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Consequences of a non-supplemented pediatric vegan diet: Nephrolithiasis & nutritional calcipenic rickets

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A B S T R A C T

Rickets and other nutritional deficiencies have largely been eradicated in the industrialized world. However, strict adherence to modern diet trends such as veganism may leave individuals vulnerable to nutritional deficiencies if proper supplementation is not followed. The effects of such deficiencies due to diet trends, particularly in children, is not well documented as occurrences are rare. Here we present a case of a 3-year-old female fed a strict vegan diet which led to the development of nutritional calcipenic rickets, failure to thrive, and nephrolithiasis.

1. Introduction

Rickets is a metabolic disorder of childhood characterized by impaired bone mineralization and disrupted microarchitecture at the growth plate. It is most often caused by severe vitamin D deficiency causing nutritional calcipenic rickets, although there are other metabolic and genetic causes.[1] Through the fortification of food with vitamin D, rickets has been largely eradicated in the modern world. However, in areas with poor food access, nutritional deficiencies leading to nutritional rickets, such as diets low in calcium or vitamin D, still occur.[1] Plant-based foods in particular are low in calcium, vitamin D, and vitamin B12. Accordingly, vegetarian and vegan diets have also been associated with vitamin D deficiency.[2] While vegetarian and vegan diets are not homogeneous, they tend to exclude all meat and fish, with the added exclusion of animal products, including dairy, for vegans. Ready access to dietary supplements should preclude vitamin deficiencies, especially those severe enough to cause rickets, in those following plant-based diets in the United States (US). Yet, strict adherence, lack of proper supplementation, and lack of medical care can lead to severe nutritional deficiencies. Such a diet is uncommon, and it is therefore rare to see a case of nutritional rickets in the US. Here we present a case of a 3-year-female fed a non-supplemented vegan diet who presented with nutritional calcipenic rickets and failure to thrive complicated by nephrolithiasis.

2. Case presentation

A 3-year-old female presented to an outside hospital for a possible seizure and was found to be febrile with acute hypoxic hypercapnic respiratory failure. She was subsequently intubated and transferred to our hospital. Her medical history included a full-term birth with no NICU stay. She had received no vaccinations and was not previously seen by any pediatrician. Her family followed a strict vegan diet. While she was within normal millstones with crawling at 1 year, she did not start walking until 2 years of age and was not yet running at 3 years. She only had an estimated 200 words per family reporting. Initial laboratory findings were notable for low vitamin D (<7 ng/ml), calcium (5.4 mg/dl), and phosphorus (3.9 mg/dl), and high PTH (1050.9 pg/ml), alkaline phosphatase (2404 U/L), and WBC (15.2 thous/mm^3) with a neutrophil predominance. She also had deficiencies in vitamin B12 and iron. Bone imaging revealed a clavicular fracture and findings consistent with rickets including diffuse osteopenia, metaphyseal cupping, poor mineralization of epiphyseal center, and age-inappropriate mineralization (Fig. 1).[3] Her findings and history were consistent with failure to thrive and calcipenic rickets. Renal ultrasound demonstrated grade 1 hydronephrosis and a 7 mm stone in the right urinary collecting system (Fig. 2). On hospital day 2, her urinalysis was notable for turbidity, brown color, blood, protein (200), and RBCs (TNTC). By hospital day 3, the stone had progressed to the ureterovesical junction (UVJ) and

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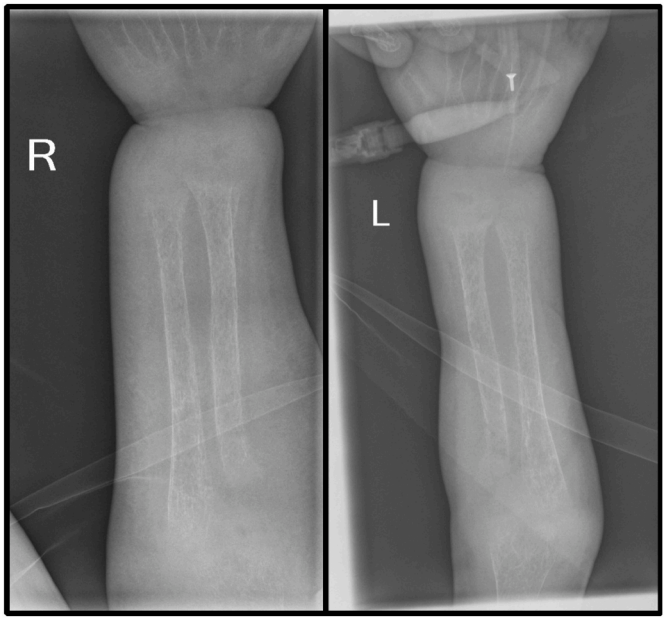

Fig. 1. X-rays from bone scan demonstrating findings associated with rickets.

hydronephrosis was grade 2 (Fig. 2). The stone was spontaneously passed by hospital day 5, though not collected, with resulting resolution of hydronephrosis. No evidence of UTI or AKI developed during progression or resolution of her nephrolithiasis.

Her respiratory status remained poor. She failed an extubation trial on hospital day 6 and was thus reintubated the next day. After remaining intubated for 20 days with an NG tube in place, a tracheostomy was performed, and a G-tube was placed for long term ventilation and nutritional management respectively. Complications during her hospital stay included a nonocclusive PICC line thrombosis and refeeding syndrome, which were treated appropriately. Her nutritional deficiencies, vitamin deficiencies, and electrolyte imbalances were corrected throughout her hospital stay. She also began receiving missed vaccinations.

3. Discussion

This case demonstrates an example of rickets due to lack of proper nutritional supplementation in a child caused by parental dietary and lifestyle choices. Because of the stringent adherence to a vegan diet, lack of vitamin supplementation, and lack of routine health care, the child developed severe enough nutritional deficiencies to cause life-threatening rickets and failure to thrive. Such a case should be avoidable in the US with current availability of vitamin supplements, fortified foods, and public education.

Literature on vegan diets in pediatrics is limited. Studies have shown nutritional deficiencies, as mentioned previously, commonly including calcium and vitamins D and B12.[2,4,5] In published studies of pediatric vegan diets, the study populations typically consume diets with supplementation of essential vitamins and minerals. A recent meta-analysis demonstrated that vegan diet-fed children had lower intake of calcium, but comparable intake of vitamin D and vitamin B12 compared to their omnivore counterparts, likely due to supplementation.[6] Health agencies across the world have provided varying guidelines and recommendations regarding supplementation to vegan and vegetarian diets. The American Academy of Pediatrics (AAP) specifically recommends vitamin D and B12 supplementation for all children following vegan diets and case-by-case supplementation of other nutrients including calcium, iron, and omega-3-fatty acids.[7] While some published position statements, including those from the Canadian Pediatric Society and the American Academy of Nutrition and Dietetics, assert that a carefully supplemented vegan diet can be appropriate for pediatrics, other groups, particularly from Europe, advise against a vegan diet for children.[8–11]

In the 21st century, only three reports of a vegan diets resulting in

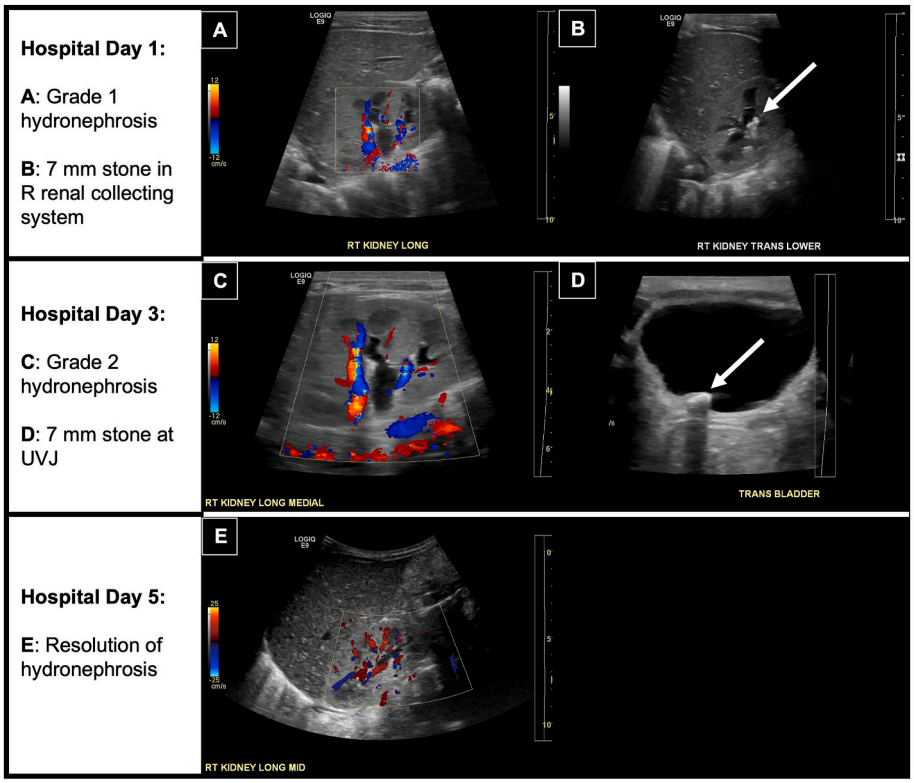

Fig. 2. Hydronephrosis and stone progression course. White arrows pointing to renal stone.

rickets were found in our search of existing literature, two in infants and one in a 15-year-old.[12–14] To our knowledge, this is the first reported case of a non-supplemented vegan diet in a child which presented with rickets as a toddler. Additionally, none of the existing reports of vegan diets leading to rickets in pediatrics described nephrolithiasis as an associated complication in rickets. Although the stone in this case was not caught and analyzed, we hypothesize it was likely calcium oxalate as vegan diets are known to have high amounts of oxalate and low calcium. Normally, in the GI tract, oxalate binds calcium and is excreted in feces. Yet, when calcium is low in the diet, oxalate absorption is unopposed, thus calcium oxalate stones precipitate in the urine.[15,16] Few studies have evaluated a relationship between vegan diets and nephrolithiasis in any age group. Still, several reviews similarly suggest that calcium oxalate stones would be likely and furthermore suggest that uric acid stones may also be likely in vegan diets due to a lack of dairy products which aid in uric acid excretion.[17–19]

This case highlights the need for public education on proper dietary supplementation when following restrictive diets such as veganism, especially in populations that do not seek out medical care. Awareness should be increased not only of severe disease consequences such as rickets and failure to thrive but also of more common problems such as nephrolithiasis which itself can cause added urologic problems including urinary tract infections or acute kidney injury.

4. Conclusion

This case adds to the limited knowledge about consequences of non-supplemented vegan diets in children leading to vitamin D deficiency manifesting as nutritional calcipenic rickets, failure to thrive, and nephrolithiasis.

CRediT authorship contribution statement

Stacy R. Bedore: Conceptualization, Data curation, Investigation, Writing – original draft. **Joshua van der Eerden:** Investigation, Writing – review & editing. **Om Sakhalkar:** Investigation, Writing – review & editing. **Sung Alexander:** Investigation, Writing – review & editing. **Pablo J. SantaMaria:** Investigation, Supervision, Writing – review & editing. **Martha K. Terris:** Supervision, Writing – review & editing. **Bradley Morganstern:** Conceptualization, Investigation, Supervision, Writing – review & editing.

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