Case Study: Nutritional management of the vegan with end-stage kidney disease

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Introduction

Chronic kidney disease (CKD) is associated with nutritional complications such as anaemia, electrolyte imbalances, bone-mineral disorders, malnutrition and cardiovascular disease.[1] The nutritional management in CKD is very complex since it includes multiple dietary factors e.g. the intake of protein, energy, sodium, phosphorus and potassium. Protein energy malnutrition is widely prevalent in this population, however recently obesity has also become more common. Poor dietary compliance often occurs in patients prescribed renal diets because it is known to be unpalatable and very restrictive with major lifestyle changes required.[2,3] In a patient following a vegan diet, the complexity of dietary management increases due to further limitations in meeting specifically protein and micronutrient requirements. This is due to vegan diets being high in wholegrains, legumes, fruits and vegetables, which often need to be restricted in CKD.[4] There are also some micronutrients that might be lacking due to avoidance of all animal products. Recent dietary pattern studies have indicated that healthy diet patterns in CKD patients reduced all-cause mortality with evidence from other studies also indicating that some of the dietary restrictions are not warranted.[5,6,7] Chauveau et al[8] suggested that plant-based diets should be used in clinical recommendations in the treatment and prevention of CKD. This case study explores a strictly vegan patient, admitted with end-stage kidney disease (ESKD) and his nutritional management which aimed at allowing the patient to continue veganism while trying to optimise his nutritional status.

Case report

Patient V was a 32-year-old man newly diagnosed with ESKD, of unknown cause, at the end of May 2018. He was of the Hindu faith and a known vegan (avoided all animal and animal-derived products, including dairy and eggs for the past six years), although he had been a vegetarian since the age of 16 years. Patient V was accepted for renal replacement therapy (RRT), specifically continuous ambulatory peritoneal dialysis (CAPD), but due to leakage from the dialysis catheter and subsequent peritonitis, CAPD had to be stopped. He was started on haemodialysis (HD) temporarily (a total of eight weeks). He lived a healthy lifestyle, did not smoke or drink alcohol and went to the gym six days a week, twice a day with cardio training in the morning and weight training in the evening. He also took a vegan protein shake at every gym session. From admission and follow-up over eight weeks, the patient lost a significant amount of weight (Table I) and had some electrolyte disturbances (Table II). He was seen by a dietitian, after referral, from Week 4 which included a two-week follow-up during hospital stay; thereafter he was discharged with weekly follow-up while receiving haemodialysis until week 11.

What are the possible reasons for weight loss?

It is known that malnutrition in CKD patients involves an interplay of multiple pathophysiological alterations like metabolic acidosis, uraemia, dialysis catabolism, hormonal derangements, psychological factors, infection and inadequate intake due to chronic disease.[9,10,11] Protein-energy wasting in ESKD patients receiving intermittent haemodialysis also occurs because of protein turnover in metabolic stress, protein losses from frequent blood testing and losses in the dialysate, together with an inadequate intake related to dialysis treatment and inability to meet increased nutritional requirements.[12]

In this patient the factors relevant to his weight loss included uraemia (as reflected by his increased serum urea and serum creatinine levels), an inadequate intake or decreased appetite, dietary restrictions of a vegan diet, catabolism and nutrient losses.

Clinical examination

The patient was lean and well-built with a small frame size, a normal nutritional status, but presenting with clinical signs of muscle wasting. No clinical signs of fluid overload were observed while his intradialytic weight gain (IDWG), calculated as the patient's weight

Table I. Weight on admission and during the follow-up period

Anthropometry/Weight history			
Height (m)		1.8	
Date	**Dry weight (kg)**	**BMI[a] (kg/m²)**	**Comments**
Week 1, upon hospitalisation	82.4	25.4	
Week 4, first contact with dietitian	77	23.7	6% weight loss (5 kg) in ~ 4 weeks
Week 8	64	19.7	22% weight loss in 2 months (18.4 kg)
Week 9	63.8	19.6	Weight stabilised slightly
Week 11 and ongoing follow-up	61.2	18.8	Lost weight again

[a]Body mass index

Table II. Renal function and electrolyte profile prior to admission and during follow-up

	Ref. range	Prior to admission	Week 1	Week[a] 4	Week[a] 5	Week 7	Week 8
Sodium (mmol/L)	136–145	132	138	150	144		
Potassium (mmol/L)	3.5–5.1	6.3	4.9	5.1	4.9	4.3	5.0
Urea (mmol/L)	2.1–7.1	51.7	64.8	21.8	20.7		25.6
Creatinine (µmol/L)	64–104	2 000	1 822	844	879		
eGFR[b] ml/min/1.73m²	> 60	2	3	6	6		
Calcium (mmol/L)	2.15–2.5			2.16	2.12	2.40	2.30
Magnesium (mmol/L)	0.63–1.05			1.05	0.95	0.86	1.03
Phosphate (mmol/L)	0.78–1.42			2.79	1.91	1.51	1.90
Albumin (g/L)	35–52			39	37	38	

[a]Week 4 and Week 5 managed by dietitian during hospital stay
[b]Estimated glomerular filtration rate

at the beginning of each HD session (pre-weight) minus the weight after (post-weight) the previous HD session, was consistently below 1 kg.

Dietary intake

In hospital

Dietary intake in hospital was initially very poor, not because of the uraemia but due to his own dietary beliefs and restrictions as a vegan and not having a keen interest in the hospital menu, even with ongoing motivation and support. The patient appeared not to present with uraemic symptoms and he reported to have a good appetite. A vegan diet (composition not available) was prescribed with no added milk or egg. The patient was discharged during Week 5 of follow-up, before an oral supplement could be prescribed to complement his intake. However, the standard supplements available at the hospital were also not vegan-friendly (containing milk products).

Usual intake at home

The patient's diet was rich in fruit and vegetables, four portions of fresh fruit and four to five portions of vegetables per day, excluding all meat types, eggs, milk and milk products.

Lunch and dinner included any of the following:

- a cooked vegetable salad including butternut, rocket, seeds
- noodle salad with mixed vegetables and salad dressing
- one to two veggie burgers, or a wrap with mixed vegetables and pesto

Snacks: salted nuts and raisins 50 g or dried fruit 50 g

Beverages: fruit juice 1–1.5 L/day

Supplement: vegan protein shake 350 ml, two servings per day containing 20 g protein per serving, according to patient, was used before diagnosis. The rest of the composition of the product is not known and the patient was not able to recall which supplement he used before his diagnosis.

What are the challenges with a vegan diet in CKD?

A vegan avoids all protein of animal and animal-derived origin, therefore only eats food of plant origin, veganism being a way of living that excludes all forms of animal exploitation and cruelty.[13] Vegan diets are becoming more popular amongst teenagers, especially females where food choices are based on care for the earth's resources and environment, ethical and/or religious issues regarding animal care and the benefit of plant-based diets.[14] Meeting protein and micronutrient requirements for veganism in a healthy individual is a challenge. However, this challenge is more pronounced in CKD patients due to good plant-based protein sources being high in other nutrients that are meant to be restricted in CKD, for example fruits, vegetables and wholegrains. In a large cohort comparing nutrient intake of meat eaters compared to non-meat eaters, there was a 5% lower mean energy intake for vegetarians and 14% lower intake in vegans.[4] Nutrients of particular concern in CKD patients following a vegan diet are omega 3 fatty acids, zinc, calcium, vitamin B_{12}, iron and vitamin D. Another known potential negative outcome of a vegetarian diet is the risk of osteoporosis.[14,15]

In a vegetarian diet, the bioavailability of phosphorous from plant-based food sources is as low as 20–40%, because most of the phosphorus is found as part of phytate resulting in decreased intestinal absorption, which is why protein from these foods is more beneficial in managing serum phosphate.[16,17,18] The potassium intake in vegan diets is known to be high due to the high intake of fruit, vegetables, nuts and wholegrains. Consideration should also be given to processed and packaged vegan foods, due to added potassium and phosphate additives. Additives are used to improve taste, texture, shelf-life and processing time of food, and have a bioavailability of 90–100% that is a lot higher compared to natural food sources.[3,7,16,19]

Is a vegan diet suitable for CKD?

Vegetarian diets provide large amounts of wholegrains, nuts, fruits, and vegetables that are high in n-6 fatty acids, dietary fibre, folic acid, potassium, magnesium, vitamin C, vitamin E, carotenoids and phytochemicals.[4,15]

Evidence suggests that increasing the proportion of plant-based protein intake in patients with CKD may improve renal outcomes, without compromising nutritional status.[16] Correcting metabolic acidosis can reduce the loss of glomerular filtration rate (GFR), therefore in CKD patients on a renal diet, oral bicarbonate and intake of fruits and vegetables are important with close monitoring of potassium serum levels.[19] Plant-based foods high in potassium can be a risk in CKD but because of its base-inducing effect, the risk for hyperkalaemia is limited. A vegetarian diet yields an alkaline load due to its high organic bicarbonate-producing anions, like citrate and lactate resulting in a 50% reduction in bicarbonate prescriptions together with improved insulin resistance in the case of patients with diabetes. Therefore protein from plant-based food sources is highly recommended in CKD patients to decrease the risk for cardiovascular and metabolic disorders. In dialysis patients a vegetarian diet was associated with lower serum blood urea nitrogen, serum creatinine, muscle mass, BMI, and levels of inflammatory markers, but they required more erythropoietin. However, when comparing the vegetarian and non-vegetarian dialysis patients, there were no differences between the two groups in the serum albumin, pre-albumin, muscle strength, subjective global assessment, and daily activities. Vegetarian diets may be beneficial for CKD patients due to their cardiovascular benefits, anti-oxidant and lipid-lowering properties, but they need to meet protein and other micronutrient requirements to provide adequate nutrition.[4,19]

Vegan diets also improve the gut microbiome in CKD patients. There are various reasons for gut dysbiosis in CKD including low dietary fibre intake, constipation and changes caused by uraemia.[20] It is mainly due to the inability of the kidney to excrete waste products that the colon becomes the main excretory organ to maintain body homeostasis; urea is excreted into the gut and the end product of urea metabolism is ammonia, thus increasing luminal pH due to the action of urease-producing bacteria causing changes in the gut barrier.[21] The latter increases gut-derived uraemic toxins including indoxyl sulphate (IS), p-cresyl sulphate (PCS) and trimethylamine-N-oxide (TMNO). These changes are believed to contribute to uraemic toxicity, systemic inflammation and are associated with cardiac mortality.[20]

Microbiota in the large intestine contribute to digestion through two main catabolic pathways i.e. saccharolytic (fermentation) or proteolytic (putrefaction).[22] CKD diets are often low in fibre due to dietary restrictions and constipation, a frequent complication of CKD, which not only worsens dysbiosis and uraemic status, but also increases the risk of hyperkalaemia.[22] Vegan diets on the other hand with their high fibre content assist in improving gut dysbiosis in CKD.[21] Fibre plays an important role in favour of sacchrolytic species, influencing immunity, metabolism, and health status, while lowering proteolytic-derived uraemic toxins.[23] Similarly, the Mediterranean diet high in complex carbohydrates, fibre, vitamins and low in animal proteins and fats, promotes the beneficial saccharolytic profile. The Western-style diet, rich in animal proteins and fats, by means of an increased bile salts secretion, has a selective effect on bile-resistant and sulphate-reducing bacteria resulting in a proteolytic action, worsening dysbiosis.[22]

What is the effect of soy protein in CKD?

Soy protein is also known to be beneficial in patients with CKD due to cardiovascular protection, cancer prevention, decreased proteinuria and positive effect on glucose levels which has also been a suggested mechanism for reducing kidney malfunction.[4,24,25] Other benefits include the antioxidant properties and their positive effect on dysbiosis of the gut microbiome caused by uraemia.[24,25] A meta-analysis by Jing and Wei-Jie reported that soy intake in pre-dialysis patients resulted in a significant reduction in proteinuria, C-reactive protein (CRP) and serum phosphate but the latter did not change in dialysis patients.[26] In another meta-analysis including nine trials involving 197 subjects, the effect of dietary soy protein intake significantly reduced serum creatinine and serum phosphorus concentrations.[4,25] Most animal and human studies indicated that soy protein compared with animal protein can improve renal function.[25]

What were the main nutritional issues experienced by Mr V?

Since being hospitalised, patient V had already lost 6% of his body weight before being referred to the dietitian and had about 22% body weight loss over a period of about eight weeks. The patient experienced fatigue and felt unwell, and was dealing with emotional factors with regard to his diagnosis of ESKD, as well as starting on renal replacement therapy that was also complicated by infection. A very poor dietary intake during hospitalisation was partly due to him not receiving a vegan diet initially when he was admitted, prior to being referred to the dietitian. Even after being managed by the dietitian and receiving a vegan diet in the hospital, the patient's intake remained insufficient due to his dislike of the hospital vegan meals. During his out-patient follow-up he also had other strict dietary preferences e.g. only consuming low energy beverages and following a low fat diet which further limited his energy intake.

What prescription would one advise to improve Mr V's nutritional status?

During the first week of follow-up patient V's hospital diet was changed from a normal diet to a vegan diet and the patient was encouraged to increase his oral intake to meet his requirements and improve his nutritional status. From the second week of follow-up and before discharge, the patient was prescribed higher requirements due to ongoing catabolism, peritonitis and ongoing weight loss. Even though the patient's appetite and intake improved by the time he was discharged and during ongoing follow-up as out-patient, he continued to lose weight. At this point of his management (after Week 8), a vegan supplement was prescribed (Table III). Also during his hospital stay and for his discharge a less restrictive recommendation for phosphate and potassium was prescribed because his dietary intake was predominantly plant-based. His fluid intake was not restricted as he reported a good urine output and a low IDWG.

Table III. Recommended dietary prescription

Prescription[a27,28,29]		
Energy	35 kcal/kg	2 611 kcal (10 966 kJ)
Protein	1.2–1.4 g/kg	90–104g
Carbohydrate	53%	342 g
Fat	30%	87 g
Fluid	Individualise	Not restricted due to residual renal function
Sodium	< 2.3 mg	
Phosphate	800–1 000 mg	Low bioavailable plant-based protein sources
Potassium	2 700–3 100 mg	Adjust intake based on serum levels and limit if increased

[a]Using an initial weight 74,6 kg

Renal exchanges

For the patient's discharge a more liberal healthy vegan diet was prescribed (compared to the standard renal diet, traditionally lower in fruit and vegetables) as it's been shown to improve renal outcomes and compliance,[19] using the renal exchange lists to prescribe exchanges for the patient (Tables IV and V).

Examples of the meat alternatives included are legumes (e.g. bean salad, veggie wrap, hummus, lentils and peas), nuts, seeds, tofu, soy (e.g. veggie burger, soy mince) and almond butter.

Table IV. Renal exchanges prescribed upon discharge

Renal exchange groups	Type of exchanges	No. of renal exchanges
Meat alternatives	High phosphate	7
Fruit	Low K[a]	2
	Moderate K	1
	High K	1
Vegetables	Low K	2
	Moderate K	2
	High K	2
Starches	Low K	7
	High K	2
Beverages	Low energy	8
Sugar		5
Fats		7

[a]K – Potassium

How did the prescription affect Mr V's electrolyte-, fluid balance and nutritional status?

After providing a more liberalised and less restrictive diet, especially regarding potassium- and phosphate-containing food sources and a continuous monitoring of his biochemistry, the patient's electrolyte balance improved, with normal serum potassium level and improvement in the serum phosphate levels compared to his initial serum levels.

Both his restrictive salt intake, good urine output (receiving diuretics) and receiving renal RRT, in the presence of good oral intake, ensured a normal fluid balance and good blood pressure control.

It was a challenge though meeting his energy and protein requirements with a plant-based diet. Vegan supplements are typically low in energy, carbohydrates and fat, but high in protein. Therefore, with the current supplement, the patient's protein requirements are better met (106–111%; Table V) , but with a lower than recommended energy intake (86–88%). The patient continued to lose weight not only due to insufficient energy intake but also due to his catabolic state as a result of dialysis and peritonitis. However, patient V was able to maintain a good dietary intake, his weight started to stabilise at 61.2 kg with a gradual increase in weight of 1 kg observed after week 11 of follow-up and after increasing the supplement to two servings per day.

Table V. Comparing patient's renal exchanges and supplement prescribed with dietary prescription (see Table III)

	Energy kJ	Prot g	CHO g	Fat g	Sodium mg	Phosphate mg	Potassium mg
Dietary prescription[27, 28, 29]	10 966	90–104	342	87	< 2 300	800–1 000	3 100
Composition of exchanges	9 115	75	387	70	1 550	1 410	4 355
% of dietary prescription	83	72–83	113	80.5	67	141	140
Supplement (1–2 /day)[a]	281–562	20–40	1.0–2.0	1.0–2.0	105–110		
% of dietary prescription (including supplement)	86–88	106–111	113–114	82–83	72		

[a]Supplement (vegan-friendly) per serving 25 g: 281 kJ, 20 g Protein, 1.0 g CHO, 1.0 g Fat

Taking into consideration that he is scheduled to start peritoneal dialysis, the additional energy in the form of glucose that will be absorbed from the Dianeal solution will help to improve his energy intake by further increasing his carbohydrate intake, which is already high. His carbohydrate intake will, therefore, need to be decreased by making the sugar exchanges less and also decreasing some of the starch exchanges while staying within his recommended protein allowance.

Is the patient's current supplement appropriate?

The vegan supplement that patient V received was high in protein. It provided 20 g protein per serving, which supplied an additional 6.2% protein in his diet, but was low in energy, providing 67 kcal per serving (250 ml serving). The supplement contained an acceptable amount of sodium, 105 mg per serving. However, the potassium and phosphate content of the supplement was not available. The Pea protein used was also free from genetically modified organisms (GMOs), gluten, soy, added sugars, and preservatives. The rest of the supplement ingredients included 1% flavouring, salt, red beet juice powder, and steviol glycosides (non-nutritive sweetener). The patient continued with this supplement, since he was already using it. After an extensive search for other vegan supplements available on the market, an alternative supplement, a bit higher in energy, fat and carbohydrates was found and recommended.

Discussion

In patients with CKD, the goal of dietary prescriptions should be aimed at interventions that are simple, easily understandable and implementable in daily life by patients.[30] Very strict dietary limitations have not been proven to be of major benefit, but instead worsen the patient's satisfaction and quality of life.[3] Patient survival can be improved through the impact of a plant-based diet on metabolic acidosis and blood pressure, lower production of uraemic toxins through altered gut flora, improved body weight and cardiovascular outcomes.[16,31] The low potassium diet usually prescribed in CKD is not in line with a healthy diet and therefore contributes to the burden of cardiovascular disease.[3] Instead of restricting the intake of fruit and vegetables, patient education should focus on limiting potassium and phosphate in processed food and food preservatives, while treatment of acidosis and efficient dialysis schedules can be offered instead of dietary restrictions. Therefore patients should be informed that the renal diet for CKD is not based on deprivation or severe restrictions, but it aligns with healthy eating guidelines as for the general population.[28]

Patient V was prescribed a healthy balanced vegan diet to meet his requirements which was high in fibre and non-digestible carbohydrates including wholegrains, legumes, fruits, vegetables and unsalted nuts. This was done by empowering the patient through ongoing education, with weekly follow-up and support for eight consecutive weeks after diagnosis. The patient was allowed to make informed choices regarding the different potassium-containing foods that are within the 'heart-healthy' range and was further informed about appropriate cooking procedures e.g. soaking and boiling to help reduce potassium content in food, which can result in removal of potassium of up to 60–80% from raw foods. Dietary advice emphasised a reduction of the hidden food sources of potassium and phosphate from additives in preserved foods, processed foods and low sodium salt substitutes.

The patient's dietary belief as a vegan was encouraged as it aligns with healthy eating guidelines while the prescribed diet was not based on deprivation or severe restrictions to improve adherence.

Conclusion

Managing protein-energy malnutrition in a vegan with CKD on dialysis is especially challenging to meet the prescribed energy and protein requirements, while including only plant-based food sources rich in potassium and phosphate. An individualised nutritional education approach should be used with regular follow-up and counselling which are all important aspects of clinical management to improve patients' nutritional status.

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