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Qualitative chemical analysis and incidence of renal stone disease in rural population of South Solapur, Maharashtra

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Abstract

Background: There are many reports regarding renal stone disease, which have documented that it is a complex disease process and widely distributed in developed as well as developing world with varied chemical constitution of these stones in relation to a varied risk factors. The present study was designed to qualitatively investigate the chemical constitution of the renal stones in the rural population of South Solapur, Maharashtra and also to study the dietary habits and water used for drinking purpose in renal stone patients.

Method: The study was conducted on a total of 130 renal stone patients, comprising 90 males and 40 females, selected from Ashwini Rural Medical College, Hospital and Research Centre, Kumbhari, Solapur, Maharashtra.

Results: The analysis of chemical composition of renal stones showed that all the analysed stones were of different types. Carbonate was predominantly present (96.1%) which was followed by uric acid (94.6%), calcium (92.3%), phosphate (83.8%), oxalate (52.3%), ammonia (44.6%) and cystine (23.0%). The relative frequency of urolithiasis was more (67.6%) in patients who used ground water for drinking purpose as well as in those with a non-vegetarian diet (73.8%).

Conclusion: The study concludes that simple qualitative chemical analysis helps us to evaluate chemical composition of renal stones and serves as a reliable diagnostic marker. Thus it can be useful in advising people for taking preventive measures.

Keywords: Renal stone disease, Chemical analysis, Dietary habits

Introduction

Among urinary disorders, stone formation is of paramount importance. The incidence of renal stones is rising in rural and urban societies in India.(1) A large population of the country suffers from renal stones which are formed due to deposition of calcium, phosphates and oxalates. The chemicals start accumulating over a nucleus, which ultimately takes the shape of a stone.(2) These stones may persist for indefinite period of time, leading to secondary complications thereby causing serious consequences to patient's life.

Renal stone disease can occur due to various factors such as disturbed metabolism, infections, hormonal imbalance, dietary conditions and habits, less intake of fluid that results in concentrated and thereby decreased urine volume. This can also occur due to urinary bladder obstructions or elevated excretion of calcium, magnesium, oxalate, carbonate, phosphate, urate, xanthine, cystine, etc. It is one of the most agonizing urologic ailments.(3)

It is the most common problem of the urinary tract. Renal stones may contain various combinations of chemicals which are part of a person's normal diet and are also present in bones and muscles.(4) The possibility of recurrence of renal stone disease is quite high. In a survey of Anderson DA the recurrence rate of renal calculi is 60% in 7 years and 80% in 18.5 years(5). Stones cause problems when they block the flow of urine through or out of the kidneys. When the stone moves along the ureter, it causes severe pain and is also associated with morbidity and renal damage.(6) There are varying reports of high incidence of renal stone disease with varying chemical composition has been reported from different regions of India.(7-13)

The present pilot study was undertaken to analyze the composition of renal stones qualitatively from rural population of South Solapur, Maharashtra and also to study the dietary habits and source of drinking water in renal stone patients which may help the general population to carry out preventive measures in minimizing the risk of prevalence and recurrence of renal stone disease in this region.

Material and Methods

The present study was conducted during the period of 2014-2016 in Department of Biochemistry, Ashwini Rural Medical College, Hospital and Research Centre, Kumbhari, Solapur, Maharashtra. The research project was approved by Institutional ethical committee.

Patients presenting with renal stones who have undergone renal stone surgery for the first time comprised the study group. The data of Urolithiasis cases was collected with the help of structured questionnaire proforma. The stones obtained from Surgery department to clinical Biochemistry laboratory were further processed for chemical analysis. Patients of all age groups as well as both sexes were included in the study.

Informed consent was obtained and the patients were interviewed to collect information regarding the detailed dietary history, about his/her general meal pattern as well as the source of water they use for

drinking purpose by means of a comprehensive questionnaire.

Renal stones were thoroughly washed with distilled water to remove the debris and completely dried in an incubator and weighed. The stones were cut and crushed. The powdered form was analyzed qualitatively for their chemical composition by adopting standard methods[14] for oxalates, calcium, phosphates, uric acid, carbonates, ammonia and cystine. All the chemicals used were of Analytical reagent grade.

Observations and results

Table 1: Showing gender wise distribution of stone patients

Gender	Number	Percentage
Male	90	69.3%
Female	40	30.7%
Total	130	100%

Table 1 depicts that the incidence of kidney stones was more common in men than women. The sex ratio was found to be 2.25:1.

Table 2: Showing chemical composition of stones and their percentage in stone patients

Sex	Frequency	Carbonates	Uric acid	Calcium	Phosphates	Oxalates	Ammonia	Cystine
Male	90	88(97.7%)	87(96.6%)	85(94.4%)	80(88.8%)	50(55.5%)	40(44.4%)	20(22%)
Female	40	37(92.5%)	36(90%)	35(87.5%)	29(72.5%)	18(45%)	18(45%)	10(25%)
Total	130	125(96.1%)	123(94.6%)	120(92.3%)	109(83.8%)	68(52.3%)	58(44.6%)	30(23%)
Percentage	-	96.15%	94.6%	92.30%	83.84%	52.3%	44.6%	23.07%

Table 2 shows the composition and percentage of 130 renal stone patients that were analysed. Most of the stones that are recovered from patients had mixed heterogenous chemical composition. This was found to be carbonate (96.1%), uric acid (94.6%), calcium (92.3%), phosphate (83.8%), oxalate (52.3%), ammonia (44.6%), cystine (23.0%). Calcium, carbonate and urate were present in almost all the stones which were followed by phosphate, oxalate, ammonia and cystine.

Table 3: Showing source of water used for drinking purpose by kidney stone patients

Particular: Source of drinking Water	Male (n=90)	Female (n=40)	Total (n= 130)
Tap (surface water)	10 (11.1%)	4 (10%)	14 (10.7%)
Hand pump (ground water)	58 (64.4%)	30 (75%)	88 (67.6%)
Well water (stagnant water)	22 (24.4%)	6 (15%)	28 (21.5%)

Table 3 reveals that in majority of kidney stone patients (67.6%), the source of water was hand pump (groundwater). Only 10.7% and 21.5% of patients were using tap water (surface water) and well (stagnant) water respectively.

Table 4: Showing dietary habits in kidney stone patients

Particular: Diet	Male (n=90)	Female (n=40)	Total (n= 130)
Predominantly Non vegetarian diet	70 (77.7%)	26 (65%)	96 (73.8%)
Predominantly Vegetarian diet	20 (22.2%)	14 (35%)	34 (26.1%)

The eating habits of kidney stone patients are presented in Table 4. Data in the table revealed that 73.8% of total renal stone patients were non-vegetarian while 26.1% were vegetarian. The high non-vegetarian diet may be a reason of formation of urine stone.

Discussion

In the present study, kidney stones were analyzed for chemical composition. Along with this, we have attempted to study eating habits and source of water for drinking purpose in renal stone patients. Knowledge of the chemical composition of renal calculi is necessary to know the etiology, therapeutic management, and for the prevention of disease recurrence.

Our results from Table 1 are in agreement with the study carried out by Stapleton FB.[15] The incidence and prevalence rates of kidney stones are 2 to 4 times more in men than that of in women.[16,17] The sex ratios range from 2.5:1 in Japan to 1.15:1 in Iran.[18,19] The reason behind this could be the presence of larger muscle mass of men as compared to women. Therefore, the daily breakdown of the tissue results in increase in the metabolic waste and may predispose into stone formation. Also, male urinary tract is more complicated than female urinary tract.[20]

Renal stones result when urine becomes very concentrated and substances in the urine crystallizes to form stones. Most of the stones that are recovered from patients had mixed heterogenous chemical composition (Table 2). The presence of mixed stones is a suggestive of multifactorial etiology.

We found a high percentage of uric acid stones. Hyperuricosuria is an important risk factors involved in the formation of kidney stones by urates, which plays an important role in the elimination of uric acid as the final product of purine degradation. The formation of urate stones is favoured by excessive consumption of animal proteins from beef, poultry, fish, seafood, organ etc. Excessive consumption of meat protein causes a marked increase in kidney stones because meat causes over acidification of urine causing increased excretion of oxalate, calcium and uric acid whereas excretion of citrate decreases which provides protection against stone formation.[21,22]

There are various risk factors for calcium calculi such as hypercalciuria, hyperparathyroidism, hypocitruria and renal tubular acidosis. Increased dietary protein is also associated with increased urinary calcium. Thus, there is a connecting link between consumption of non-vegetarian diet and formation of uric acid and calcium stone.[22]

Phosphates were present in most kidney stone that formed during bacterial infection possessing urease activity such as Proteus, Klebsiella, Pseudomonas, and enterococi.[23]

The presence of oxalate stone was more common constituent in the present study. This may occur due to excess ingestion of oxalate containing foods (spinach, cocoa, nuts, pepper, beet and tea) or the excess oxalate absorption due to various enteric diseases.[24]

In France, the main component of kidney stones in adults have often been calcium oxalate (70.2%), followed by calcium phosphate (13.4%) and uric acid (9.5%).[25] In a study by Ochmański et al.[26] in Poland shows that in chemical terms, kidney stones have a content of 78% calcium oxalate, 72% phosphates and 64% uric acid. In the urine, oxalate is a very strong promoter of precipitation of calcium oxalate, about 15 times stronger than calcium. A study in 2004 found that low calcium diets are generally associated with a higher risk for kidney stones formation.[27] Mixed stones chemical composition analysis allows us to understand the existence of a number of risk factors that act simultaneously.

In the present study we have attempted to study the source of drinking water in stone patients. Most of the urine stone patients were using ground water for drinking. Our results are in accordance with Siener R.[28] Mineral composition in different rock varies. Groundwater is constantly in contact with the rocks like sandstone, limestone and basalt and moves slowly as compared to surface water. Consequently, more dissolved minerals are found in groundwater than surface water. Use of groundwater for drinking purpose may be one of the reasons of stone formation in patients. The longer contact of the groundwater with the minerals results in greater extent of its reaction with those minerals. So, there will be higher content of dissolved minerals in it. In case of well (stagnant water), water remains stagnant for lesser time as compared to underground which may be a reason of less mineral content in its water.

The results of dietary habit reveal that in most (73.8%) of the renal stone patients the predominant diet was non-vegetarian. Vasanthamani and Sushmitha[29] have reported that about 87% kidney stone patients were non-vegetarian while only 13% were vegetarian. Our results are in agreement with the earlier reports. Sinha et al.[30] also reported more incidences of kidney stones in non- vegetarians.

A better understanding of the relationship between the composition of urine stone, the dietary habits as well as drinking water can provide simple and cost effective measure for prevention of stones. Proper guidance regarding dietary management and source of drinking water to patients at the right time, will help in prevention of further complications due to kidney stones and its recurrence.

Conclusion

The chemical analysis of kidney stones recovered from patients in the rural region of South Solapur, Maharashtra has shown that majority of stones had mixed composition. Urolithiasis is the result of many predisposing factors. Better knowledge of the chemical composition of urinary stones and their etiology will help improve disease management. Diet intervention on a large scale as well as knowing the risk of using ground water for drinking can be helpful as a measure for preventing recurrence. The urologist must claim the chemical analysis of kidney stones recovered on a regular basis.

References

1. Madhavi Awasthi, SR Malhotra, Rajni Modgil. Dietary habits of kidney stone patients of Kangra district, Himachal Pradesh, North India. J Hum Ecol.2011;34 (3):163-169.
2. Misra A, Kumar A. Studies on ayurvedic drugs for the cure of urinary tract stones. J Indian Bot Soci. 2000;79: 47-48.

3. Prien E L, Frondal C. Studies in urolithiasis. The composition of urinary calculi. J Urol. 1947;57:549-556.
4. Herring L C. Studies on urinary calculi. J Urol.1962;88:545-562.
5. Anderson DA. A survey of incidence of urolithiasis in Norway from 1853 to 1960. J Oslo. City Hospital. 1966;16:101-147.
6. Parmar MS. Kidney stones. Brit Med J.2004;328:1420-1424.
7. Newcomb C, Ranganathan S. The composition of urinary calculi. Indian J Med Sci. 1930;17:1037.
8. Parikh H S, Shah R C .Chemical composition of urinary calculi. Indian J Med Sci. 1960;14:401-405.
9. Rao B K, Gupta H N, Rangnekar C V. Chemical composition of urinary calculi. J Indian Med Assoc. 1964;13:469-473.
10. Thind SK, Nath R. Chemical analysis of urinary calculi in Chandigarh area. Indian J Med Res. 1969;57:1790.
11. Kabra SG, Gaur SB, Sharma SS, Patni MK, Benerji P. Urolithiasis incidence of urinary calculi in South- Eastern Rajasthan- Report of 1144 cases. Indian J Surg. 1972;34:309.
12. Ansari MS, Gupta NP, Hemal AK, Dogra PN, Seth A, Aron M. Spectrum of stone composition: Structural analysis of 1050 upper urinary tract calculi from Northern India. Int J Urol. 2005;12:12-16.
13. Malhotra KK, Ahuja MS, Singh SM and Baphna BC. Correlative study of urinary calculus disease. Ind J Med Sci. 1968;23:380.
14. Hodgkinson A.A combined qualitative and quantitative procedure for the chemical analysis of urinary calculi. J Clinical Pathol. 1975;24:147-151.
15. Stapleton FB. Childhood stones. Endocrinol Metabol Clin North Amer. 2002;31:1001-1015.
16. Johnson CM, Wilson DM, O'Fallon WM, Malek RS, Kurland LT. Renal stone epidemiology: A 25-year study in Rochester, Minnesota. Kidney Int.1979;16:624-631.
17. Hiatt RA, Dales LG, Friedman GD, Hunkeler EM. Frequency of urolithiasis in a prepaid medical care program. Am J Epidemiol. 1982;115:255-265.
18. Safarinejad MR. Adult urolithiasis in a population-based study in Iran: Prevalence, incidence, and associated risk factors. Urol Res. 2007;35:73-82.
19. Fujita K. Epidemiology of urinary stone colic. Eur Urol. 1979;5:26-28.
20. A Pandeya, R Prajapati, P Panta, and A Regmi. Assessment of kidney stone and prevalence of its chemical compositions. Nepal Med Coll J. 2010;12(3):190-192.
21. Frank M, De Vries A. Prevention of Urolithiasis. Education to adequate fluid intake in a new town situated in Judean Dessert Mountains. Arch. Environmtl Health.1966;13:625.
22. Harpreet Kaur, Jagmohan Singh, Minni Verma and Kamaljit Singh. Analysis of biochemical profile of renal stones referred to advanced Biochemistry laboratory of a multispecialty tertiary care Hospital in Punjab. European Journal of Experimental Biology. 2012;2(3):543-546.
23. Heilberg IP, Schor N. Renal stone disease: Causes, evaluation & medical treatment. Arq Bras Endocrinol Metabol. 2006;50:823-831.
24. Durgawale P, Shariff A, Hendre A, Patil S, Sontakke A. Chemical analysis of stones and its significance in urolithiasis Biomed Res.2010;21:305-311.
25. Daudon M. Épidémiologie actuelle de la lithiase rénale en France. Ann Urol.2005;39(6):209-231.
26. Ochmański, W., Kmiecik, J., Sułowicz, W. Analysis of Chemical Composition of Urinary Stones. Interantional Urology and Nephrology. 1999;31(6):743-750.
27. Liebman, M., Al-Wahsh, I.A. Probiotics and Other Key Determinants of Dietary Oxalate Absorption. Advances in Nutrition. 2011;2:254-260.
28. Siener R. Impact of dietary habits on stone incidence. Urol Res. 2006;34:131-133.
29. Vasanthamani G, Sushmitha Y. Impact of diet counselling on patients suffering from urinary stones. Indian Nutr Dietet. 1997;34:24-28.
30. Sinha T, Karan S C, Kotwal A. Increased urinary uric acid excretion: A finding in Indian stone formers. Urol Res. 2010;38:17-20.