

URINARY CALCULI CONTAINING SILICA: A CASE REPORT

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Urinary calculi containing silica have rarely been reported. The finding of silica without calcium, magnesium, uric acid, oxalate or phosphate in a calculus alleged to be urinary in origin, might even be taken as *prima facie* evidence that it was not authentic. This was at first considered to be a possible explanation in the case we are reporting here. Only one other 'calculus' containing silica had been previously seen by one of us (B.M.B.), and this was alleged to have been passed *per urethram* by a boy aged 7 years; doubt was however expressed about its urinary origin. A similar view has been taken by other authors.^{1,2}

A second possibility is an association with silicosis. Very rarely 'calculi' have been reported to contain silicates in individuals with long exposure to silica.³ However, our patient was not a miner, had not worked underground, and had no undue exposure to silica-containing dust. The third and most likely cause advanced by one of us (E.L.), followed a report by Lagergren⁴ of the development of silica calculi after prolonged oral administration of magnesium trisilicate. Our attention was then drawn to the fact that our patient, too, had taken magnesium trisilicate for some years for a digestive disorder. As magnesium trisilicate is a commonly used antacid, we felt it would be of interest to record this apparently unusual complication, which may, however, be more common than the few published reports suggest.⁴⁻⁷

CASE HISTORY

Mr. J.M., aged 62 years, has a hiatus hernia with resultant pyrosis, and has taken magnesium trisilicate for years, 2-4 times daily. He also has coronary artery disease—he has had two, or probably three attacks of coronary thrombosis, and has had anticoagulant therapy. He is hypercholesterolaemic and has been taking a diet low in dairy and animal fats and high in fruit and vegetables for some years.

In June 1961 he complained of pain, and a calculus was diagnosed in the left lower ureter with blockage. He passed some calculous fragments *per urethram* in the subsequent few days. In October 1961 he again passed 'gravel', which was found to consist almost entirely of inorganic material. Tests for urates, oxalates and calcium were negative, but there was insufficient material for further analysis. An intravenous pyelogram was normal and no calculi were evident.

In June 1962 prostatectomy was carried out, and 8 days later the patient passed a calculus *per urethram* which was later tested and found to be radiopaque. His pain indicated that the calculus had, like the others, come down the left ureter. Since it was opaque it must have been formed subsequent to the intravenous pyelogram. It was irregularly round, faceted, approximately 0.5-1 cm. in diameter and brown in colour. Calcium, magnesium, oxalate, uric acid, cystine and xanthine were not detected. A trace of phosphate and a slight amount of organic matter were present. Tests for silicates gave a positive result.⁸ Some of the powdered material was sent to Dr. I. Webster, Director of the Pneumoconiosis Research Unit, who confirmed that a large amount of silica—approximately 50% of the specimen—and traces of iron were present.

DISCUSSION

In 1962 Lagergren⁴ reported 5 cases of silica stones in Sweden. One consisted only of silica, 3 also contained

small quantities of calcium hydroxyapatite, and 1 contained small quantities of calcium oxalate. He also referred to 2 previous cases of calculi in Sweden, the first reported by Hammarsten and his associates⁵ in 1953, and the second by Hammarsten⁶ in 1958. A further case was recorded by Herman and Goldberg⁷ in 1960. All the patients had taken magnesium trisilicate more or less regularly for some years. A search of the literature has revealed no further cases.

Silicon, as silicates, is present in vegetables and the husks of whole grains. Soluble silicates are easily absorbed from the alimentary tract, but silica, as far as is known, has no physiological role. The blood-plasma level is approximately 1 mg. per 100 ml., and usually does not rise since any excess is rapidly excreted in the urine.⁹

Synthetic magnesium trisilicate ($Mg_2Si_2O_5 \cdot nH_2O$), which is a white insoluble powder, was shown by Mutch¹⁰ not to be absorbed from the intestine and to have absorbent and antacid properties of particular value in the treatment of gastric acidity and chronic peptic ulceration. The value of magnesium trisilicate and the silica resulting from the reaction with gastric hydrochloric acid apparently depends on the fact that both are active hydrated colloids. Although the chemical reaction can be represented as $Mg_2Si_2O_5 \cdot nH_2O + 4 HCl \rightarrow 2 MgCl_2 + 3 SiO_2 + (n+2) H_2O$ the conditions of interaction are complex and are not completely understood. Page *et al.*¹¹ suggested that more complex end-products than silicon dioxide (or silica) were produced, viz. various combinations with water to form different silicic acids and silicates. They considered that these products could include soluble orthosilicic acid (H_4SiO_4 , i.e. $SiO_2 + 2 H_2O$), partially soluble metasilicic acid (H_2SiO_3 , i.e. $SiO_2 + H_2O$), partially soluble trisilicic acid ($H_3Si_3O_8$, i.e. $3 SiO_2 + 2 H_2O$), and nearly insoluble disilicic acid ($H_2Si_2O_6$, i.e. $2 SiO_2 + H_2O$). The variation in the hydration of the SiO_2 molecule thus gives a change in solubility, and this factor, as well as the physico-chemical state of the silica—which may remain in solution as a colloidal sol or may partially separate as a gel—probably determine its absorption from the intestine.

Page *et al.*¹¹ showed that there was a ten-fold increase of the normal silica content of the urine following oral administration of magnesium trisilicate. From a mean daily level of 16.2 mg. of silica before treatment, the daily excretion of silica reached 172, 178 and 162 mg. of silica on the second, third and fourth days of the administration of 5 G. of magnesium trisilicate daily, indicating that about 5% of the silica ingested was excreted in the urine.

The manner in which silica is excreted in the urine after magnesium trisilicate ingestion does not, however, appear to have been studied, nor has the effect of pathological changes in the urinary tract been considered. It is not surprising, therefore, that the pathogenesis of silica calculi remains obscure and that no explanation can be offered for the occurrence of this complication of magnesium trisilicate therapy. Lagergren⁴ considered that the structure

of the calculi in his cases, and the finely crystalline form of the silica, supported Hammersten's view⁶ that the silica was precipitated in the gel form apparently mixed with fibrin.

SUMMARY

A case is described of urinary calculi composed mainly of silica, which was apparently due to the prolonged taking of magnesium silicate for a digestive disorder. Although the pathogenesis is obscure, and only 8 previous cases have been reported, attention is drawn to the possibility that this may not be a rare complication.

OPSOMMING

'n Geval van nierstene bestaande hoofsaaklik uit silika word beskryf. Die stene is vermoedelik toe te skryf aan die langdurige neem van magnesium trisilikaat vir indigestie wat

deur 'n hiatusbreuk veroorsaak word. Die mening word uitgespreek dat sulke gevalle moontlik nie baie seldsaam mag wees nie, al is net 8 gevalle tot dusver in die mediese literatuur beskrywe.

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