Staged treatment for substantial bilateral calcium carbonate nephrolithiasis in vegan patient

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ABSTRACT

Calcium carbonate (CaCO3), or calcite, stones average 0.15% of annual nephrolithiasis cases. The authors report a 53 year old female, following a 15 year vegan diet, presenting with left flank pain and later found to have bilateral extensive staghorn renal calculi requiring multiple procedures over the course of months.

Calcite stone formation is likely attributed to the patient’s vegan diet and vitamin supplements. This stone’s formation increases with neutral or alkaline urinary pH in the presence of high levels of magnesium. The authors discuss staged surgical treatment plans and non-surgical management prophylaxis with surgery as another possible route for treatment.

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1. Introduction

Despite growing trends toward healthier diets, the incidence of kidney stones (nephrolithiasis) has been increasing. Abufaraj et al. states kidney stones prevalence was 6.5% in 2007, growing to 9.4% in 2017, particularly among women. Non-Hispanic white ethnicity, obesity, diabetes, and multiparity were associated with increased chances of developing kidney stones, but predilections for stone formation of a certain composition is difficult as little information is available. We report a vegan woman with extensive calcium carbonate (calcite), which make up 0.01%–0.25% of all stones. Excessive amounts of certain nutrients or vitamins predispose to development of kidney stones, but is it possible for lack of certain nutrients to also predispose to kidney stone formation?

1.1. Case presentation

A 53-year-old female of undisclosed ethnicity, past medical history of psoriasis, and BMI of 18.1 kg/m² presents with acute left side flank pain and intermittent gross hematuria without clots. She has no history of tobacco, alcohol, or illicit drug use. Family history is negative for kidney stones or renal diseases. Patient had recently been treated for recurrent UTIs with trimethoprim-sulfamethoxazole. At this time of presentation, CT abdomen and pelvis showed bilateral extensive staghorn renal calculi (Fig. 1) with extension into proximal ureters; an additional 14 mm stone was found in the left distal ureter (Fig. 2). Basic laboratory testing showed abnormal values of creatinine at 1.5 (baseline 1.0), and hypermagnesemia likely due to vitamin supplements. Urinalysis was negative with a pH of 7.7.

The extensive stone burden prompted surgery with laser lithotripsy. Fluoroscopy showed right ureter tortuosity with a collection of stones, contrast was unable to pass this area. Due to purulent presentation of the left distal ureter and right sided stone burden, it was decided to put ureteral stents bilaterally and plan for staged treatment of her staghorn and upper ureteral stones. Two weeks later, patient underwent left renal
and ureteral ESWL and right sided lithotripsy with stent exchanges. KUB film revisualized the extensive bilateral renal and ureteral calculi (Fig. 3), but lithotripsy only caused incomplete fragmentation. Many round yellow stones were extracted on the right side with imaging confirming the stone burden of the right kidney in preparation for the next procedure.

Prior to this subsequent surgery, an extensive H&P found the patient had been adherent to vegan diet for 15 years. At this point, research was done into management plans in vegan patients presenting with similar extensive stone burden, but little information was discovered on treatment or prevention. The decision was made to continue with staged treatment via incremental dissolution of the stones.

Three weeks later, the patient returned for right ESWL and left laser lithotripsy for the distal ureteral stone with bilateral stent exchange. Ureteral and left renal pelvic stones were cleared and visual confirmation adjudged no stone fragments larger than 10 mm remained. Three weeks later, one final surgery cleared the right sided stones via right sided laser lithotripsy with right stent replacement. KUB showed significant stone debris in the right mid-distal ureter along the stent but no stone > 2–3 mm. The ureter, renal pelvis, and calyceal system were now visually clear of any residual stones bilaterally. No additional surgeries were anticipated. Microscopic analysis of the stones showed calcium carbonate composition with minimal calcium oxalate.

2. Discussion

This patient is unique because of both the staged treatment requiring multiple procedures and the stone composition being calcium carbonate (CaCO3), or calcite, typically averaging 844 Hounsfield units on CT. Alternative treatment with percutaneous nephrolithotomy was not done on account of patient preference but also because her anorexic habitus would require pediatric instruments to be used, making the procedure more difficult. Throughout treatment, inquiry was done into associations between vegan diets and extensive nephrolithiasis to guide management. An article from 1982 demonstrated the protective effect of vegetarianism on urinary stone formation, but little data exists on potential complications or alternative procedures used in vegans presenting with similar burden to our patient. Less than a half dozen articles were found on calcium carbonate stones, most of which studied vegetarian rather than vegan diets. A study from China in 2013 found associations of kidney stone formation among women with increased grain/bean consumption, with odds ratios of 2.9 and 3.5 respectively.
while those consuming vegetables >3 times per day had an odds ratio of 3.86 for development of kidney stones, allowing for deductions to be made on vegan associations.

Only one article was found documenting therapies for calcium carbonate stones. The similarities between our patient and that in Christiansen et al. were the presence of underweight BMI, magnesium supplements, and evidence of pure calcium carbonate stones. Rodriguez-Blanco et al. proved transformation of calcium carbonate into calcite occurs through reprecipitation mechanisms in the setting of either neutral or alkaline pH. An environment composed of magnesium further increases the time for amorphous calcium carbonate (ACC) to crystallize into calcite stones. A treatment plan to resolve or lessen the severity of kidney stone formation in vegan patients is through acidification of urine such as ammonium chloride on a weekly basis, but this is more useful for prophylactic prevention of additional calcite stone formation. However, our patient’s desire of immediate treatment and extensive stone burden made rapid relief with urine acidification impractical. While urine acidification has been used for decreasing the likelihood of typical struvite stone formation, no research has been done on its efficacy in dissolution of calcium carbonate stones on account of this stone composition’s rarity.

3. Conclusion

The pathophysiology of nephrolithiasis of all compositions is a multifactorial process in which environmental factors play a role. Conclusions on whether veganism is associated with an increased risk of calcium carbonate stones cannot be drawn definitively at this time. Regardless, there is potential for increased patients presenting similarly to the one above as the spread of vegan diets and healthier foods gains popularity in the Western world. Documenting how this patient was treated and assessing the current understanding for the underlying mechanism could potentially provide invaluable information for healthcare professionals encountering similar patients to help guide management plans.

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