



A STUDY OF TAP WATER HARDNESS RELATED TO URINARY STONE FORMATION

Biochemistry

Dr. J. Pratheeba	Final Year Postgraduate, Department of Biochemistry, Meenakshi Medical College and Research Institute, Meenakshi Academy of Higher Education and Research, Chennai, Tamil Nadu, India.
Dr. Ursula Sampson*	Professor and Head, Department of Biochemistry, Meenakshi Medical College and Research Institute, Meenakshi Academy of Higher Education and Research, Chennai, Tamil Nadu, India.* Corresponding Author
Dr. B. Natarajan	Professor, Department of Urology, Meenakshi Medical College and Research Institute, Meenakshi Academy of Higher Education and Research, Chennai, Tamil Nadu, India.

ABSTRACT

Aim: To assess the tap water hardness and its relation to urinary stone formation. Urinary stone disease or urolithiasis is one of the most common afflictions of modern society. It is a common urologic disease with prevalence of about 1%–20%, that is increasing throughout the world.

Materials and methods: In a prospective study, from March 2017 to July 2018, biochemical analysis of urinary stones in patients was done. The drinking water supply of patients was evaluated and compared with biochemical stone analysis.

Results: Stone analysis was performed in 150 patients. The most dominant composition of urinary stones was calcium oxalate (74.7%), followed by uric acid (22%), ammonium urate (2%), and cystine (1.3%).

Conclusion: we conclude that the dominant stone composition of inhabitants in and around Kanchipuram, where water hardness is high, was calcium oxalate stones.

KEYWORDS

Stone Analysis, Water Hardness, Urolithiasis, Stone Composition

I. INTRODUCTION

Urinary stone disease or urolithiasis, is one of the most common afflictions of modern society.¹ It is a common urologic disease with prevalence of about 1%–20% that is increasing throughout the world. Almost three million visits to health care providers have been attributed to urinary stones. It is one of the most important causes of acute and chronic urinary failure and thus results in high morbidity and enormous socio-economic burden. Urolithiasis is seen mainly in younger age groups, with higher preference in males. Different epidemiological factors like age, gender, industrial development, socioeconomic status, diet and environmental factors have been thought to play a role in urinary stone formation.³ Urinary stones are usually unilateral, common sites being urinary pelvis, calyces and in the urinary bladder. Protocol based metabolic evaluation in high risk patients would reveal several metabolic abnormalities, including hypercalciuria, hyperoxaluria, hyperuricosuria, hypocitraturia, and hypomagnesiuria.

Although these metabolic disturbances are responsible for most cases, stone formation may occur in the absence of any of these risk factors as well. Previously various studies have analyzed the chemical composition of urinary stones in India.^{4,5} Studying and understanding the chemical composition of urinary stones form an integral part of managing patients with urinary stones. In this prospective study, the prevalence of different biochemical forms of urinary stones was analyzed and its relationship with tap water hardness was evaluated.

II. Materials and Methods

Ia. Chemicals:

All the chemicals used were of analytical grade and purchased from Merck

Iib. Experimental Design

From March 2017 to July 2018 all stones retrieved from patients with renal or ureteral stones were sent for Biochemical analysis. To rule out the effects of infravesical obstruction, bladder stone cases were excluded. Gender and age of patients, water source, and composition of stones were analyzed. Stones were obtained by spontaneous passage, surgical manipulation (open or endoscopic surgery), or after Extracorporeal shockwave lithotripsy. A total of 150 stones were obtained from 150 adult patients. Paediatric patients were excluded, as metabolic disorders are more common in this group. Included patients were residents for at least 10 years, and all consumed city tap water as drinking or cooking water.

Each stone sample was washed, dried and crushed and then analysis was performed using semi quantitative chemical analysis technique. All data were gathered in an outpatient setting.

III. Statistical Analysis

Data were analyzed using the SPSS software package, version 17.0 (SPSS Inc., Chicago, Illinois, USA). Quantitative data were expressed using range, mean, SD, and median, whereas qualitative data were expressed as frequency and percentage. P value was assumed to be statistically significant at 0.05.

IV. Ethical Concern

Ethical clearance was obtained from the Ethical committee meeting conducted at Meenakshi Medical College and Research Institute, Kanchipuram, Tamil Nadu, India.

IV. Results

Figure.1. Prevalence of Stone types classified by major component of the stones. A majority of stone presented in the form of calcium Oxalate stone (74.7%) followed by Uric acid stone (22.0%) and Cystine stone also present only (1.3%) few patients.

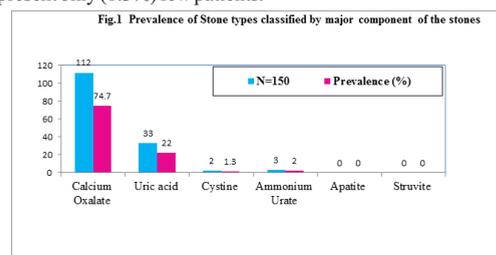


Table.1. shows the sex distribution of stones according to stone types classified by major component of the stones. Calcium oxalate stones and uric acid stones were significantly present in male patients ($P < 0.001$) compared with female patients.

Stone Type	Male	Female	Male/ Female Ratio	P Value
Calcium Oxalate	63	12	5.25	<0.001
Uric acid	62	14	4.42	<0.001
Cystine	0	100	0	NS
Ammonium Urate	100	0	0	NS
Apatite	0	0	-	NS
Struvite	0	0	-	NS

Comparison of Water Hardness in Tap water and Packaged mineral water

Table.2. indicates the comparison of water hardness in tap water and packaged mineral water. Tap water hardness, Calcium and Magnesium levels were significantly ($P < 0.001$) increased and also decreased in zinc when compared with packaged drinking water.

Particulars	Water Hardness (ppm)	Calcium(mg /L)	Zinc (mg/L)	Magnesium (mg/L)	P value
Tap Water	457.7	86	0.7	52.7	0.001
Packaged Drinking Water	17.5	75	5	30	

V. Discussion

Tap water has a significant hardness. Hardness range is 390–1202 ppm with a mean of 651 ppm.

Water hardness is defined as the molar sum of calcium and magnesium found in water. On the basis of Water Quality Association classification, water hardness data were classified into five groups: soft (17.1 ppm), slightly hard (17.1–60 ppm), moderately hard (60–120 ppm), hard (120–180 ppm), and very hard (180 ppm).³ With a daily water intake of 2 L, inhabitants in areas with very hard water receive at least 360 mg of calcium daily (30% of reference value).⁴ The quality of tap water is very hard (457.7 ppm). In recent years, the use of treated home water by miniature house desalination plants has become very common. Comparing the results of this study with those from previous studies,⁷ no significant difference ($P > 0.05$) in biochemical stone analysis distribution between tap and other softer drinking water was found.

Calcium oxalate stones were present as calcium oxalate dihydrate (weddelite) or monohydrate (whewellite). These calcium oxalate stone subtypes were not evaluated in this study. Mehrsai et al⁷ evaluated urinary calculi in two large urban areas of Iran with much softer drinking water and found that the most common stone type was weddelite, seen in 77% of mixed stones.

The facilitative role or protective role of water hardness in stone formation is controversial and still to be proven.⁸

Although the lithogenic effects of water hardness is not proven, it has been shown in some studies that the calcium quantity of tap water may cause hypercalciuria with concomitant hypocalcemia. Bellizi et al⁹ observed that drinking soft water is preferable to hard water, as it is associated with a lower risk of calcium stone recurrence. In contrast, Sierakowski et al¹⁰ found that living in areas with a hard water supply is related to less urolithiasis formation.

VI. Conclusion

On the basis of this study, there is significant relationship between the quality of tap water and the distribution pattern of urinary stones. Although there is a conflict between water hardness and incidence of urinary stone formation, no correlation was found between water hardness and the type of urinary stones.

References

1. Scales CD Jr, Curtis LH, Norris RD, et al. Changing gender prevalence of stone disease. *J Urol*. 2007;177(3):979–982.
2. Mousavi-Bahar SH, Mehrabi S, Moslemi MK. The safety and efficacy of PCNL with supracostal approach in the treatment of renal stones. *Int Urol Nephrol*. 2011 Mar 1. Epub ahead of print.
3. Moslemi MK, Safari A. A huge left Staghorn kidney, a case of inevitable open surgery; a case report. *Cases J*. 2009;2:8234.
4. Basiri A, Shakhssalim N, Khoshdel AR, Pakmanesh H, Radfar MH. Drinking water composition and incidence of urinary calculus. Introducing a new index. *Iran J Kidney Dis*. 2011;5(1):15–20.
5. Jing Z, Guo Zeng W, Ning J, Jia Wei Y, Yan G, Fang Y. Analysis of urinary calculi composition by infrared spectroscopy: a prospective study of 625 patients in eastern China. *Urol Res*. 2010;38(2):111–115.
6. Water Quality Association. Centralized “water softening” – know the facts. 2008. Available from: <http://www.wqa.org/site/ologic.cfm?ID=1052>. Accessed July 26, 2008.
7. Mehrsai A, Taghizadeh Afshar A, Zohrevand R, et al. Evaluation of urinary calculi by infrared spectroscopy. *Urol J*. 2004;1(3):191–194.
8. Ramello A, Vitale C, Marangella M. Epidemiology of nephrolithiasis. *J Nephrol*. 2000;13(Suppl 3):S45–S50.
9. Bellizi V, De Nicola L, Minutolo R, et al. Effects of water hardness on urinary risk factors for kidney stones in patients with idiopathic nephrolithiasis. *Nephron*. 1999;81(Suppl 1):66–70.
10. Sierakowski R, Finalyson B, Landes R. Stone incidence as related to water hardness in different geographical regions of the United States. *Urol Res*. 1979;7(3):157–160.