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Research Article

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Effect of Fruit Intake on Prevention of Arrhythmia Induced by Hypokalemia in Maintenance Hemodialysis Patient During Hemodialysis Sessions: A Case Report

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Abstract
Hypokalemia is a common malignant like hyperpotassemia complication of maintenance hemodialysis (maintenance hemodialysis, MHD) patients. Hypokalemia increased risks of cardiovascular disease, cerebrovascular events, hospitalization and death. In this article, we report a 56-year-old female MHD patient with repeat arrhythmia during hemodialysis sessions due to hypokalemia. After a month of attempt of fruit intake programme, the patient developed no symptoms or signs of arrhythmia, hypokalemia, hypoglycemia during hemodialysis sessions.

Keywords: Maintenance Hemodialysis, Hypokalemia, Arrhythmia, Intake, Fruits

Introduction

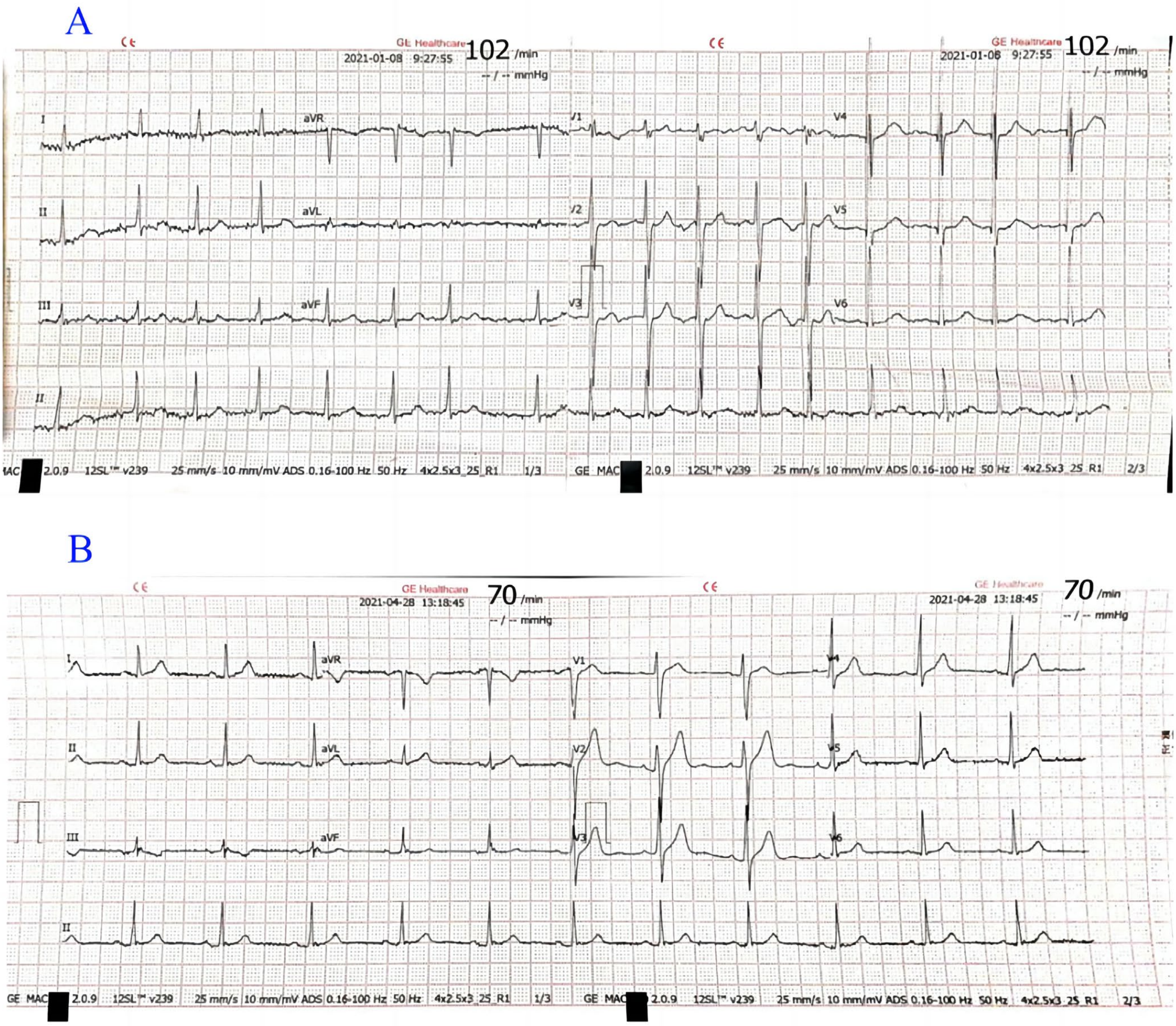
Hypokalemia is a common malignant complication of maintenance hemodialysis (maintenance hemodialysis, MHD) patients like hyperpotassemia [1, 2]. Given that the primary excretion route of potassium is through the kidney, MHD patients should be given a potassium-restricted. Patients with MHD are routinely educated to reduce the intake of foods with high potassium [3]. Thus, hypokalemia during the intra- and interdialytic periods occurs frequently due to excessive restriction of high-potassium foods (especially fruits) [4]. However, hypokalemia in MHD patients is as dangerous as hyperkalemia, but it is often overlooked. In MHD patients, hypokalemia is a common complication in the middle and late stages of hemodialysis sessions, and its incidence is as high as 40.08% to 54.59% [5]. Hypokalemia increased risks of cardiovascular disease, cerebrovascular events, hospitalization and death [2, 6]. The main treatment is to supplement potassium with drugs [7].

In this article, we report a 56-year-old female MHD patient with repeat arrhythmia during hemodialysis sessions due to hypokalemia. After the poor effect of drug treatment, we tried to implement fruit intake programme for her by calculation of potassium and glucose and adjustment by monitoring of level of serum potassium and blood glucose. After a month of attempt, the patient developed no symptoms or signs of arrhythmia, hypokalemia, hypoglycemia during hemodialysis sessions. In addition, the patient's constipation symptoms have also been relieved and even be laxatives-free.

Case Presentation

A 56-year-old female received maintenance hemodialysis therapy in our hospital for 14 years, with a complaint of chest tightness and dyspnea during hemodialysis sections for more than 10 days from January 2021. She had a medical history of coronary heart disease, renal anemia. The patient has no residual renal function, with a urine volume of 0ml/24h. Potassium concentration in the dialysis solution was 2.0 mmol/L, and the bicarbonate concentration was 32 mmol/L. The hemodialysis prescription: blood pump flow rate was setting by 200ml/min; dialysis time per session was for 4 hours; dialysis frequency was 3 times per week; dialysate flow rate was 500ml/min; The ultrafiltration rate is 5.4-6.1ml/h/kg. The patient had good appetite and had good nutritional status after physical examination and laboratory examination with long-term oral administration of calcium supplements, baking soda, folic acid tablets, B-complex vitamins without drugs influencing blood potassium such as insulin, aldosterone, and potassium ion binders.

The anticoagulant protocol was for enoxaparin sodium 2,000 units/time. She was treated with lanthanum carbonate to deal with hyperphosphatemia for 2 years. Meanwhile, the patient was constipated for nearly one year and mainly assisted in defecation by oral lactose. She had 1 bowel movement a day with about 15ml of each bowel movement. Predialysis laboratory examination: creatinine: 963.6mmol/L, urea nitrogen: 28.5mmol/L, albumin: 35.7g/L, hemoglobin: 121g/L, β2 microglobin: 39.97g/L, serum calcium: 2.29mmol/L, potassium: 4.87mmol/L, carbon dioxide binding capacity: 24.8mmol/L, phosphorus: 1.68mmol/L, magnesium: 0.98mmol/L, chlorine: 96.4mmol/L, Low-density lipoprotein: 3.61mmol/L, high-sensitive troponin: 27.2pg/ml, brain natriuretic peptide: 1021pg/ml. cardiovasc ultrasound examination revealed reduced left ventricular ejection fraction (LVEF, 63%) and mitral regurgitation. The score of coronary-artery calcification was 1748.78. After 2 hours on hemodialysis session, the patient's serum potassium was reduced to 2.7mmol/L, blood glucose was reduced to 4.6mmol/L, and the electrocardiogram showed sinus arrhythmia, as shown in Figure 1. Thus, she was diagnosed with hypokalemic arrhythmia. The patient reported greatly enjoying eating fruits. However, she did not dare to eat fruits because of the experience of rescue for hyperkalemia caused by excessive intake of fruit and vegetables one year ago. Therefore, the patient was very depressed and helpless for being unable to eat fruit and vegetables like a healthy person.



To correct for hypokalemia in hemodialysis (serum potassium ≤ 3.5mmol/L), the potassium dialysate concentration was changed to 3.0mmol/L. However, the patient still complained of dizziness, chest tightness, palpitations, with serum potassium of 3.2 mmol/L and blood glucose of 3.9mmol/L. We found that dizziness and palpitations were relieved, and chest tightness did not relieve after the patient consumed her meal. Therefore, we implemented a potassium supplementation scheme for the patients. The potassium supplementation protocol was changed to: dialysate concentration of K+ was 3.0 mml/L, 5% glucose 250ml+ 10% potassium chloride injection of 7.5ml (including 750mg / 10mmol potassium chloride, glucose 12.5g) was given constant intravenous infusion after the start of dialysis. intravenous infusion 250ml of 10% glucose solution and 7.5ml of 10% potassium chloride injection after 2 hours of hemodialysis at a consistent speed. serum potassium concentrations were 4.5mmol/L, 3.6mmol/L, 3.1mmol/L and, blood glucose was 7.1mmol/L, 5.4mmol/L, 5.3mmol/L, respectively at the time of pre-hemodialysis, 2 hours after hemodialysis initiation and post-hemodialysis. After applying this scheme, the chest tightness was relieved, but was not completely disappeared.

We tried to supplement the fruit on dialysis after obtaining the patient's consent, considering the disadvantages of drug potassium supplementation in increasing the additional fluid load and the patient's love for fruit, and dietary lack of cellulose and subsequent constipation of the patient. Treatment schemes: first, the fruit were weighed, and the potassium content and glucose content were calculated according to the composition exchange table [8]. The patient consumed 2/3 portions of fruit at the start of hemodialysis (within 30min) and 1/3 portions of fruit at 2 hours after hemodialysis initiation. Concentrations of serum potassium and blood glucose were tested at dialysis initiation, 2h of hemodialysis session (before eating fruit) and post-hemodialysis session, while continuous electrocardiographic monitoring was administered during hemodialysis session. The next fruit intake scheme was adjusted according to the changes in serum potassium and blood glucose of this results. The patient finally tried four schemes for seven courses of experiments, as detailed in

Table 1 Potassium and glucose content of fruits in different schemes

Scheme	Type and amount of fruits	weight (g)	Potassium (mg)	glucose (g)	Calories (kcal)	Timing of intake
A	Banana, 1	144	368.6	28.08	133.9	30 minutes after hemodialysis initiation
B	Banana,1.5	200	512.0	39	186	30 minutes after hemodialysis initiation
C	Banana, 2	289	739.8	56.36	268.8	30 minutes after hemodialysis initiation
C	Banana, 2	312	798.7	60.84	290.2	30 minutes and 2 hours after hemodialysis initiation
D	Banana, 2 granulated sugar orange, 4	360	874.2	66.22	334.8	30 minutes and 2 hours after hemodialysis initiation
D	Banana, 2 granulated sugar orange, 4	340	825.4	63.66	316.2	30 minutes and 2 hours after hemodialysis initiation
D	Banana, 2 granulated sugar orange, 4	348	842.7	64.68	323.6	30 minutes and 2 hours after hemodialysis initiation

Too fast sinus rhythm was found in implementation of scheme A and B before the end of hemodialysis. When trying to implement scheme C and D, symptoms and signs of arrhythmias such as chest tightness and palpitations were disappeared. However, scheme C remained with low blood glucose at 2h of hemodialysis. After implementing scheme D, serum potassium, blood glucose and vital signs were the most stable and complications was least. See Tables 2 and 3 for more details. The ECG in Figure 1 shows that normal cardiac rhythm in dialysis through via trying scheme D. Besides, hypokalemia and hypoglycemia of patient were relieved. So, we suggest that patients try to apply scheme D in dialysis session and increase the fruit and vegetable content in the daily diet by soaking and boiling to reduce the potassium content in vegetables and fruits. After one month of follow-up, the hypokalemia and hypoglycemia and discomfort on dialysis of patient disappeared and the constipation symptoms were relieved, thus suspending the oral lactose oral solution.

Table 2 Changes in serum potassium and blood glucose of the patient under different schemes

Schemes	Serum potassium (mmol/L)			Blood glucose (mmol/L)		
	T1	T2	T3	T1	T2	T3
A	4.81	3.67	3.15	6.25	4.13	4.21
B	5.10	3.70	3.39	7.80	4.44	4.90
C	5.20	4.30	3.41	8.10	4.30	5.00
C	4.90	4.00	3.63	8.83	4.70	5.50
D	5.07	3.79	3.72	7.10	5.90	6.10
D	4.76	3.90	3.69	10.58	6.52	6.81
D	5.10	4.43	3.73	7.50	5.93	6.65

T1: pre-hemodialysis; T2: 2 hours after hemodialysis initiation; T3: post-hemodialysis

Table 3 Changes in blood pressure and heart rate of the patient under different schemes

Schemes	Blood pressure (mmHg)			Heart rate (beats per minute)			Arrhythmia
	T1	T2	T3	T1	T2	T3	
A	130/77	109/69	133/73	76	100	123	Yes
B	133/69	118/66	129/71	68	94	114	Yes
C	128/64	127/68	136/72	71	88	107	Yes
C	134/78	116/77	144/74	62	77	93	No
D	138/74	103/73	136/69	81	87	91	No
D	135/75	113/66	141/72	72	86	81	No
D	135/67	123/68	130/73	72	86	88	No
T1: pre-hemodialysis; T2: 2 hours after hemodialysis initiation; T3: post-hemodialysis							

方案	A方案			B方案			C方案			D方案		
	透析前	透析2h	透析后	透析前	透析2h	透析后	透析前	透析2h	透析后	透析前	透析2h	透析后
PH	7.37	7.46	7.48	7.39	7.42	7.48	7.42	7.45	7.51	7.44	7.46	7.49
PCO2	40	42	42	42	46	40	38	42	37	42	42	36
PO2	119	118	111	105	108	105	124	111	112	105	107	107
Na+	133	138	140	133	142	137	134	137	138	138	140	138
Ca2+	1.19	1.23	1.25	1.06	1.23	1.15	0.96	1.14	1.21	1.05	1.15	1.13
lac	1.1	0.7	0.5	1.3	2.1	1.6	1.9	0.7	0.8	1.7	0.7	1.3
HCT	36	40	46	38	42	52	45	46	47	32	42	53
Hco3-	23.1	29.9	31.3	25.4	29.8	29.8	24.6	29.2	29.5	27.4	28.5	29.4
Beb	-2	5.5	7	0.3	4.2	5.8	0.3	4.6	6.3	0.3	2.5	4.2
Hgb	123	145	158	120	133	142	119	130	147	120	145	160

Discussion

As reported, incidence of arrhythmia was 10.2% when serum potassium concentrations were lower than 3.5mmol/L [9]. The differential diagnosis of arrhythmia in this case includes electrolyte concentration, blood glucose concentration, cardiovascular and cerebrovascular diseases, infection, albumin, hemoglobin, decrease rate of urea, antihypertensive drugs, etc. There was no significant support point except for low serum potassium and coronary heart disease history in dialysis. Moreover, in this case, after potassium supplementation via dialysate and drug during hemodialysis, related symptoms had improved, supporting the diagnosis of hypokalemia, which is the main cause of arrhythmia in patients on dialysis.

At present, prevention of hypokalemia in dialysis mainly treated by dialysate with high concentration of potassium (3.0mmol/L) and intravenous injection of potassium chloride. Reports of fruit intake for hypokalemia during hemodialysis was few. International Society for Renal Nutrition and Metabolism (ISRNM) pointed out meals and supplements during hemodialysis contributing to the improvement of nutritional status, hemodialysis quality and clinical outcome should be considered as a part of the standard-of-care practice for patients without contraindications [10].

Daily intake of potassium of 2000-2500mg was recommended by the guidelines, and that dietary potassium intake is not associated with serum potassium or hyperkalemia [11]. Before limiting dietary potassium intake, patient potassium intake should be carefully evaluated and other potential clinical factors associated with serum potassium balance should be considered in the management of hyperkalemia [12]. However, 80% of potassium and about 22g glucose in blood are cleared by diffusion, so the incidence of hypoglycemia and hypokalemia is highest at 2 hours after hemodialysis initiation [13, 14]. Since fruit and vegetables are the major source of potassium in human body, we tried to make a safe fruit intake scheme for the patient, which was based on composition table of foods [8, 15]. The fruit was consumed twice in a 2:1 ratio, which can not only prevent hypopotassium and hyposaccharemia during hemodialysis, but also can provide other nutrition from high potassium foods (vitamins, high dietary fiber, etc.) without worry about hyperkalemia. In addition, the biological components of fruit (e. g., vitamins, antioxidants, micronutrients) may have additive and synergistic cardioprotective effects, including reduced oxidative stress and blood pressure, as well as improved lipoprotein profile and insulin sensitivity [5].

In addition, bowel disorders such as constipation are common in MHD patients. And the incidence of constipation in hemodialysis patients was up to 30.5% [16]. Constipation not only aggravate the accumulation of uremia toxins, cause dizziness, anxiety and insomnia, but also increase the risk of malnutrition, cardiovascular and cerebrovascular disease events and hyperkalemia [17]. Constipation of patient in this case may be related to lanthanide carbonate, restriction of water and high cellulose food intake. The patient was hospitalized for hyperkalemia after many days of constipation. Therefore, the patient may have had a serum potassium accumulation caused by constipation. Surprisingly, the program we tried using fruit alleviated the patient's constipation symptoms and even stopped laxatives. It may be because fruit provide alkali and fiber in the diet, which may be beneficial to alleviate metabolic acidosis, regulating the internal balance of potassium, and increasing the excretion of potassium in feces [18]. At the same time, the intake of fruit during hemodialysis treatment satisfied the patient's desire to eat fruit so as to reduce the incidence of hyperkalemia caused by excessive intake of fruit during interdialytic periods. Last but not least, the daily stress related to dietary restriction significantly reduced the patient's quality of life [19]. The patient can eat fruit like a healthy person, which greatly increases their confidence in life and improves the patient's quality of life.

In summary, the intake of fruit containing 847mg of potassium and about 64g of glucose during dialysis can not only treat MHD patients with hypokalemic arrhythmia, but also relieve the symptoms of hypoglycemia and even constipation, and improve the quality of life of patients. Considering that there are individual differences in hypokalemia arrhythmia in different MHD patients, the patient's condition should be fully evaluated and the risk factors for arrhythmia should be checked before implementing the program. During the implementation of the program, serum potassium should be monitored to ensure that its serum potassium is stable and controllable.

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Statement of Ethics

The research was conducted ethically in accordance with the World Medical Association Declaration of Helsinki. The patient gave his consent for publication of the report. The approval letter was obtained from the Ethics Committee of the Guangdong Provincial People's Hospital, Guangdong Academy of Medical Sciences (KY-Q-2021-172-02).

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