Urol Res (2010) 38:211–213
DOI 10.1007/s00240-009-0229-x

SYMPOSIUM PAPER

Stone composition and metabolic status

B. S. Bibilash · Adarsh Vijay · Y. M. Fazil Marickar

Received: 2 October 2009 / Accepted: 23 October 2009 / Published online: 17 November 2009
© Springer-Verlag 2009

Abstract This paper aims to study the correlation between biochemical risk factors of the stone former and the type of oxalate stone formed, namely calcium oxalate monohydrate (COM) and calcium oxalate dehydrate (COD). A retrospective study of 487 patients who had been attending the urinary stone clinic, Trivandrum during 1998–2007 was conducted. The stones retrieved from them were subjected to chemical analysis and FTIR spectrographic analysis. They were categorized into COM, COD, mixed COM+COD and others. Of 142 pure calcium oxalate stone patients, 87 were predominantly COM stone formers and 55 COD stone formers. Their metabolic status of 24 h urine and serum was assessed. The values of urine calcium, phosphorus, uric acid, magnesium, creatinine, oxalate, citric acid, sodium and potassium, serum values of calcium, phosphorus, uric acid, magnesium and creatinine and calculated values of creatinine clearance, tubular reabsorption of phosphate, calcium magnesium ratio and calcium oxalate ratio were recorded. Comparison was made between the COM stone group and the COD stone group. Patients forming COM stones had significantly higher mean values for urine calcium ($P < 0.05$), oxalate ($P < 0.01$) and magnesium ($P < 0.05$) levels and significantly lower level of urine calcium–oxalate ratio ($P < 0.01$) and urine calcium–magnesium ratio ($P < 0.01$) compared to COD stone forming patients. All other values failed to show significant difference. Patients, with higher urine oxalate, formed COM stones. Those with low magnesium (which is an inhibitor) formed more of COD stones. Urine calcium was high in both groups without showing significant variation from the mean. In patients with high calcium–oxalate and calcium–magnesium ratios, there is higher chance of forming a COD stone than COM. Identification of the crystallization pattern of the calcium stone will help in selecting treatment modalities.

Keywords COM stone · COD stone · Metabolic status · Calcium · Oxalate · Magnesium · Calcium–oxalate ratio · Calcium–magnesium ratio

Introduction

Kidney stone disease is a common disorder, affecting mostly males in third and fourth decades. Majority of the stones are idiopathic and calcium oxalate forms the most common type [1], followed by mixed stones, uric acid, phosphates and rarer types. More than 60% of the patients who present to the clinic for the first stone episode are likely to form stones again within 10 years. There are mainly two types of oxalate crystals: calcium oxalate monohydrate (COM) and calcium oxalate dihydrate (COD). Occurrence of COM stone is higher compared to COD in our populations [2]. The aim of this paper is to study whether there is any correlation between biochemical risk factors of the stone former and the type of oxalate stone formed. We have tried to derive this in order to get an insight into the etiology of the specific type of stone formation.

11th international symposium on urolithiasis, Nice, France, 2–5 September 2008 Urological Research (2008) 36:157–232.
doi: 10.1007/s00240-008-0145-5. http://www.springerlink.com/content/x263655772684210/fulltext.pdf.

B. S. Bibilash · A. Vijay · Y. M. Fazil Marickar (✉)
Department of Surgery, Zensa Hospital,
Trivandrum 695009, India
e-mail: fazilmarickar@hotmail.com

Materials and methods

The setting of the study was the urinary stone clinic Trivandrum. A retrospective study of 487 patients who had been attending the clinic during 1998–2007 was conducted. All the patients had been assessed for epidemiological factors and metabolically analysed. The patients were asked to collect 24 h urine samples in thymol while on ordinary diet. Serum was also collected. The biochemical tests performed included 24 h urine calcium, phosphorus, uric acid, magnesium, creatinine, oxalate, citric acid, sodium and potassium, serum levels of calcium, phosphorus, uric acid, magnesium and creatinine and calculated values of creatinine clearance, tubular reabsorption of phosphate, calcium–magnesium ratio and calcium–oxalate ratio. The stones retrieved from the patients were subjected to chemical analysis and FTIR spectrographic analysis. They were categorized into pure COM stones, pure COD stones, mixed COM+COD and others. Of 142 pure calcium oxalate stone patients, 87 were predominantly COM stone formers and 55 COD stone formers. These data were analyzed using statistics program SPSS 10.5. Comparison was made between the values of the COM stone forming group and the COD stone forming group using small sample Student *t*-test.

Results

The various biochemical values of the two groups of patients are detailed in Table 1. Patients with COM stones had significantly higher ($P < 0.05$) mean values for urine calcium level (303.9 mg/day) compared to the calcium level (267.3 mg/day) of the COD stone forming group. The 24 h urine oxalate level was also significantly higher (106.7 mg/day) as against the value (72.3 mg/day) of the COD patients ($P < 0.01$). COD patients had significantly low mean value (9.9 mg/day) for urine magnesium compared to the value of 5.3 mg/day of the COM stone forming patients ($P < 0.05$). COD patients had significantly higher mean values for urine calcium−oxalate ratio ($P < 0.01$) compared to COM. In addition, COD patients had significantly high mean values for calcium−magnesium ratio compared to COM patients ($P < 0.01$). All other values failed to show significant difference. The difference in biochemical environment has a significant effect on the pattern of crystallization of calcium oxalate stones. In those patients who have comparatively higher values of urine oxalate, there was higher chance of forming a COM type of stone than COD, while in those who have lower values of magnesium (which is an inhibitor), there was higher chance of forming a COD type of stone than COM. Urine calcium was high in both the groups without showing significant variation from the mean. In patients with high calcium−oxalate and calcium−magnesium ratios there was higher chance of forming a COD stone than COM.

Discussion

Calcium and phosphate metabolisms were initially considered to be important in the process of calcium oxalate stone formation [3]. However, with the passage of time, the interest

Table 1 Biochemical values of the COM and COD groups of stone patients

No.	Parameter	COM group	COD group	*T* value	*P* value
1	Urine calcium (mg/day)	303.9	267.3	2.67	<0.05
2	Urine phosphorus (mg/day)	2,650	2,340	1.74	NS
3	Urine uric acid (mg/day)	640.7	670.2	1.36	NS
4	Urine magnesium (mg/day)	9.9	5.3	2.65	<0.05
5	Urine creatinine (mg/day)	2.3	2.1	1.42	NS
6	Urine oxalate (mg/day)	106.7	72.3	3.03	<0.01
7	Urine citrate (mg/day)	312.4	282.7	1.33	NS
8	Urine sodium (mEq/day)	310.6	269.4	1.74	NS
9	Urine potassium (mEq/day)	10.6	9.7	1.67	NS
10	Serum calcium (mg%)	9.3	9.7	1.45	NS
11	Serum phosphorus (mg%)	3.9	4.1	1.18	NS
12	Serum uric acid (mg%)	6.2	6.7	1.27	NS
13	Serum magnesium (mg%)	1.8	1.6	1.16	NS
14	Serum creatinine (mg%)	1.2	1.1	1.24	NS
15	Creatinine clearance (mg%)	108	99	1.73	NS
16	Tubular reabsorption of phosphate	79.4	83.6	1.26	NS
17	Calcium–magnesium ratio	37.6	57.2	3.48	<0.01
18	Calcium–oxalate ratio	3.1	4.6	6.61	<0.01

of scientists in the two factors has gradually dwindled. The findings of the present study appear to give a value for the calcium metabolism. The higher calcium value in the COM stone forming group shows the increasing importance of calcium on the type of stone than the COD group.

Oxalate metabolism has been considered to have a major involvement in calcium oxalate urinary stone formation [4–6]. Oxalate first forms as calcium oxalate trihydrate in the tubules, but before long, it gets dehydrated to calcium oxalate dihydrate which is seen as a normal occurrence in the human urine. If, however, the oxalate dihydrate crystal stays longer in the tubular lumen, it gets further dehydrated to monohydrate form and this is considered a pathological entity in the human urinary deposit. The finding of the present study confirms that the oxalate level in the urine is higher in the COM group of stones indicating the role of higher oxalate content in the formation of such stones.

Citrate is a very well-known inhibitor of calcium oxalate stone formation. Much work has been done in calcium oxalate stones in general [7–11], but studies are not forthcoming on the differences in the citrate levels between the COM and the COD groups of stone formers. The findings of the present study indicate that the citrate values are not very different between the two groups of stone formers.

Magnesium is not considered as significant an inhibitor as citrate. Much has been discussed in the past about the role of magnesium in inhibiting stone formation and hence in the management of stone disease [12–22]. However, recent literature does not give much thought on the role of magnesium. The present findings in this study indicate that magnesium would probably have a greater role in the formation of the COD stones. The magnesium–calcium ratio has been reported to be relevant in the causation of stone disease [23]. It appears to be true considering the findings of the present study. A higher calcium–magnesium ratio is an indicator of calculogenesis. The present study showed that this was higher in the COD stone group. It is thus presumed that different types of stone may form due to different mechanisms and in different individuals. Hence prophylaxis of future stone formation should be planned keeping all possible parameters under consideration.

Conclusion

It is important to differentiate the crystallization pattern of the calcium stone which will help in selecting treatment modalities. If urine oxalate value is high, then there is higher chance of forming a COM stone and if urine magnesium value is low, then there is higher chance of forming a COD stone. Therapy should be based on stone analysis along with biochemical studies. Knowledge about stone composition will help to predict the most probable cause of the calculogenesis.

References

1. Trinchieri A, Castelnuovo C, Lizzano R, Zanetti G (2005) Calcium stone disease: a multiform reality. Urol Res 33(3):194–198
2. Ansari MS, Gupta NP, Hemal AK, Dogra PN, Seth A, Aron M, Singh TP (2005) Spectrum of stone composition: structural analysis of 1050 upper urinary tract calculi from northern India. Int J Urol 12(1):12–16
3. Lemann J (1996) Calcium and phosphate metabolism: an overview in health and in calcium stone formers. In: Coe F, Pak CY, Parks JH, Preminger GM (eds) Kidney stones medical and surgical Management. Lipincott-Raven, Philadelphia, p 264
4. Jeghers H, Murphy R (1945) Practical aspects of oxalalate metabolism. N Engl J Med 292:756
5. Albuquerque PF, Tuma M (1962) Investigations on urolithiasis. II. Studies on oxlalate. J Urol 87:504
6. Milliner DS, Wilson DM, Smith LH (1998) Clinical expression and long-term outcomes of primary hyperoxaluria types 1 and 2. J Nephrol 11(Suppl 1):56–59
7. Rudman D, Kutner MH, Redd SC et al (1982) Hypocitraturia in calcium nephrolithiasis. J Clin Endocrinol Metab 55:1052–1057
8. Nicar MJ, Skurla C, Sakhaee K et al (1983) Low urinary citrate excretion in nephrolithiasis. Urology 21:8–14
9. Hosking DH, Wilson JW, Liedtke RR et al (1985) Urinary citrate excretion in normal persons and patients with idiopathic calcium urolithiasis. J Lab Clin Med 106:682–689
10. Kok DJ, Papapoulos SE, Bijvoet OL (1987) Low inhibition of crystal agglomeration and citrate excretion in recurrent calcium oxalate stone formers. Contrib Nephrol 58:73–77
11. Cupisti A, Morelli E, Lupetti S et al (1992) Low urine citrate excretion as main risk factor for recurrent calcium oxalate nephrolithiasis in males. Nephron 61:73–76
12. Kohler P, Uhle C (1966) Oral magnesium intake and its effect on various urinay constituents in the prophylaxis of urolithiasis. J Urol 96:812–815
13. Melnick I, Landes RR, Hoffman AA et al (1971) Magnesium therapy for recurring calcium oxalate urinary calculi. J Urol 105:119–122
14. Takasaki E (1975) Urinary magnesium and oxalic acid excretion in patients with recurrent oxalate urolithiasis. Invest Urol 12:251–254
15. Fetner CD, Barilla DE, Townsend J et al (1978) Effects of magnesium oxide on the crystallization of calcium salts in urine in patients with recurrent nephrolithiasis. J Urol 120:399–401
16. Johansson G, Backman U, Danielson BG et al (1980) Magnesium metabolism in renal stone disease. Invest Urol 18:93–96
17. Wunderlich W (1981) Aspects of the influence of magnesium ions on the formation of calcium oxalate. Urol Res 9:157–161
18. Resnick MI, Munday D, Boyce WH (1982) Magnesium excretion and calcium oxalate urolithiasis. Urology 20:385–389
19. Li MK, Blacklock NJ, Garside J (1985) Effects of magnesium on calcium oxalate crystallization. J Urol 133:123–125
20. Kohri K, Garside J, Blacklock NJ (1988) The role of magnesium in calcium oxalate urolithiasis. Br J Urol 61:107–115
21. Schwille PO, Schmiedl A, Herrmann U et al (1999) Magnesium, citrate, magnesium citrate and magnesium alkali citrate as modulators of calcium oxalate crystallization in urine: observations in patients with recurrent idiopathic calcium urolithiasis. Urol Res 27:117–126
22. Massey L (2005) Magnesium therapy for nephrolithiasis. Magnes Res 18:123–126
23. Takasaki E (1972) The magnesium:calcium ratio in the concentrated urines of patients with calcium oxalate calculi. Invest Urol 10:147–150