Case Report

Revisit percutaneous dissolution of uric acid stones: A case report with review

Abstract

Uric acid stones are second most common cause of kidney stones after calcium oxalate and calcium phosphate stones. Its prevalence varies based on the age, climate, ethnicity, and geographic location. Here we are presenting a case report where a 55-years old male with a history of prostate cancer and MGUS presented with acute renal failure due to bilateral ureteral obstruction with uric acid stones. The computer tomography (CT) scan of abdomen and pelvis showed two obstructive stones measuring 28 mm and 30 mm in the left proximal ureter and one obstructive stone measuring 30 mm in the right mid ureter. The first line conservative management with hydration failed as patient becomes significant volume overload. He was successfully treated with percutaneous chemolysis using a 3amps of bicarbonate in 20cc solution every six hours and potassium citrate (20meq) 2160mg three times in a day. By hospital day five majority of his stones resolved and repeat CT scan showed only punctate non-obstructing calcifications. The usual treatment of uric acid nephrolithiasis consists of hydration to produce at least 2L of urine volume daily, low animal protein diet, and urine alkalization. Although localized alkalization via retrograde or percutaneous is now an uncommon practice due to longer hospital stays and cost effectiveness. However, physicians should be aware of this effective alternative especially in situations with complete bilateral ureteral obstruction, severe metabolic disorders, acute renal failure, or fluid overload.

Keywords: Uric acid stones, nephrolithiasis, bilateral ureteral obstruction, percutaneous chemolysis.

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Introduction

Uric acid stones account for 5-10% of all kidney stones in the United States. Its prevalence can vary by age, climate, ethnicity, and geographic location making Israel one of the countries with uric acid stone incidences of 40%. Acidic pH (<5.5) is a major risk factor in uric acid stone formation. Prevention is a key to manage uric acid nephrolithiasis. The conservative treatment of uric acid stones includes increased fluid intake to alkalization of urine either systemically or locally. Surgery is the last resort. Localized dissolution of uric acid stones is an effective non-surgical approach that was a common practice in the past. With the effectiveness of systemic alkalization and longer hospital stays for localized dissolution of uric acid stones, it has become less favorable overtime. However, it should be considered as first line treatment in situation with complete bilateral ureteral obstruction, severe metabolic disorders, severe renal failure, or fluid overload, as seen in our presented case report. With a coordinated and timely care by specialists, the hospital stay can be shortened making this modality much more cost effective.

Prevalence

The prevalence of uric Acid stones accounts for 5%-10% of all kidney stones in the United States. In a study by Mandel[1] at Veterans Administration hospitals revealed that 9.7% analyzed stones were pure uric acid stones whereas, 12% of the stones contained some uric acid components.[1] The prevalence of uric acid stones can vary by age, climate, ethnicity, and geographic location. The history of diabetes and obesity increase the risk of stone formation.[2] Gentle et al.[3] reported uric acid stone prevalence of 11% in a geriatric population.

Higher uric acids stone incidences are reported in the factory employees working in the higher temperature environments that is likely the contributor of highest levels of uric acids stones reported in the Israel.[4] Approximately 50% of patients with nephrolithiasis in the Hmong population of the United States are reported to have uric acid stones. Geographically, only 4% of uric acid nephrolithiasis have been reported in the southern states of the United States; whereas, incidence rates are 17% in Chicago.[5] Outside of the United States, the incidence of uric acid stones varies such as, 4% in Sweden, 15% in Japan, 20%-25% in Germany, and 40% in Israel.[6] These variations indicate that genes, diet, and environmental factors play major role in formation of uric acid stones.

Risk factors

Two main risk factors for uric acid stones formation are low urinary pH and hyperuricosuria. Of these two major risk factors, acidic (low, <5.5) urinary pH is most common and it is usually caused by tubular disorders, low urinary volume, chronic diarrhea, or severe dehydration. Hyperuricuria (>800mg of urinary uric acid/24hrs) can be associated with hyperuricemia, such as in primary gout or myeloproliferative disorder, or may manifest as an isolated cause due to diet or uricosuric drugs.[7] The monogenic metabolic conditions such as Lesch-Nyhan also predisposes to uric acid nephrolithiasis. A gene ZNF365 located on chromosome 10q21-q22 linked to uric acid calculus formation is detected but its purpose is not well defined yet.[8]

Recent analysis from multiple retrospective studies by Daudon et al.[9] has concluded that within frequent stones formers, uric acids stones are most common in patients who have diabetes, obesity, or metabolic syndrome.[9]

Case report

55-yrs-old-male with history of prostate cancer Gleason 3 plus 4 status post radical prostectomy 3 weeks ago presented with 2-days of nausea, vomiting, weakness, decreased urine output, and pre-syncopal episode. His past medical history included MGUS, hypertension, depression, nocardial osteomyelitis, pyelonephritis, and megaloblastic anemia. His initial vital signs were abnormal with respiratory rate of 32rpm and systolic blood pressures of 80mmHg. En-route from outside hospital he received 9 liters of IVFs for hypotension. On presentation to emergency department, he was fluid overload and got intubated for respiratory distress. His laboratory work up was abnormal with pH of 7.15, PCO_2 26mmHg, Hgb 6.2g/dl, glucose 36mg/dl, Potassium 6mmol/L, CO_2 9mmol/L, phosphorus 9.9mg/dl, albumin 3.1g/dl, amylase 181U/L, lipase 364U/L, BUN 98mg/dl, and Creatinine 9.8mg/dl.

Computer tomography (CT) scan of abdomen and pelvis showed two obstructive stones measuring 28mm and 30mm in the left proximal ureter and one obstructive stone measuring 30mm in the right mid ureter. Emergently right femoral vascular catheter was placed and received 2 hours of dialysis for volume overload, electrolyte and acid base disorder. Few hours later bilateral nephrostomy tubes were placed by interventional radiologist and drained very little urine volume. His urine was examined under microscope and showed uric acid crystals, few granular casts, and many normo-morphic red blood cells.

Overnight he continued to drain from both nephrostomies but urine output was not significant. He was started on local irrigation with a solution of 3amps of bicarbonate in 20cc, every six hours. He also received potassium citrate (20meq) 2160mg three times a day, initially via nasogastric tube and later by mouth. The following day, the patient's urine output increased, he was extubated, and his dialysis catheter was discontinued. His BUN and creatinine continued to improve and within five days it returned to baseline form 13mg/dl to 0.87mg/dl. On day five, repeat CT abdomen and pelvis showed only tiny punctate (<3mm) non-obstructing calcification in the upper pole of right kidney. His nephrostomy tubes and Foley catheter were discontinued. Two day later, he had Lasix renogram which showed normal perfusion, concentration, and excretion by both kidneys with a split function of 44% left and 56% right. It did not show any obstruction to the flow of urine on either side. The patient was discharge home on day 10 (Table 1).

Table I Patient observations

Days	Potassium (mmol/L)	CO_2 (mmol/L)	BUN (mg/dL)	Cr (mg/dl)	Phosphorus (mg/dl)
Admission	6	9	98	9.8	9.9
Day #2	4.1	20	51	3.17	6.1
Day #5	3.3	22	13	0.87	4.3
Discharge	3.9	23	15	0.85	3.5

Metabolism and pathophysiology

Uric acid is a metabolic end product of purine compounds which can be found in excess either in purine-rich foods or rapid cell turnover in conditions such as tumor lysis syndrome. The major enzyme involved in this mechanism is xanthine oxidase which can be inhibited by purine analogue allopurinol or non-purine analogue febuxostat. One third of daily generated uric acid is metabolized by the gastrointestinal tract bacteria into carbon dioxide and ammonia. Rest of the uric acid is excreted by proximal tubules of kidneys.[10] About 95% of serum uric acid is in monosodium urate form that is freely filtered in the glomeruli, out of which 99% gets reabsorbed in the proximal convoluted tubules. The 80% post secretory absorption occurs in the distal convoluted tubules that eventually results in only 10% excretion of the filtered urate in the urine.[11]

The humans lack Uricase enzyme (found in most mammals) that converts uric acid to allantoin which is 10-100 times more soluble.[12] At physiological pH of 7.40, uric acid mostly circulates in the ionized form as urate which is more soluble. At urine pH <5.5, most of the uric acid becomes protonated which is poorly soluble and predisposes to uric acid nephrolithiasis. Two major mechanisms for acidic urinary pH are increased acid production or impaired renal ammoniagenesis.[13]

Type 2 diabetes results in markedly higher net acid excretion that leads to low urinary pH and has been associated with increased risk of uric acid stones. Obesity contributes more than dietary factor in nephrolithiasis. Since body fat is hydrophobic, in obesity, proportion of body water decreases and leads to dehydration. Furthermore, obesity is a pro-inflammatory state associated with electrolyte imbalance and altered urine chemistry.[14] Many features of metabolic syndrome including hypertension, obesity, hyperglycemia, and dyslipidemia are associated with uric acid stone formers.

Diagnosis

Uric acid stones are more prevalent in older population. Detailed dietary and medical history such as gout, myeloproliferative disorder can suggest clues in uric acid nephrolithiasis diagnosis. The patients usually present with flank pain either dull aching or colicky along with nausea and vomiting, they may also be asymptomatic. When diagnosis is not clear or patient present with fevers, immediate imaging is recommended. An acidic urinary pH, urine analysis, urine microscopy, 24-hours urine metabolic work up, and elevated serum uric acid levels can aid in the diagnosis. Besides uric acid stones, cysteine stones are the only other stones associated with acidic urine. The bedside Ultrasound sound can be used as first line diagnostic imaging tool due to its convenience, cost, and to eliminate radiation risk. However, it is only 45% sensitive and 88% specific for renal calculi. KUB is 44-47% sensitive and 80-87% specific.[15]

Non-contrast computerized tomography (CT) is the best modality in nephrolithiasis evaluation. It is 96.6% sensitive and 94.9% specific in diagnosing nephrolithiasis.[15] On CT scan, uric acid stones appear dense and it can also help differentiating uric acid stones from papillary necrosis, transitional cell carcinoma, and fungal bezoars because all these appear radiolucent on routine radiographs, such as KUB. Other radiolucent stones include matrix, xanthine, hypoxanthine, 2,8-dihydroxyadenine, and indinavir stones. Indinavir is the only radiolucent stone that is not visualized on non-contrast CT scan.[16]

Prevention and treatment

Uric acid stones can be prevented with high fluid intake, low animal protein intake, urine alkalization to urine pH of 6.2-6.8, and xanthine oxidase inhibitors. Uric acid stones are among few urinary tract stones that can be dissolved successfully. The Treatment of uric acid nephrolithiasis consists of hydration to produce at least 2L of urine volume daily, low animal protein diet, and alkalization of urine.

Diet and fluid intake

It is recommended to decrease daily animal protein intake to 0.8g/kg/day and substitute with fresh fruits and vegetables to decrease uric acid production and provide urine alkalization, respectively.[17] The high purines rich diet that should be avoided include meat, animal organs, yeast, sweetbreads, and fish.

Even though there are no interventional studies to observe effect of urine volume on uric acid stones, intuitively, it makes sense to increase fluid intake to produce at least 2.5L urine which will reduce uric acid super-saturation. Studies have shown 40%-50% reduction in calcium stone recurrence with increased urinary volume.[18]

Urinary alkalization via systemic means

Oral alkalization for uric acid stone dissolution is effective in 80% of the patients. Sodium bicarbonate 650mg three times per day or commercial baking soda as an alternative with a dose of 1 to 2 teaspoons three times per day is inexpensive mode of alkalization. Even though both tolerated well, sodium alkali increases sodium and water load which is detrimental in patients with hypertension, congestive heart failure, and liver cirrhosis. Sodium load also increases sodium and calcium excretion in urine leading to calcium oxalate stones.[19]

Therefore, potassium citrate with a dose of 30-60meq per day is now considered as first line therapy in oral alkalization to treat and prevent uric acid stones.

Local urinary alkalization (Chemolysis)

Although majority of uric acid stones can be dissolved with systemic alkalization, there are situations when this cannot be accomplished such as, bilateral complete ureteral obstruction, severe metabolic disorders, severe renal failure, or fluid overload. In these cases, local dissolution of stones is an effective non-surgical approach. The percutaneous chemolysis to dissolve large uric acid stones was a common practice in the past. Due to prolonged hospitalization these procedures are not considered cost-effective. However, these procedures still have important non-surgical role in above mentioned situations.

It can be achieved either by retrograde or percutaneous irrigation. Earlier series of percutaneous chemolysis of renal calculi was reported by Pfister et al.[20] Struvite, apatite, and carbonate stones can be dissolved with an acidic solution (hemiacidrin, Suby solution G) due to their pH of 4. Cystine and uric acid stones can be dissolved with THAM-E (tromethamine, pH 10.2), Mucomyst (acetylcysteine, pH 8.2), or sodium bicarbonate (pH 8.2).20 In 1985, Sadi et al.[21] devised an in vitro model to evaluate the efficacy of the different irrigating solutions utilized for local dissolution of uric acid stones. Tris aminomethane (THAM-E) was noted to be superior to sodium bicarbonate. They recommended the use of 0.3M concentration of THAM-E at flow rate of 50cc/hour as first line solution whenever local dissolution of uric acid stone is attempted.[21]

After 1990, there was recent case report from Serbia with percutaneous dissolution of uric acid stone in a patient with a solitary kidney. In the United States these procedures are not consider cost-effective. However, physicians should be aware of this alternative especially in the situation as mentioned in our case report. Kachrilas et al.[22] also believe in role of percutaneous chemolysis. They presented review of 29 patients where 55% of the patients were stone free and 28% had partial dissolution with half of them showing nonsignificant (<4mm) stone fragments after percutaneous chemolysis.[22]

Carbonic anhydrase inhibitor

A combination of sodium bicarbonate and a carbonic anhydrase inhibitor (Acetazolamide) has been used to improve urinary alkalization by inhibiting bicarbonate reabsorption in proximal tubules. However, acetazolamide may reduce urinary citrate and increase urinary phosphate that can lead to calcium phosphate stones.[19]

Xanthine oxidase inhibitors

Since hyperuricemia can cause hyperuricosuria, purine analogue allopurinol or non-purine analogue febuxostat can be used to inhibit xanthine oxidase. Xanthine oxidase converts hypoxanthine to xanthine and xanthine to uric acid. Hypoxanthine and xanthine are soluble and are excreted by kidneys.[23]

Surgical management

All lithotripsy modalities are effective for uric acid stone fragmentation. This may improve oral chemolysis by increasing the exposed stone surface. Open surgical extraction is the last treatment option for the nephrolithiasis.

Conclusion

The incidence of Uric acids stones can range from 4% in the United States to 40% in Israel due to its formation based on age, climate, ethnicity, and geographic location. These variations indicate that genes, diet, and environmental factors play major role in formation of uric acid stones. Acidic pH (<5.5) is a major risk factor in uric acid stone formation. Within stone formers, patients with history of obesity, diabetes, and metabolic syndrome are more prone to make uric acid stones. The Treatment of uric acid nephrolithiasis consists of hydration to increase urine volume, low animal protein diet, and urine alkalization. Although localized alkalization via retrograde or percutaneous is now an uncommon practice due to longer hospital stays and cost effectiveness. However, physicians should be aware of this effective alternative especially in situations with complete bilateral ureteral obstruction, severe metabolic disorders, acute renal failure, or fluid overload.

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Conflict of interest

Authors declare there is no conflict of interest in publishing the article.

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