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Case report

# Plant-based dietary approach to stage 3 chronic kidney disease with hyperphosphataemia

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**SUMMARY**

A 69-year-old man with type 2 diabetes, hypertension and stage 3 chronic kidney disease (CKD), hyperphosphataemia and borderline hyperkalaemia presented to an office visit interested in changing his diet to improve his medical conditions. He adopted a strict whole-foods, plant-based diet, without calorie or portion restriction or mandated exercise, and rapidly reduced his insulin requirements by >50%, and subsequently saw improvements in weight, blood pressure and cholesterol. His estimated glomerular filtration rate (eGFR) increased from 45 to 74 mL/min after 4.5 months on the diet and his microalbumin/creatinine ratio decreased from 414.3 to 26.8 mg/g. His phosphorus level returned to the normal range. For individuals with CKD, especially those with obesity, hypertension, or diabetes, a strict, ad libitum whole-food, plant-based diet may confer significant benefit, although one must consider potential limitations of a creatinine-based GFR equation in the face of significant weight loss.

**BACKGROUND**

Approximately one in seven American adults have chronic kidney disease (CKD) and the prevalence is higher in those with metabolic risk factors such as hypertension and diabetes.<sup>1</sup> Obesity is an independent, causative factor in CKD pathogenesis.<sup>2,3</sup> People with CKD have significantly higher risks of cardiovascular disease (CVD) than those without CKD.<sup>4</sup>

Given that nutrition plays an important role in metabolic health, some kidney-related organisations advise dietary approaches for CKD addressing these risk factors,<sup>5,6</sup> including the Dietary Approaches to Stop Hypertension (DASH) diet, as it leads to weight loss, reduced blood pressure and improved glycaemic control in different populations.<sup>7</sup> The dietary recommendations in the Kidney Disease Improving Global Outcomes focus on protein and salt intake and education with attention to potassium, salt, phosphate and protein intake, but do not make specific recommendation as to dietary patterns or specific foods.<sup>8</sup>

A more stringent whole-foods, plant-based diet (WFPBD) has been shown, over a variety of trials, to successfully treat coronary artery disease,<sup>9–11</sup> hypertension,<sup>12,13</sup> obesity<sup>14</sup> and diabetes.<sup>15,16</sup> Thus it is possible that a more stringent nutritional approach may yield significant benefit in patients with CKD. Unfortunately, there is limited intervention research on the effects of this dietary pattern on CKD. This

case highlights the potentially remarkable benefit that a strict WFPBD may offer, particularly when used in the context of advanced metabolic disease and CKD.

**CASE PRESENTATION**

A 69-year-old man presented for advice regarding diet and lifestyle approaches to treat his chronic medical problems. His medical history included stage 3 CKD, class 2 obesity, hypertension, hyperlipidaemia and type 2 diabetes requiring approximately 210 total units of insulin daily (140 units insulin glargine and approximately 20–25 units insulin lispro at three meals daily).

He was most concerned about the general worsening of his numerous chronic medical conditions. His diabetes had been diagnosed roughly 30 years ago and he had progressed to requiring insulin about 4–5 years prior to our visit. His diabetes was only marginally controlled (haemoglobin A1c 7.3%) despite steady escalation of insulin dosing and significant diet and lifestyle efforts. He was on 12 different medications (box 1) and had experienced troublesome side effects, particularly weight gain. His ‘tipping point’ was his recent diagnosis of hyperphosphataemia (phosphorus 4.8 mg/dL) and a conversation with his nephrologist in which he was told that he might progress to the need for dialysis in as soon as 5 years.

He was married with a supportive wife who did the shopping and cooking. He was a retired business executive who continued to work part time on rental properties he owned. He was a former smoker (quit almost 20 years prior to visit), drank 2–3 alcoholic drinks weekly and denied illicit drug use. Foods and meals typical of his baseline diet included: a breakfast of shredded wheat, coffee, lunch of macaroni with meat sauce or grilled cheese sandwich, dinner of Italian wedding soup (with meatballs) and beans and rice. Beverages consisted of coffee, water and an occasional alcoholic drink. He and his wife dined out once a week. He often had an evening snack of cookies or peanut butter cheese crackers. He walked 45 min a day on his indoor treadmill.

**INVESTIGATIONS**

His laboratory values from approximately 6 weeks prior to his office visit are shown in the first column of table 1. The estimated glomerular filtration rate (eGFR) was calculated by the Chronic Kidney Disease Epidemiology (CKD-EPI) equation,



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**Box 1 Baseline medications**

- Amlodipine 2.5 mg daily.
- Aspirin 81 mg daily.
- Carvedilol 25 mg two times per day.
- Hydrochlorothiazide 12.5 mg daily.
- Losartan 100 mg daily.
- Pravastatin 40 mg daily.
- Insulin glargine 140 units nightly.
- Insulin lispro 20–25 units three times per day before meals.
- Glimepiride 4 mg daily.
- Sitagliptin 100 mg daily.
- Fish oil 1000 mg daily.
- Vitamin D 2000 IU daily.
- Continuous positive airway pressure device at night.

incorporating age, serum creatinine, sex and race as independent variables.<sup>17</sup>

**TREATMENT**

The patient and his wife were given a food guide detailing what groups of food were appropriate for a WFPBD (table 2). He was counselled to eat whenever hungry and as much as needed to be comfortably full without counting calories, carbohydrates, or restricting portion sizes. He was provided with a shopping list consisting of common products in area grocery stores consistent with the food guide and a restaurant guide to facilitate compliance with the diet while eating out. He also received a book with over 50 whole-food, plant-based recipes and ‘how-to’ instructions for implementing the diet. He was asked to start a vitamin B12 supplement.

The comprehensive counselling and behavioural intervention took over 1 hour and both the patient and his wife participated. They decided to start the dietary programme 3 days after the office visit.

An example day on this plan included breakfast of oatmeal with fruit and flaxseed, lunch of beans and kale (greens and

beans) cooked in vegetable stock, dinner of whole-wheat spaghetti and steamed veggies, all cooked and prepared without oil, and at least two fresh clementines as snacks.

Due to the rapid effect of major dietary change on insulin sensitivity, immediate adjustments in insulin dosing were made and the patient was called daily after starting the diet to assess blood sugars and further decrease insulin as necessary.

**OUTCOME AND FOLLOW-UP**

The patient and his wife reported being highly compliant. They admitted to one meal a week at a restaurant when they were not 100% compliant, but otherwise followed the food guide strictly. Within 4 days, insulin had been reduced from roughly 210 to 70 units daily and glimepiride was stopped due to rapidly improving blood sugar. After his blood sugar stabilised his insulin was titrated up slightly to about 80 units a day by the end of his second week on the diet to achieve tighter glucose control.

He stopped carvedilol, hydrochlorothiazide, amlodipine and sitagliptin within the first 2 months due to improving blood pressure and blood glucose. His insulin was steadily titrated downward. His pravastatin dose was cut in half and he had a follow-up visit with nephrology about 4.5 months into the dietary change, at which point he had lost roughly 22.2 kg. Due to marginal hyperkalaemia (potassium of 5.3 mmol/L) and improvements in weight, blood pressure and creatinine, his nephrologist halved his losartan dose, from 100 mg to 50 mg daily. His insulin dose had dropped to 46 units daily total within 5 months. His remaining medications after 20 weeks of dietary change are shown in box 2.

His renal function, as measured by creatinine and eGFR, showed slight improvement within 2 months, and significant improvement 4.5 months after changing his diet (figure 1). His creatinine was in the normal range for the first time in at least 8 years (the duration of available laboratory tests in the electronic medical record). His microalbuminuria resolved, at least temporarily, but then increased thereafter. His metabolic acidosis resolved. Selected laboratory results are shown in table 1.

**Table 1** Selected laboratory values and weight before and after dietary therapy

|                                    | 17 February 2017 | 9 April 2017 | 18 April 2017 | 3 May 2017 | 1 June 2017 | 24 August 2017 | 15 March 2018 |
|------------------------------------|------------------|--------------|---------------|------------|-------------|----------------|---------------|
| Potassium (mmol/L)                 | 4.6              | Started diet | 5             | 4.5        | 4.7         | 5.3            | 5.1           |
| CO <sub>2</sub> (mmol/L)           | 21               |              | 24            | 23         | 22          | 25             | 25            |
| Urea nitrogen (mg/dL)              | 39               |              | 32            | 22         | 23          | 19             | 21            |
| Creatinine (mg/dL)                 | 1.56             |              | 1.67          | 1.45       | 1.44        | 1.03           | 0.98          |
| eGFR (mL/min/1.73 m <sup>2</sup> ) | 45               |              | 41            | 49         | 49          | 74             | 78            |
| Phosphorus (mg/dL)                 | 4.8              |              | 4.4           | 3.9        | 4.7         | 4.1            | 4.1           |
| Albumin (g/dL)                     | 4.3              |              |               |            | 4.1         | 4.3            | 4.7           |
| Total cholesterol (mg/dL)          | 181              |              |               |            | 118         | 110            | 148           |
| Triglycerides (mg/dL)              | 148              |              |               |            | 123         | 103            | 84            |
| HDL cholesterol (mg/dL)            | 48               |              |               |            | 37          | 44             | 50            |
| LDL cholesterol (mg/dL)            | 103              |              |               |            | 56          | 45             | 81            |
| Chol/HDL ratio                     | 3.8              |              |               |            | 3.2         | 2.5            | 3.0           |
| Haemoglobin A1c (%)                | 7.3              |              |               |            | 6.8         | 6.1            | 6.0           |
| Creatinine, UR (mg/dL)             | 89               |              |               |            | 60          | 28             | 75            |
| Microalbumin, UR (mg/dL)           | 36.87            |              |               |            | 1.61        | 2.71           | 11.56         |
| Microalb/creat ratio               | 414.3            |              |               |            | 26.8        | 96.8           | 154.1         |
| Weight (kg)                        |                  | 109.4        |               | 102.8      | 94.8        | 87.1           | 78.5          |
| BMI (kg/m <sup>2</sup> )           |                  | 39.5         |               | 37.1       | 34.3        | 31.5           | 28.4          |

BMI, body mass index; eGFR, estimated glomerular filtration rate; HDL, high-density lipoprotein; LDL, low-density lipoprotein.

**Table 2** Food guide

| 'Allowed' foods                                 | Foods to avoid   | Foods to enjoy sparingly  |
|---|--|---|
| Non-starchy vegetables                          | Meat (including fish and poultry)  | Unsalted, raw or dry roasted nuts, natural nut butters                |
| Starchy vegetables (potatoes and beans)         | Dairy foods  | Avocados  |
| Whole grains, including whole grain flours      | Added pure fats (all oils, butter, margarine)  | Coconut   |
| Fresh fruit (not dried, no juices or smoothies) | Eggs   | Seeds   |
| All spices                                      | Vegan 'replacement' foods—fake meats, fake cheeses                                     | Dried fruit   |
| Ground flaxseed and chia seed                   | Refined flours   | Added sweeteners (maple syrup, fruit juice concentrate, added sugars) |
| Water, non-dairy plant-'milks', tea             | Predominantly 'added sugar' foods (candy, snack/energy bars, cookies, cakes, pastries) | Coffee, alcohol   |
|   | Soda, fruit juice, sports drinks, energy drinks, blended coffee and tea drinks         | Refined soy protein and wheat protein (tofu, seitan)                  |

His hyperphosphataemia improved on a WFPBD, without adjustment for phosphorus intake and his potassium, which had been on the high end of the normal laboratory range, remained there or marginally above the normal range. He was advised continued adherence to the food guide, but to choose lower potassium plant-based foods.

The patient and his spouse remained compliant and results from approximately 11 months after starting the diet showed persistent benefit, although his microalbuminuria increased after a nadir 4 months after changing his diet.

**DISCUSSION**

This case illustrates an alternative treatment approach that may be appropriate for select, highly motivated patients, using a strict WFPBD. This approach may offer effective treatment of CKD in patients with the common metabolic comorbidities of obesity, hypertension and diabetes.

Previous studies offer support for this approach, though to our knowledge few controlled diet or lifestyle intervention have shown improvement of kidney function to the degree found in this case. Goldner described two patients with lupus nephritis who improved dramatically after adoption of a raw vegan nutrition protocol.<sup>18</sup> Banerjee *et al* found that among American adults with CKD, those with the highest dietary acid load (DAL) (associated with increased meat and cheese intake and reduced fruit and vegetable intake),<sup>19</sup> had significantly higher risk of progressing to end stage renal disease (relative hazard of 3.04 for highest tertile of DAL compared with lowest tertile of DAL).<sup>20</sup> A prospective cohort study by Khatri *et al*<sup>21</sup> found increasing adherence to the Mediterranean diet among New Yorkers was associated with reduced risk of incident eGFR <60 mL/min. Similarly, a randomised controlled trial found that adding fruits and vegetables to the diet of individuals with stage 3 CKD and metabolic acidosis

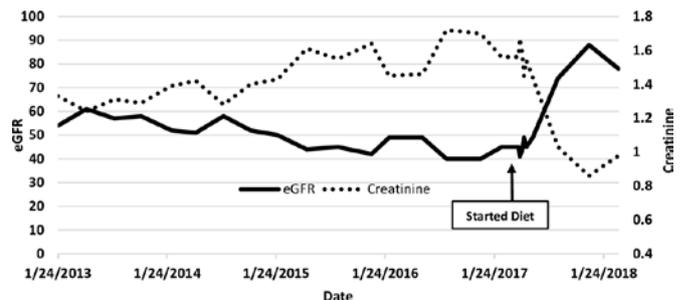
reduced blood pressure, improved the acidosis and slowed eGFR declines over 3 years compared with control patients.<sup>22</sup> More recently Kim *et al* analysed data from the Atherosclerosis Risk in Communities study and found higher adherence to a healthy plant based diet correlated with a decrease rate of incident CKD.<sup>23</sup> Apart from kidney-specific outcomes, overall mortality is significantly lower among individuals with eGFR <60 mL/min who consume higher ratio of plant to animal protein.<sup>24 25</sup> This last point deserves emphasis as individuals with CKD of any stage are more likely to die prematurely than progress to dialysis,<sup>26</sup> with CVD being the most common cause of death.<sup>27</sup> Given the benefits of a WFPBD in CVD in general<sup>9-11</sup> it is feasible they exert a similar effect in CKD patients, who are already at increased CVD risk.

Phosphorus and potassium are often a concern in CKD patients. Plant-based diets may offer benefit for hyperphosphataemia as phosphorus is not as efficiently absorbed from plant sources.<sup>28</sup> Moe *et al* demonstrated this in a randomised crossover trial examining nine patients randomised to alternate between an animal-protein-heavy diet or a plant-protein-heavy-diet for two separate 7-day period separated by a 2-4-week washout period. Despite the diets having a similar phosphorous content, patients' phosphorus values were significantly lower after the high plant-protein diet compared with the high animal-protein diet.<sup>29</sup> Potassium is plentiful in plant-based diets, and the risk of hyperkalaemia requires specific dietary counselling on a case by case basis, although a small pilot study investigating the effects of 2 weeks of a DASH diet in subjects with stage 3 CKD did not find any increased risk of hyperkalaemia with the higher potassium DASH diet.<sup>30</sup>

Weight loss alone has significant impact on labs related to kidney function. Whether through bariatric surgery or pharmaceutical intervention, weight loss has been shown to improve GFR and reduce albuminuria in several studies.<sup>31 32</sup> Yet there are

**Box 2** Follow-up medications 30 August 2017

- Aspirin 81 mg daily.
- Losartan 50 mg daily.
- Pravastatin 20 mg daily.
- Insulin glargine 28 units nightly.
- Insulin lispro 6 units three times per day before meals.
- Fish oil 1000 mg daily.
- Vitamin D 2000 IU daily.
- Continuous positive airway pressure device at night.
- Vitamin B12 1000 µg daily.



**Figure 1** Changes in eGFR and creatinine from 2013 to 2018. eGFR, estimated glomerular filtration rate.

## Innovations in treatment

inaccuracies in evaluating kidney function in the face of significant weight loss using creatinine-based eGFR formulas such as the CKD-EPI formula. The amount of lean body mass is significantly, positively associated with serum and urinary creatinine<sup>33</sup> and significant weight loss is accompanied by lean body mass loss. Approximately 25% of total body weight lost, on average, may be lost from fat free mass, though this proportion is highly variable and dependent on many factors.<sup>34</sup> Thus, serum creatinine may not be a reliable marker of kidney function in the face of significant weight loss.

In this case, while the patient dramatically improved his health in obvious, measurable ways, it is not possible to quantify exactly how much his kidney function changed given his significant weight loss (22.2 kg in the first 4.5 months). Body composition was not measured in this case. One study of bariatric surgery patients without CKD found that creatinine-based eGFR increased by 12%–15% with an average weight loss of 27 kg, while measured GFR did not change.<sup>35</sup> In the case presented here there was an increase in eGFR of 73%, suggesting that the improvement in estimated kidney function was greater than what would be expected from weight loss alone.

### Patient's perspective

At the outset, it seemed like this was going to be a difficult and restrictive way to eat. What I quickly discovered was that I could begin eating foods that I'd been depriving myself of for years because I thought they were unhealthy. By enjoying fresh, ripe fruits, for example, I was suddenly encouraged rather than discouraged. I began feeling different almost immediately and we had to decrease my insulin after ONE day. It seemed like almost overnight I had more energy than I'd had in years. Weight that I had been trying to lose for a decade began dropping off. As the weight came off, I felt lighter, and more able to move my body again. I began walking daily and am now up to 6 miles per day. This lifestyle change has been the greatest gift I've ever received. I am off most of my medications, I've lost over 70 pounds, and I've regained control over my health. I feel empowered by this lifestyle change and I finally feel like I'm in charge of my health, not just an unlucky victim shuffling from one specialist to the next. My only regret was that I didn't know about this sooner.

### Learning points

- ▶ A strict whole-food, plant-based diet, excluding meat, dairy, added fats and processed foods, may offer significant benefit for a motivated patient with chronic kidney disease due to diabetes, hypertension and obesity.
- ▶ If a motivated patient makes a major dietary change to a whole-food, plant-based diet and is on high-risk medications like insulin or, to a lesser extent sulfonylureas and antihypertensives, close monitoring is required to decrease medications in advance of potential adverse effects.
- ▶ Plant-based diets may offer benefit for patients with hyperphosphataemia, as phosphorus is less readily absorbed than animal-based sources of phosphorus.
- ▶ Significant weight loss, which usually involves some degree of lean body mass loss, can reduce serum creatinine independent of its effect on renal function.

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