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BLADDER STONE IN A HUMAN FEMALE: THE CASE OF AN ABNORMALLY LOCATED INTRAUTERINE CONTRACEPTIVE DEVICE

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Abstract

A single 4.7 x 3.3 x 1.5 cm solid nodule was removed from the bladder of a 24 years old white female who had lost an intrauterine contraceptive device (IUD) installed approximately four years ago. The nodule showed no external evidence of an IUD or its string. An examination of the nodular surface by scanning electron microscopy (SEM) showed mostly amorphous material with some adherent filamentous structures. Its energy dispersive x-ray microanalysis revealed the presence of calcium and phosphorus suggesting that the nodule was actually a urolith. Fracturing the nodule exposed an embedded entity consistent with being a copper IUD. Apparently, the lost IUD had migrated from the uterus into the bladder where it became mineralized. Thus the solid nodule was actually a foreign body stone.

Key Words: Calcification, biomineralization, calcium phosphate, struvite, urinary stone, bladder stone, intrauterine contraceptive device, foreign body stone, infectious stone.

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Introduction

A variety of substances which find their way into the urinary bladder become calcified. As a result, hair, spicules of bones, catheter tips, vascular clips, needles, wires, as well as non-absorbable suture material have been found at the center of foreign body vesicle stones (1). Migrant intrauterine contraceptive devices (IUD's) that are lodged in the urinary bladder have also been demonstrated to calcify (6,7,9). To our knowledge there have been only four such cases reported, and in all of them only a part of the IUD was calcified. Two cases involved calcification of the pointed lower pole of Dalkon shield (6,9) and in one case the large upper arm of the Lippes loop(7) was calcified. Most foreign body stones consist of calcium phosphate and struvite. IUD's calcified in utero contain crystals of calcium carbonate mixed with some calcium phosphate (4,8). Crystalline composition and morphology of IUD induced foreign body stones has however, not been reported. Therefore, when we came across a bladder stone formed around an IUD nidus, we decided to study its morphology and determine its crystalline nature.

Case Report

A single 4.7 X 3.3 X 1.5 cm solid, smooth, tan colored stone was removed from the bladder of a 24 year old white female. The stone had no external evidence of any internalized entity. The patient had an unremarkable past medical history but complained of recurring urinary tract infection and persistent lateral lower back pain at the time of her visit to the clinic. Four years earlier, after the birth of her second child, an IUD was inserted postpartum, without complications. The IUD was thought lost when a pelvic examination revealed no string and she became pregnant in the previous year. Culture of urine revealed enterococci in excess of 75,000 colonies/ml. Cervical culture was negative for Neisseria gonorrhea.

Methods

The stone was fractured. Pieces from different areas of the stone were mounted on SEM stubs using colloidal carbon. After air drying, they were coated with

Table 1. Major Peaks (d spacings in angstrom units and relative intensities) obtained by X-ray diffraction analysis of the stone compared with JCPDS of struvite, carbonate apatite, and hydroxylapatite

Sample		Carbonate apatite		Hydroxyl apatite		Struvite	
d	Int	d	Int	d	Int	d	Int
		5.91	40				
5.60	17					5.60	60
4.23	30					4.26	100
4.12	14					4.14	40
3.42	42	3.46	25	3.44	40		
						2.92	55
2.80	100			2.81	100	2.80	40
		2.78	100	2.78	60		
				2.72	60		
2.68	76	2.68	40			2.69	50
				2.63	30	2.66	45
2.26	13	2.23	16	2.26	20		
1.95	19	1.93	16	1.94	30		
1.83	11	1.84	16	1.84	40		

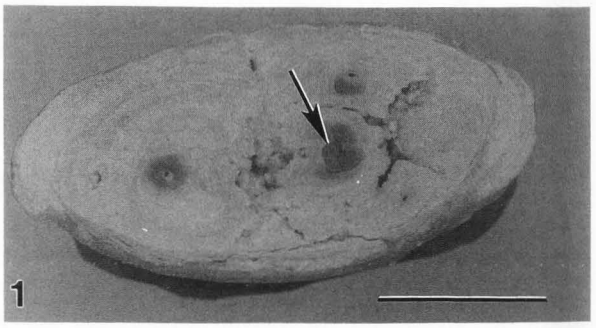
silver and examined using a Hitachi HS 450 scanning electron microscope at 20 kV. X-ray microanalysis was carried out by using a Kevex 7000 energy dispersive x-ray detector with a beryllium window . During microanalysis, the specimen stage of the microscope was raised and tilted approximately 30° towards the x-ray detector for optimum x-ray collection.

Pieces of stone were sent to Louis C. Herring & Co., Orlando, Florida for crystallographic analysis. Part of the stone was also analyzed by a Phillips Automated Powder Diffractometer at the Major Analytical Instrument Center of the University of Florida.

Results

A copper IUD was found enclosed inside the stone. Crystalline material was organised concentrically around the IUD (Figs. 1,2). Calcification appeared to have started at various places along the body and tail of the IUD (Figs. 1,2). Stones grew individually around these nidi till they were large enough to coalesce with the neighbouring units resulting in the formation of a single aggregate. Additional growth resulted in the formation of a single, large nodular stone.

According to the Herring laboratory analysis of stone pieces, the IUD stone consisted of 37% apatite, 58% struvite and 5% biological material including blood. Our x-ray diffraction analysis of a part of the stone showed it to contain both carbonate-apatite and hydroxylapatite (Table 1). Analysis by scanning electron microscopy and x-ray microanalysis revealed two major mineral components. One of the components was amorphous (Fig. 3) to spherical (Fig. 4) in structure and positive for calcium and phosphorus (Fig. 5a), indicating its apatitic nature (2,5). The other consisted of large rhomboidal crystals (Fig. 4) with characteristic surface



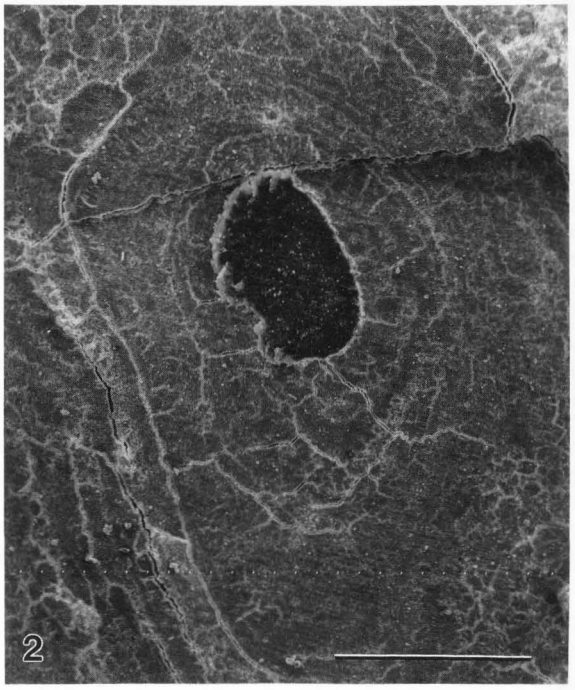
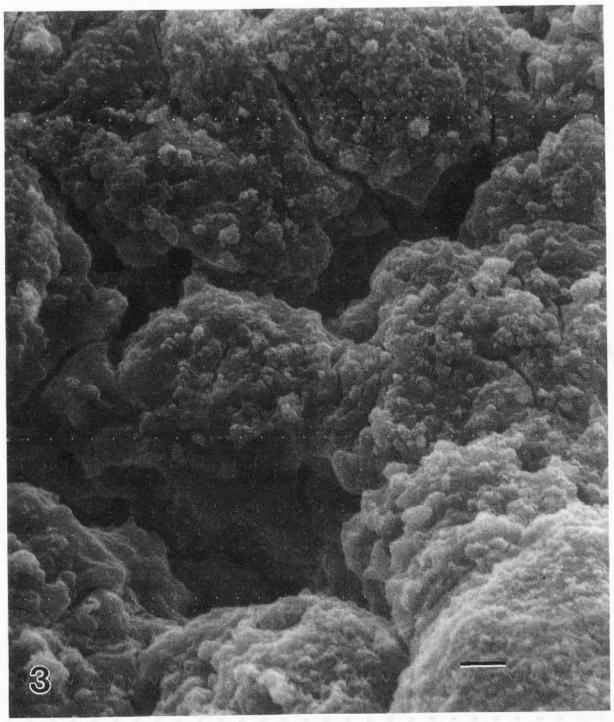


Fig. 1. Light micrograph of fractured stone surface showing calcification starting around various parts of the IUD and then coalescing to form an aggregate. Arrow points to the cross fractured main body while other nidi are parts of the IUD string. Bar = 1mm

Fig. 2. Concentrically organized calcification around the IUD string. Bar = 500μm

cracks. These crystals were positive for magnesium and phosphorus (Fig. 5b) and thus their morphology and elemental composition was consistent with their being struvite (3,5). Spherical apatite crystals were mostly matted together (Fig. 6) while struvite was present as individual crystals. Stone surface was generally apatitic with occasional struvite protruding through (Fig. 4). Internally, the apatite and struvite were mixed together except near the IUD surface where crystalline material was exclusively apatitic in nature. Both amorphous calcium phosphate layers and spherical apatite crystals were sometimes covered with slightly round bacteria-like imprints (Fig. 6).



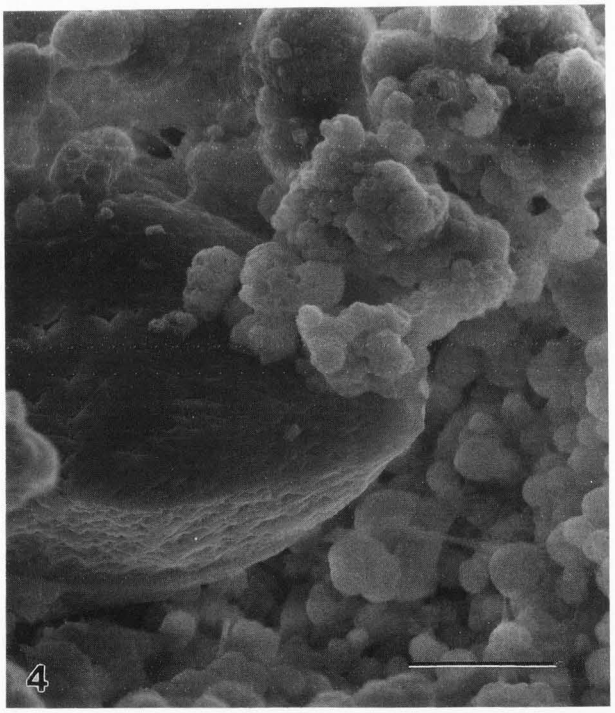
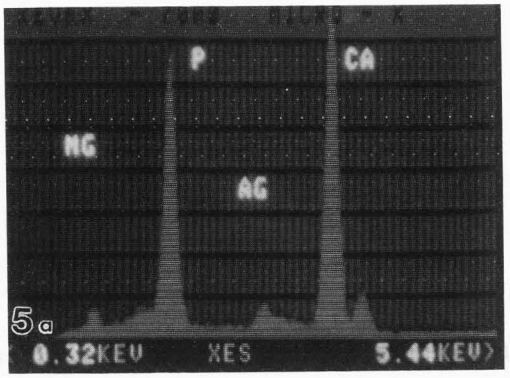
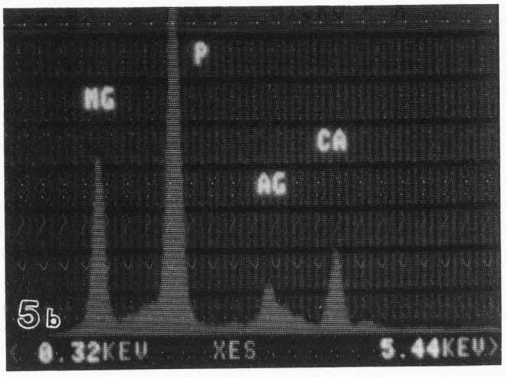


Fig. 3. Amorphous surface of the IUD foreign body stone. Bar = 5μm

Fig. 4. Higher magnification of a part of the stone surface displaying a large struvite crystal protruding through the surface which consists of spherical calcium phosphate crystals. Bar = 5μm





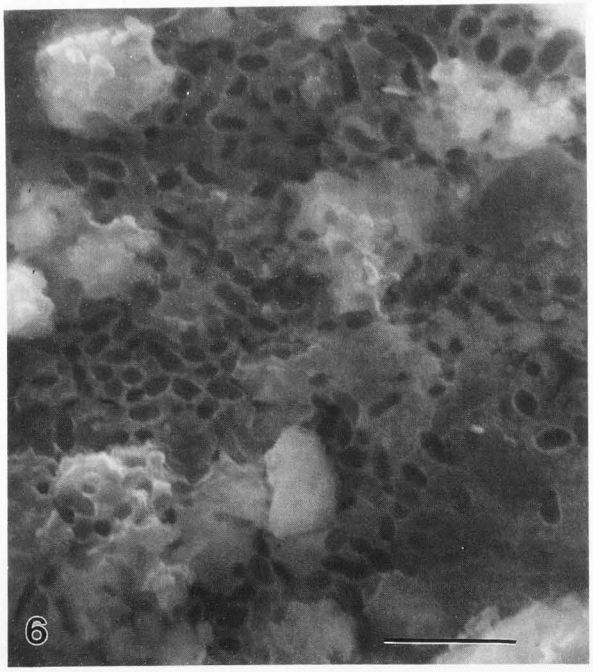


Fig. 5. X-ray microanalysis spectra of the stone. 5a. Surface layer. 5b. struvite crystals inside the stone. CA, calcium; MG, magnesium; P, phosphorus; AG, silver.

Fig. 6. Bacteria-like imprints on the surface of matted calcium phosphate crystals inside the stone. Bar = 5μm

Discussion

The most common and serious complication of IUD use is perforation of the uterine wall (7,9). Such perforations can result in migration of IUD into the peritoneal cavity or in some cases into the bladder. Once in the bladder, these IUDs act as foreign bodies and become encrusted. Apparently, this is what happened in case of our patient. Earlier reports have described IUD induced foreign body stones in which only a part of IUD was encrusted. But in our patient, the entire IUD was encrusted and was totally enclosed in the stone. The reason may be that in previous reports of IUD stones, most of the IUD body was located in the bladder and the uterine wall. Only a part of the IUD was protruding into the bladder and was exposed to the bladder urine. Therefore, only a part of the IUD became encrusted. In our patient, the entire IUD must have migrated to the bladder and thus became exposed to the urine.

Human urine is generally metastable for calcium phosphate. Occasional supersaturation, however, is common and results in the formation of calcium phosphate crystals which are the most frequently encountered crystals in the human urine and urinary stones (3,5). Introduction of a foreign body in such a system results in crystallization of calcium phosphate and encrustation of the foreign body. Additional infection with urease producing bacteria induces nucleation of magnesium orthophosphates (2). Infection also increases the likelihood of carbonate apatite nucleation instead of hydroxyapatite. Thus, in the presence of a foreign body and urinary infection, bladder stones are formed which contain crystals of carbonate apatite as well as struvite.

In our study, the IUD stone contained both apatite and struvite indicating that the stone developed in an infected urinary environment. The crystals present directly on the IUD surface were exclusively apatitic in nature. Some of these crystals had bacterial imprints on their surfaces suggesting that bacterial colonization of the encrusted surfaces occurred very early in the life of the stone. Struvite crystals were found only in layers away from the IUD. Thus, the chronology of events leading to the formation of the IUD associated bladder stone in this patient appears to be as follows. The implanted intrauterine device migrated completely to the bladder. Exposure to the urine resulted in its initial encrustation with apatite. Urinary infection resulted in bacterial colonization of the stone, which in turn induced the formation of crystals of struvite and carbonate apatite. The latter became incorporated into the growing stone, resulting in the formation of the calcified nodule.

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Discussion with Reviewers

K.P.H. Pritzker: Did you find any copper within the crystals or the amorphous material? Since copper is antibacterial and struvite are formed in association with infection, what do you account for the abundance of struvite but paucity of bacterial imprints?

Authors: We did not detect copper in the crystals or the amorphous material. As we mentioned in the paper, the crystals directly coating the IUD surface were apatitic in nature. Struvite was found only in the layers away from the IUD. A number of studies have demonstrated that encrustation of the copper wire of an IUD causes a decrease in the rate of copper release (Gosden C, Ross A, Loudon NB (1977) Br. Med. J. 1:202-206). Obviously a total containment as in the case here will totally stop the copper release.

In our experience bacterial imprints are not as frequently encountered in infectious human stones as one would expect.

N.S. Mandel: What was the Ca:P ratio in the apatite portion of the stone? It does not appear to be 1.66. Where is the discrepancy?

Authors: We are unable to give the Ca:P ratio because our microanalysis technique is not quantitative. The stone consists of three types of phosphate crystals, struvite, carbonate-apatite and hydroxylapatite. Signals may be interfering.