisation in patients who form calcium stones[13] as oxalate is the oxidized product of vitamin C.

The main risk factors for calcium stones are a low volume of urine, increased excretion of oxalic acid and calcium and a deficiency of citrate, which inhibits crystallization in the urine. Also the sodium contained in common salt can increase the risk of stone formation, probably by increasing the urinary excretion of calcium.

Table-3: Chemical composition of stones and their valid percentage

Sex	Frequency	Organic constituents		Inorganic constituents			
		Oxalate	Uric acid	Calcium	Phosphate	Ammonium	Carbonate
Males	61	61	40	58	56	29	3
Females	38	37	22	37	29	17	2
Total (%)	99	98 (98.9)	62 (62.6)	95 (95.9)	85 (85.8)	46 (46.4)	5 (5.0)

Increased excretion of calcium results from impaired renal tubular reabsorbtion of calcium and increased bone resorption as a result of primary hyperparathyroidism.

The abundant form of phosphate in plants is phytate which forms insoluble complexes with calcium in the gastrointestinal tract and reduces calcium absorption and urinary calcium excretion, that consequently could reduce the risk of stone formation. However, this same action could result in increased oxalate absorption and urinary oxalate excretion, which would increase the risk of stone formation.[14]

Most kidney stones can pass through the urinary system with plenty of water—2 to 3 quarts a day—to help move the stone along, hence a simple and most important lifestyle change to prevent stones is to drink more liquids—water is the best. Someone who tends to form stones should try to drink enough liquids throughout the day. The basic pathophysiology of all stones is urinary super saturation with respect to the stone material, and treatment is based on decreasing or eliminating super saturation. Normal-Calcium, Low-Sodium, and Low-Animal-Protein Diets are recommended for Stone Prevention.

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