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Miscellaneous

Evaluation of Urinary Calculi by Infrared Spectroscopy

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ABSTRACT

Purpose: To analyze urinary calculi composition and its relationship with gender, age, calculus weight, color, and location.

Materials and Methods: Two hundred and forty one patients with urinary calculus, who had undergone open lithotomy from June 1999 to April 2001, were enrolled in this prospective study which was performed by Tehran and Oroomieh Medical Sciences Universities. The calculi compositions were analyzed by infrared spectroscopy in Bonn University. Statistical analyses were made by paired t test

Results: One hundred and forty five males with a mean age of 40.4 years and 96 females with a mean age of 42.5 years were enrolled in this study. Mean calculus weight was 4.28 gr. Mean calculus number was 4.33. Thirty four (14.1%) calculi were pure (carbonate apatite: 2, brushite: 1, uric acid: 19, cystine: 3, weddellite: 6, mono-NH_4-urate: 2, struvite: 1), 207(85.6%) were mixed and none of them contained octa-ca-phosphate, apatite, newberyte, 2,8-dihydroxyadenine, mono-Na-urate, or xanthine. Weddellite was found in 77% of calculi. It comprised more than 50% of them in 26% of cases. Whewellite crystals were found in 78% of calculi. It comprised more than 50% of them in 46% of cases. The most common pure calculus was uric acid and the most common component of calculi was whewellite followed by weddellite.

Conclusion: Although there is no comprehensive study on urolithiasis incidence and prevalence in Iran, it can be concluded that whewellite and weddellite may be the most common components of urolithiasis in Iran and uric acid calculi are the most common pure calculi. There was no significant difference in calculi composition in our study.

KEY WORDS: urinary stone, infrared spectroscopy, whewellite, weddellite

Introduction

Urinary calculi have a long history returning to 7000 years age. Renal and bladder calculi were the first to be discovered in Egypt about 4800 BC.[1] Despite long history, no accurate method has been detected so far to control and prevent the formation of these calculi. The exact prevalence and incidence rates of urinary calculi in Iran are not clear.

In this survey 241 Iranian patients with urinary calculi underwent open surgery and their calculi composition was analysed by infrared spectroscopy in Bonn University. Obviously, obtaining information about calculi composition could lead to find out their metabolic bases, effective factors in their formation and the way to prevent them. The relationship between calculi composition and gender, age, calculus weight, location, and color were also studied in this survey. The results were

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compared to the results of similar studies conducted in Iran and other countries.

Materials and Methods

One hundred and forty five males and 96 females with mean ages of 40.4 and 42.5 years, respectively, were enrolled in this study, whose urinary calculi were removed through open surgery from June 1999 to April 2001.

One hundred and sixty seven of these patients were referred to Tehran University of Medical Sciences (Sina Hospital) and 74 were referred to Oroomieh University of Medical Sciences. The Calculi were analyzed by infrared spectroscopy in Bonn University (Med Einrichtungen der Universitat Bonn). Number of calculi, their color, weight, surface, components, as well as patients' gender and age were studied. The results were analyzed by paired t test.

Results

One hundred and forty five males and 96 females with a mean age of 42.15 (range 3 to 85) years, whose urinary calculi were removed by an open surgery, were studied. Seventy five females and 92 males were referred to Tehran University of Medical Sciences (Sina Hospital), while, 23 females and 51 males were referred to Oroomieh University of Medical Sciences. The results of calculi analysis were as follows:

Six children under 12 years were among the patients. Their calculi composition consisted of whewellite (mostly), weddellite, struvite, carbonate apatite, mono-NH_4-Urate, and cystine. The mean calculus weight was about 4.28 gr (3.95 gr in females and 4.53 gr in males). The mean number of calculi was about 4.33 (range 1 to 20).

The location of calculi was right kidney in 65(26.9%), left kidney in 73(30.2%), right ureter in 46(19%), left ureter in 47(20%), and bladder or urethra in 10(4%). According to calculus analysis, 34 calculi (14.1%) were pure (table 1).

TABLE 1. *Frequency of pure calculi according to calculus material*

The material of pure calculus	Number
Uric acid	19
Oxalate-Ca-dihydrate	6
Cystine	3
Carbonate apatite	2
Mono-NH_4-urate	2
Brushite	1
Struvite	1

Uric acid calculi were the most common pure calculi. The other 207(85.9%) calculi were mixed calculi, which were composed of different components. None of them contained octa-Ca-phosphate, newberyte, apatite, 2,8-dihydroxyadenine, mono-Na-urate, and xanthine. Weddellite was seen in 77% of them. It contained more than 50% of the calculus in about 26% of patients. Moreover, whewellite was found in 78% of them and it contained more than 50% of the calculus in 46% of patients. The incidence of other crystals is indicated in table 2.

Brown was the most common color of urinary calculi (more than 90% of calculi with whewellite or weddellite components). There was no significant difference between the results of calculus analysis and components in the patients who were referred to Tehran University of Medical Sciences (167 patients) and Oroomieh University of Medical Sciences (74 patients).

The distribution of calculi location according to gender is indicated in table 3.

Discussion

Generally, the possibility of calculus formation differs in various parts of the world: 1% to 5% in Asia, 5% to 9% in Europe, 13% in North America, and 20% in Saudi Arabia.[2]

The accurate incidence rate of urinary calculi in Iran is not clear; however, regarding this study, mixed calculi (85.9%) were the most common ones and whewellite crystals were the most common component of urinary calculi. These results are consonant with previous studies, which indi-

TABLE 2. *Distribution of calculus components in 241 patients*

	Number	Minimum (%)	Maximum (%)	Mean (%)	Standard Deviation
Whewellite	191	5	95	51.43	23.11
Weddellite	190	5	100	43.71	24.35
Struvite	7	5	100	50	38.62
Carbonate Apatite	94	5	100	18.01	22.26
Whitlockite	1	20	20	20	0
Brushite	2	10	100	55	63.64
Uric Acid	39	5	100	71.06	34.45
HS-dihydrate	6	10	20	18.33	4.08
Mono-NH_4-urate	12	10	100	42.50	29.28
Cystine	3	100	100	100	0

TABLE 3. *Distribution of the place of calculus according to gender*

		Right Kidney	Left Kidney	Right Ureter	Left Ureter	Bladder Urethra
Gender	Male	32	42	28	31	10
	Female	33	31	18	16	0

cate the frequency of upper urinary system calculi in patients from industrial countries (such as the United States and Germany) and developing countries (such as Sudan and Thailand).[3,4]

No particular relationship was seen between the location of calculus or its weight and the components. Considering previous studies, primary bladder calculi are relatively common in Asia and mostly formed from NH_4-urate and Ca-oxalate crystals;[5] while, in this study weddelitte crystals were the most common components of bladder and urethral calculi. The incidence rate of cystine calculi is nearly 1% to 3%.[6] About 1% of calculi were cystine in this study.

Different results of calculi analysis by infrared have been obtained from similar studies, conducted in various parts of the world. As in a study performed on 80 urinary calculi in Morocco in 2000, it was found that calcium monohydrate was the most common component of oxalate calculi. The calculi were mixed in 91.25% of cases.[7]

Although mixed calculi were the most common in this study (85.9%), whewellite and weddellite were the most common components of them in all ages. Calcium Oxalate is the most common calculus component in Sudanese children and this result is the same in Germany, but with a lower prevalence.[8] Furthermore, the analysis of children urinary calculi in Morocco by infrared spectroscopy indicated that whewellite was found in 84.4% of cases and weddellite in 26.7%.[9] These results agree with our findings. Obviously, for more accurate determination of the prevalence of calculi components in Iranian children, further studies are needed.

The prevalence of uric acid calculi in our patients was 16%, which was a little more than that in Sudan and Germany (12%).[8] The distribution of uric acid calculi in German males was more than that in females (10 to 1); while, this ratio was equal in Sudan and 1.5 to 1 in our patients.

Other studies indicate that struvite calculi are more common in females; while, a female to male ratio of 2/5 was obtained in this study. The prevalence of other calculi components was approximately similar in both genders.

Regarding previous studies, the prevalence of mono-NH_4-urate calculi is very low in Germany; however, these calculi were seen in 5% of the cases in this study and in more than 30% of calculi of Sudanese children, which was due to their malnutrition. A high prevalence of mono-NH_4-urate calculi was seen in Thai patients.[8] It seems that genetic or nutritional factors (high consumption of protein in industrial countries and high consumption of carbohydrates in developing countries) accounts for the difference of calculi components in various countries.

Conclusion

There is no comprehensive study on the prevalence and incidence rates of urinary calculi in Iran. However, considering the findings of this study and similar previous studies,[10] weddellite and whewellite were the most common calculi components in our patients. Urinary calculi components in Iran may be approximately similar to those of Sudan, Taiwan,[11] and Germany. However, components such as weddellite and carbonate apatite are more common in Sudanese patients. Moreover, mono-NH_4-urate calculi were less common in the studied Iranian children as well as German children in comparison to Sudanese children.[8]

There was no significant difference in the results of urinary calculi analysis of patients who were referred to Tehran University of Medical Sciences and Oroomieh University of Medical Sciences.

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