

Evaluation of biochemical urinary stone composition and its relationship to tap water hardness in Qom province, central Iran

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Purpose: The aim of this study was to evaluate the biochemical stone composition in general population of Qom province, central Iran, and its relationship with high tap water hardness.

Materials and methods: In a prospective study, from March 2008 to July 2011, biochemical analysis of urinary stones in patients living in Qom province for at least 5 years was performed. Stones were retrieved by spontaneous passage, endoscopic or open surgery, and after extracorporeal shockwave lithotripsy. Demographic findings and the drinking water supply of patients were evaluated and compared with biochemical stone analysis.

Results: Stone analysis was performed in 255 patients. The most dominant composition of urinary stones was calcium oxalate (73%), followed by uric acid (24%), ammonium urate (2%), and cystine (1%). The peak incidence of urinary stone was in patients in their forties. Overall male to female ratio was 4.93:1.

Conclusion: The dominant stone composition in inhabitants of central Iran, where tap water hardness is high, was calcium oxalate stones. On the basis of this study, biochemical urinary stone composition of Qom does not differ from other regions of Iran with lower water hardness.

Keywords: stone analysis, water hardness, urinary stones, stone composition

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. Urinary stone incidence in Iran is high.^{2,3} The highest incidence was reported in Ilam province, western Iran, at 3222 per 100,000 people per year.⁴ The incidence in Qom province is 234 per 100,000 people per year.⁴

Urinary stone analysis is important in determining the possible etiology and pathophysiology of stone formation. A better understanding of stone composition may help prevent urinary stone formation.⁵ Incidence and composition of urinary stones has wide geographic variation.

People believe that the quality of water supply and its mineral content, specifically calcium, may contribute to urinary stone formation.⁶ Mineral content of tap water differs dramatically throughout Iran depending on the water source. Qom province, located in central Iran's desert, has a hot and dry environment, which may influence the prevalence or quality of stone formation.

In this prospective study, the prevalence of different biochemical forms of urinary stones was analyzed and its relationship with tap water hardness was evaluated.

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Table 1 Prevalence of stone types classified by major component of the stones

Stone type	N = 255	Prevalence (%)
Calcium oxalate	187	73
Uric acid	61	24
Cystine	2	1
Ammonium urate	5	2
Apatite	0	0
Struvite	0	0

Materials and methods

From March 2008 to July 2011 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. Analysis was performed in two nonprofit private medical laboratories (Boo-Ali and Danesh Medical Laboratory). 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 255 stones were obtained from 255 adult patients. Pediatric patients were excluded as metabolic disorders are more common in this group. Included patients were residents of Qom for at least 5 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 semiquantative chemical analysis technique (Merckognost Urinary Analysis Kit; Merck, Darmstadt, Germany).

All data was gathered in an outpatient setting.

Results

There were 255 patients included in the analysis, 212 were males (83%) and 43 were females (17%) aged 14 to 84 years.

Table 2 Prevalence of stone types classified by minor component of the stones

Stone type	N = 255	Prevalence (%)
Calcium oxalate	67	26.2
Uric acid	6	2.3
Cystine	0	0
Ammonium urate	73	28.6
Apatite	108	42.35
Struvite	1	0.4

Table 3 Sex distribution of stones according to stone types classified by major component of the stones

Stone type	Male (%)	Female (%)	Male/Female ratio
Calcium oxalate	84	16	4.94
Uric acid	82	18	4.55
Cystine	0	100	0
Ammonium urate	100	0	–
Apatite	0	0	–
Struvite	0	0	–

Calculi prevalence in the population is shown in Table 1 and Table 2. All of the stones except one were mixed calculi, evidenced by major and minor stone components. Calcium oxalate was the most prevalent type of calculi overall. The most frequent major component of stones was calcium oxalate (73%), followed by uric acid (24%), ammonium urate (2%), and cystine (1%).

Table 3 and Table 4 show the sex distribution of calculi patients based on the major and minor component of stones, respectively. The overall male to female ratio of stone prevalence was 4.93:1. Table 5 shows average patient age classified by major component of stones. The mean age of calculi patients was 42.4 years (median 45 years, standard deviation 11.87 years).

Discussion

Tap water in Qom province has a significant hardness. Hardness range is 390–1202 ppm with a mean of 651 ppm.⁷ Its tap water ranks number one among Iran's 28 provinces for hardness. Water hardness is defined as the molar sum of calcium and magnesium found in water.^{4,8} 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).⁹ With a daily water intake of 2 L, inhabitants in areas with very hard water receive at least 360 mg of calcium daily

Table 4 Sex distribution of stones according to stone types classified by minor component of the stones

Stone type	Male (%)	Female (%)	Male/Female ratio
Calcium oxalate	80.6	19.4	4.15
Uric acid	70	30	2.33
Cystine	0	0	–
Ammonium urate	84.96	15.06	5.64
Apatite	84.26	15.74	5.35
Struvite	100	0	–

Table 5 Average of ages classified by major component of the stones

Stone type	Age (years)
Calcium oxalate	40.9
Uric acid	46.73
Cystine	44
Ammonium urate	44.4
Apatite	0
Struvite	0

(30% of reference value).⁴ The quality of Qom province tap water is very hard (443.7; Table 6). 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,¹⁰⁻¹² no significant difference ($P > 0.05$) in biochemical stone analysis distribution between Qom province and other provinces with 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 al¹⁰ 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. In another similar Iranian study of 103 stones, the most common component was whewellite (81.5%).¹² In Sun et al's¹³ study of 177 urinary stones, whewellite (50%) and weddelite (15%) were found to be the most common stone. Similar to the results in this current study, another study from Iran showed that the most common component of stone in 165 pediatric urolithiasis cases was calcium oxalate.¹¹

The facilitative role or protective role of water hardness in stone formation is controversial and still to be proven.¹⁴⁻¹⁶ 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 hypoxaluria.^{14,17}

Bellizi et al¹⁸ 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 al¹⁹ found that living in areas with a hard water supply is related to less urolithiasis formation.

Table 6 Incidence of urinary calculi in provincial capitals of Iran and tap water data^{2*}

City	Calculus incidence (per 100,000 people per year)	Water hardness (ppm)	Calcium (mg/L)	Bicarbonate (mg/L)	Magnesium (mg/L)	Stone risk index
Ilam	3222	233.4	60	176.7	17.5	0.0194
Sanandadj	1420	159.3	56	178.3	6.1	0.0515
Bushehr	854	558.5	60	–	–	–
Sari	577	412.7	64	379.1	36.7	0.0046
Birjand	564	298.8	55	–	–	–
Rasht	506	382.8	53	175.3	42.0	0.0072
Shahrekord	500	277.3	67	246.8	34.8	0.0078
Urmia	471	57.4	55	168.8	13.3	0.0245
Arak	449	359.2	52	–	–	–
Semnan	379	571.1	56	26.2	65.1	0.0328
Tabriz	374	227.6	62	234.7	20.8	0.0127
Kermanshah	302	212.9	58	187.5	11.9	0.026
Gorgan	298	367.1	56	260.2	28.7	0.0075
Mashhad	294	278.8	55	–	–	–
Ardabil	253	419.9	56	406.0	20.9	0.0066
Qom	234	443.7	63	152.9	40.4	0.0102
Hamedan	233	193.1	60	157.8	19.2	0.0198
Bojnourd	213	554.6	55	380.4	96.4	0.0015
Qazvin	202	135.0	60	–	–	–
Ahwaz	171	371.6	65	–	–	–
Kerman	138	281.7	55	–	–	–
Zahedan	98	874.7	53	–	–	–
Shiraz	79	468.0	53	311.9	58.6	0.0029
Esfahan	52	223.4	58	–	–	–

Notes: *Dashes indicate data not available. Tehran was excluded because of its multiple sources of tap water. Data of six other provincial capitals were not available.

Conclusion

On the basis of this study, there is no 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 in Qom province.

Disclosure

The authors report no conflicts of interest in this work.

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