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CASE REPORT

Life-threatening hyperkalemia after excessive ingestion of boiling water with Jerusalem artichoke extract: case report

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Abstract

Hyperkalemia is fatal and can be caused by various reasons. Electrocardiogram changes, such as peaked T waves, PR interval (PR) prolongation, bradyarrhythmias and QRS complex (QRS) interval widening, occur as the potassium level increases. We present a case of hyperkalemia that occurred in a 69-year-old patient who took Jerusalem Artichoke extract boiled with water. He had atrial fibrillation and was admitted to the hospital with chest discomfort. His systolic blood pressure (SBP) was 90 mmHg, while his heart rate was 32 bpm. An emergency medicine doctor used atropine for symptomatic bradycardia, although ineffective. The patient's base creatinine was 1.4 mEq/L (normal: 0.5–1.3 mEq/L), indicating mild to moderate chronic kidney disease. His serum potassium was 8.1 mEq/L (normal: 3.5–5.1 mEq/L), blood urea nitrogen was 35.5 mg/dL (normal: 8–23 mg/dL), and serum creatinine was 2.71. At admission, systolic blood pressure was 70 mmHg, and we conducted transcutaneous pacing. Although SBP was elevated to 100 mmHg and potassium level was normalized, his rhythm could not be normalized without transcutaneous pacing. Thus, we inserted a temporary pacemaker, maintaining a heart rate above 70 beats per minute. History-taking revealed that the patient was taking spironolactone (a potassium-sparing agent), digoxin (which can cause hyperkalemia), propranolol and furosemide for atrial fibrillation in another local hospital for 10 years. He admitted frequently drinking water boiled with Jerusalem artichoke extract approximately >2 liters per day for 7 days. Considering that hyperkalemia is the leading fatal cause of idiopathic sinus bradycardia, if a patient has chronic kidney disease (CKD), the characteristics of food and medication should be carefully considered when providing in an outpatient setting if a patient has chronic kidney disease.

Keywords

Jerusalem artichoke; Hyperkalemia; Electrocardiogram; Atrial fibrillation

1. Introduction

Jerusalem artichoke inulin could reduce fasting blood glucose and lipid levels in a dose-dependent manner, showing antihyperglycemic effects in rats fed a high-fat diet [1]. Additionally, previous case reports showed that Jerusalem artichoke can increase B-cell function by increasing glucose tolerance in rats with diabetes through various mechanisms, including reversing insulin resistance [2]. Therefore, Korean individuals with diabetes practice boiling Jerusalem artichoke extract in water. However, this extract has a high potassium level, approximately 630 mg per 100 g of Jerusalem artichoke.

There are many studies on potentially fatal food-induced hyperkalemia. Potassium intake of <1500 mg/day is recommended, with >250 g of Jerusalem artichoke exceeding the recommended amount. Consequently, this report presents a previously not-reported case of hyperkalemia-induced junctional rhythm caused by drinking water boiled with Jerusalem artichoke extract. This case involves a 69-year-old Korean man. His baseline creatinine (Cr) level, measured a month ago, was 1.49 mEq/L, and the glomerular filtration rate was approximately 56 mL/min/1.73 m^2, indicating a mild to moderate CKD. Boiling 10 g of Jerusalem artichoke in 1 L of water is recommended before consumption. Although the exact amount cannot be estimated, the patient boiled 50 g of Jerusalem artichoke in 500 cc of water several times and drank it. The patient drank Jerusalem artichoke extract 2–2.5 L per day for a week, which caused a junctional rhythm due to life-threatening hyperkalemia. He was treated with potassium-lowering emergency treatment and transcutaneous pacing.

No case of hyperkalemia caused by drinking boiled water with Jerusalem artichoke extract was previously described. Thus, we attempted to explain that caution is necessary when consuming this unprescribed substance, especially when concurrently using drugs that can cause hyperkalemia, such as

digoxin and spironolactone.

2. Case description

A 69-year-old Korean man received atrial fibrillation (afib) medication for 10 years according to the past medical history and was diagnosed with mild to moderate CKD, as evidenced by Cr level of 1.49 mEq/L and blood urea nitrogen (BUN) level of 57 mg/dL. He had prediabetes since his blood sugar level was below the diagnostic criteria for diabetes. Thus, lifestyle modification was recommended. He decided to drink boiled water containing Jerusalem artichoke because he heard that Jerusalem artichoke can increase B-cell function by increasing glucose tolerance in rats with diabetes through various mechanisms, including reversing insulin resistance. The patient complaining of persistent chest tightness after vomiting visited the emergency room. His afib treatment remained unchanged over the years, comprising digoxin, rivaroxaban, propranolol and spironolactone. He was a smoker for 40 pack-years with an uneventful family history. At hospital admission, the blood pressure was relatively stable, but the heart rate (HR) was only about 30 beats per minute (bpm). Therefore, atropine was used at a local hospital, although ineffectively. Then, he was transferred to our hospital. Upon the transfer, his systolic blood pressure was unstable at approximately 70 mmHg, and transcutaneous pacing was performed. Laboratory results showed a significantly increased potassium level of 8.0 mEq/L (not hemolyzed), BUN level of 35.5 mg/dL, serum Cr level of 2.71 mg/dL, sodium level of 135 mEq/L, chloride level of 105 mEq/L, bicarbonate level of 15.3 mEq/L, and creatinine kinase level of 94 IU/L (Table 1). Other laboratory results included a hemoglobin count of 13.4 g/dL, hematocrit of 46.8%, white blood cell count of 13.4 cells/mm^3, and platelet count of 227 cells/μL. Urinalysis showed a pH of 5.0 and a trace of proteins. Electrocardiogram (ECG) at admission showed a junctional escape rhythm of approximately 28 bpm (Fig. 1). The QRS interval was 114 ms, and the corrected QT interval (QTc) was 347 ms, which was normal. Hyperkalemia was promptly treated, and the potassium level decreased to 6.7 mEq/L and then to 4.6 mEq/L within a short time. With transcutaneous pacing, HR improved to >60 bpm (Fig. 2), and potassium level was restored. However, a temporary pacemaker was inserted since the HR was not normalized. BUN and serum Cr levels improved during hydration. The temporary pacemaker was removed 4 days after insertion, and the junctional rhythm was approximately 45 bpm at removal. Observation in the ward was performed for about 3 days, followed by conversion to sinus rhythm with premature ventricular complex. The patient reported vomiting after consuming 2–2.5 L of boiled water with Jerusalem artichoke extract for a week because he heard that it is helpful in reducing fast glucose levels by increasing glucose tolerance and reversing insulin resistance. Then, he complained of chest discomfort. Moreover, hot and humid Korean weather can lead to acute renal failure. Thus, he probably drank a lot of water boiled with Jerusalem artichoke extract to relieve his thirst.

3. Discussion

Potassium is the most abundant cation in the body. The resting membrane potential (RMP) in the body is determined by the potassium concentration gradient along the cell membrane [3–5]. Alterations in the RMP impair normal neural, cardiac and muscular functions. Potassium is rapidly absorbed from the small intestine, with pure gastrointestinal (GI) absorption of approximately 90%, excluding GI loss. The lower GI secretion contains a high potassium level, but the amount of stool is limited; hence, only a part of potassium is excreted into the GI [6]. The main excretion is through the kidneys, ranging from 5 to 500 mEq/dL [7]. It is filtered in the glomerulus, absorbed by the proximal tubule and loop of Henle, and ultimately removed from the tubule. Through this mechanism, potassium excretion from the kidney is flexible and adaptable. If the daily ingestion of potassium increases for several days, the

TABLE 1. Characteristics of the presented case report.

Onset	19 April 2022 6:30
Chief complaint	Chest tightness after vomiting
Medical history	
	Atrial fibrillation
	Digoxin 0.125 mg QD
	Rivaroxaban 15 mg QD
	Propranolol 30 mg BID
	Spironolactone 12.5 mg QD
Diagnostic process	Electrocardiogram, history-taking
Laboratory results	
Potassium	8.1 mEq/L (normal: 3.5–5.1 mEq/L)
Blood urea nitrogen (BUN)	35.5 mg/dL (normal: 8–23 mg/dL)
Serum creatinine	2.71 mg/dL (normal: 0.5–1.3 mg/dL)
Inorganic phosphorus	8.0 mg/dL (normal: 2.5–5.5 mg/dL)
Lactate	4.16 mmol/L (normal: 0.5–2.2 mmol/L)

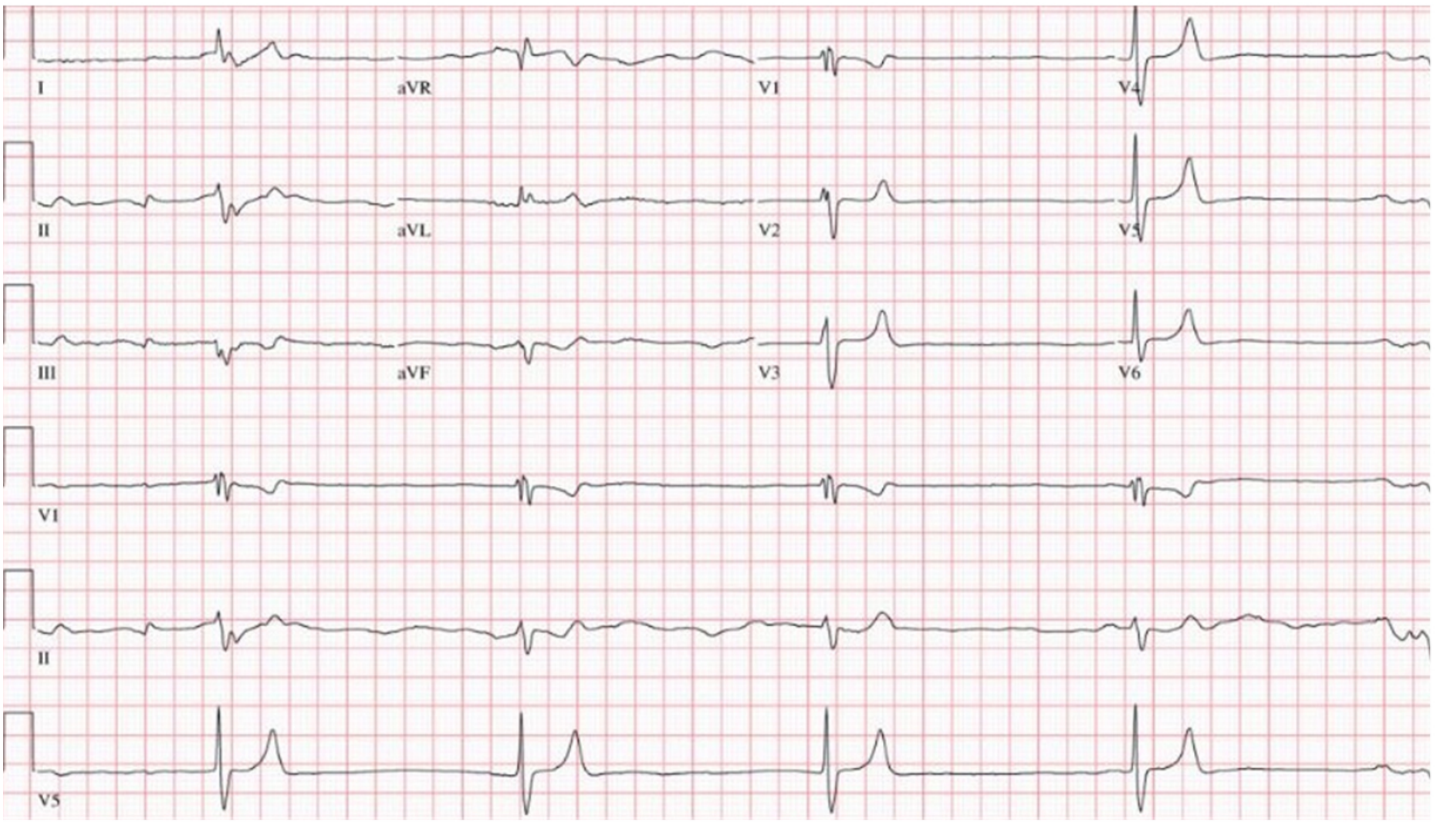

FIGURE 1. ECG at the time of admission to the emergency room.

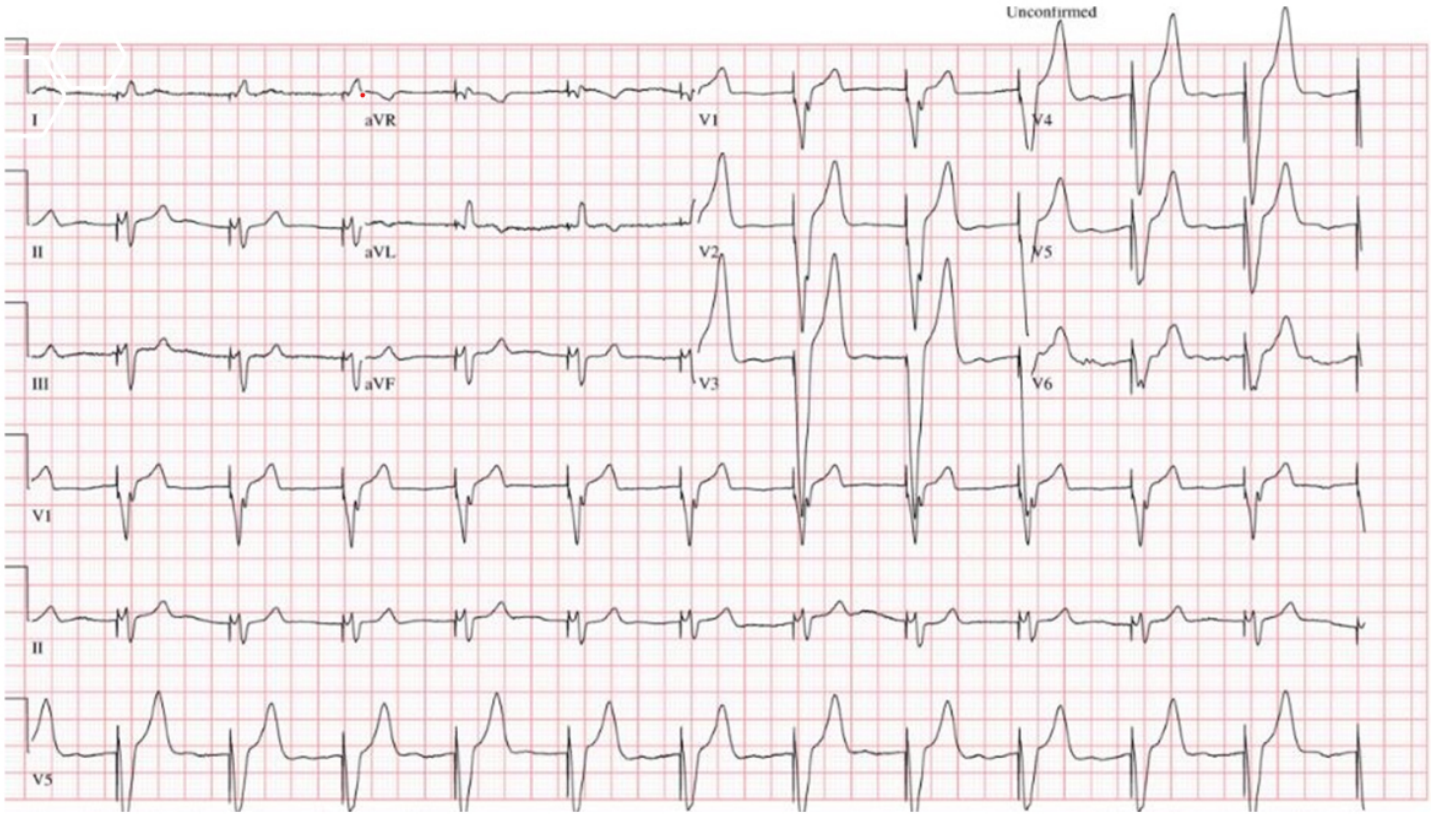

FIGURE 2. ECG after temporary pacemaker insertion.

kidney will increase its excretion. Thus, hyperkalemia does not immediately occur due to excessive potassium but occurs when there is a defect in renal potassium excretion [7].

Alterations in extracellular potassium concentration induce dramatic changes in RMP and cell ability for depolarization. Hyperkalemia makes the RMP less negative due to decreased transmembrane potassium concentration difference, eventually causing two important effects. This brings the RMP closer to the threshold and increases the potassium efflux while increasing the velocity of phase 3 repolarization [4]. First, ST-segment (ST) depression, peaked T waves, and QT interval (QT) shorten by shortening the action potential. As the RMP reaches the threshold, the myocardium becomes hypoexcitable, leading to a decrease in sodium influx, reducing both the voltage and rise rate in phase 0 of action potentiation. These effects, in turn, reduce the rate of propagation action potential throughout the myocardium, causing ECG changes, such as QRS widening and PR interval prolongation [4]. There are two explanations for the invisible p wave seen in our patient with afib. The first is very severe sinus bradycardia (*i.e.*, "sinus arrest") caused by a hypoexcitable pacemaker with a ventricle-induced junctional escape beat. The second is sinoventricular conduction over the interatrial fibers passing through the non-excitable (sinoatrial block) tissue of the atrial myocardium. Both effects usually occur when the potassium level exceeds 8 mEq/L [3–5].

Recently, several studies have been conducted on Jerusalem artichoke use in diabetes. Some researchers reported that it cannot be used as a treatment for diabetes. Some studies showed that it can aggravate diabetes [8], while other studies demonstrated that it helps control blood glucose concentration [1, 2]. For this reason, some Korean individuals include Jerusalem artichoke in their diet by boiling it with water and drinking it. Therefore, our patients also drank it. Jerusalem artichoke contains a large amount of potassium according to a study by Harmankaya *et al.* [9]. Moreover, our patient was using spironolactone, a potassium-sparing agent, and digoxin, which can cause hyperkalemia. These factors acted together, causing chest discomfort. Furthermore, we believe it might have induced a junctional rhythm.

The main morbidity and mortality of unrecognized hyperkalemia is life-threatening arrhythmia, such as the one seen in our patient. This case was intended to emphasize the importance of history taking and knowledge of various foods consumed by individuals in a special clinical scenario.

AVAILABILITY OF DATA AND MATERIALS

Not applicable.

AUTHOR CONTRIBUTIONS

JHL—designed the study. JHL and DHL—contributed to manuscript writing and data collection. DHL—contributed to editing and supervision. All authors have read and approved the final manuscript.

ETHICS APPROVAL AND CONSENT TO PARTICIPATE

Our work does not infringe on any rights of others, including privacy rights, and intellectual property rights. There is no human rights violation in our manuscript. The patient provided written informed consent for the publication of this case report. Our institution (College of Medicine, Gwnagju, Chonnam National University Hospital) provided an exemption for consideration since it was a case report article with permission from the patient.

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Not applicable.

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CONFLICT OF INTEREST

The authors declare no conflict of interest.

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