

Case Report

Prevention of Paralysis Attacks with Potassium Supplementation, Additional Fluid and Carbohydrate-Potassium Rich Workout Meals in a Male Patient with Familial Hypokalemic Periodic Paralysis Living a Strenuous Physically Active Lifestyle – A Case Report

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Abstract

The rare neurological disorder of familial hypokalemic periodic paralysis (hypoPP) causes intermittent muscle paralysis that might lead to hospitalization with acute intensive care and sudden cardiac arrest. Reported lifestyle triggers include carbohydrate rich meals and hard physical activity, and may include salt intake, over-eating, alcohol consumption, dehydration, and rest after exercise. However, effective lifestyle treatments are lacking in the scientific literature and current knowledge rely on expert opinions, case-reports, and retrospective case studies. To our knowledge, this is the first case-report to describe modifications of lifestyle with positive impact on prevention of paralytic attacks despite strenuous physical activity. The case has prevented paralytic attacks by securing regular meals, a diet low in carbohydrate and high in potassium, avoiding fast-food, securing large fluid intake, and a less stressful every-day life. To prevent paralytic attacks in relation to strenuous physical activity, the patient uses oral potassium chloride supplements, pre-workout carbohydrate rich meal, followed by a post-workout potassium rich protein shake and an additional 2 L water.

INTRODUCTION

Hypokalemic periodic paralysis (hypoPP) is a rare autosomal dominant inherited disorder related to defect in muscle ion channel mutations, mainly affecting calcium or sodium channels [1, 2]. There are 2 types: type 1 caused by a mutation in the calcium channel gene CACNA-1S on chromosome 1q31, and type 2 caused by mutation in the sodium channel gene SCN4A [3]. Most cases are hereditary; however, acquired cases of hypoPP have been described in association with hyperthyroidism [1-5]. HypoPP is characterized by episodic severe muscle weakness without myotonia, usually triggered by physical activity and dietary intake [6]. The weakness can be focal or generalized and ranges from mild to severe, associated with hyporeflexia (during the attacks) [7]. Attacks can last for hours, with

some persistent mild weakness for a few days [7,8]. During attacks, the creatinine kinase levels may be elevated, and serum potassium is usually reduced [9,10]. Attacks of paralysis or muscle weakness are responsive to potassium infusion/oral ingestion [7,8].

Scientific description of paralytic triggers are most often identified as carbohydrate rich meals [8,11-18] and strenuous physical activity [8-20]. Additional nutritional triggers of paralytic episodes described in case reports and small cohorts include salt intake [8], over-eating [14], irregular meals [11,17], evening meals [11], fast-food [17], and Chinese meal [17]. Additionally reported lifestyle triggers beyond strenuous physical activity include cold exposure [8-12], emotional stressors [8], fatigue and rainy weather [11]. The main management remains to

avoid triggers, carbohydrate anhydrase inhibitors such as acetazolamide and potassium- sparing diuretics [7]. To date, scientific literature reporting on the effect of lifestyle modifications to prevent paralytic attacks in hypoPP are limited and poorly described [21]. This case report describes nutritional and lifestyle modifications in a male hypoPP patient with a high level of strenuous physical activity.

Case Report

A 21-year-old Caucasian male with known familial hypoPP underwent lifestyle modifications with marked effect on the prevention of paralytic attacks requiring hospitalization and intensive care despite leading a strenuous physically active life.

The patient was diagnosed with hypoPP, gene mutation on CACNA-1S, in 2018. The patient's father and grandfather are known with the same positive CACNA-1S gene mutation. Our patient had debut of hypokalemic paralytic episodes at the age of 15 and has undergone several short hospital admissions including short intensive care days with tetra and near tetra paralytic conditions, associated with severely low plasma potassium levels. He has not experienced any cardiac arrest events, as the patient was successfully treated with potassium and natrium infusion with revival of paralytic conditions, oral potassium supplements and dietary management.

Prior to lifestyle changes, the patient reported a lifestyle including working night shifts, lack of daily rhythm, irregular meals, poor sleep and emotionally stressed. The previous 11 months, the patient has undergone lifestyle modifications adhering to the recommendations to avoid triggers, as well as experimenting on foods and fluid in relation to his strenuous exercise regimen. General lifestyle modifications include stopped working night shifts, embraced a more rhythm based daily life with day job, regular meals and sleep, while continuing strenuous weight bearing resistance training. He has had regular visits to his psychologists the previous 6 months with positive effect on his mental well-being.

Nutritional lifestyle modifications include regular mealtimes with a diet low in carbohydrate and high in potassium. More precisely, he now follows a meal plan with 2800 kcal (32 kcal/kg), including 300g carbohydrates (43 energy percentage (E%)), 65 g fat (21 E%) and 254 g protein (36 E%, 3g/kg/d). Compared to the Nordic recommendations of macronutrient intake, his intake is below the nationally recommended intake

for carbohydrate (45-60 E%) and fatty acids (25-40 E%), and protein intake well above recommended (10-20 E%) [22]. The high protein diet is chosen due to his strenuous weight bearing resistance training and ambition of muscle gain. He regularly secures 5-6 meals a day, with focus on potassium rich foods daily, such as avocado (at least 2 x daily), banana (2 x daily), as well as regularly intake of almonds and nuts (variable amounts) as described in Table 1. He avoids intake of added sugar, sugar-sweetened soda, and other sugar-sweetened beverages, as well as junk food. Cake, other sweets, and alcohol at kept at a bare minimum. His experience with food triggers includes oranges, kiwi, mango, and strawberries, which is why these are eliminated from his diet. His intake of alcohol is below 7 units per week. His fluid intake is approximately 5-6 L daily on workout days and 3-4 L on restitution days. Fluid consists primarily of tap water, sugar-free ice-tea and sugar-free soda. His meal plan is depicted in Table 1.

Table 1: Meal plan

Time of day	Food
Breakfast (5-6 AM):	Oatmeal porridge with banana, boiled using water. Additional stevia. No sugar
Snack (9 AM):	1 piece of rye bread (high fiber) with cold cuts of various meat
Lunch (Noon):	A high fiber sandwich with cold cuts of various meats
Snack (4 PM):	Restitution days: Either a hot meal low on carbohydrates (leftovers) or oatmeal (as breakfast) or ryebread (as 9 AM snack). Workout days: hot meal with high carbohydrate intake (preferably rice) prior to exercise and a potassium rich protein shake containing avocado, banana, nuts, after exercise.
Dinner (7 PM):	Hot meal, low in carbohydrates, high in meat or chicken and vegetables (incl. 2 x avocado)
Snack (10 PM):	Skyr (curdled milk, high protein) with banana and nuts or almonds.

PHYSICAL ACTIVITY

The patient keeps a physically strenuous job as a scaffolder, including unloading, carrying, and dismantling scaffolding equipment, erecting scaffolding poles, and laying planks. A good level of physical fitness is mandatory. He works 37 hours a week, daytime Monday through Friday. Additionally, the patient conducts resistance training on an ambitious level with the aim of maintaining muscle mass after a period of bulking (muscle gain). He conducts strenuous weight bearing resistance training five days a week, with restitution on two non-consecutive days. In the previous 1 year, he has gained a total of 20 kg, mainly consisting of skeletal muscle. The body weight has now stabilized at his target weight of 86 kg.

Special considerations in prevention of paralytic attacks in relation to strenuous resistance training

The patient takes preventative actions to prevent attacks induced by strenuous exercise by eating a carbohydrate rich meal prior to training, primarily containing rice. He increases his fluid intake by 2 L on training days. Additionally, he makes use of 2 oral potassium tablets, containing 1500 mg, prior to training as a prophylactic agent. Immediately following the workout, he consumes a potassium rich protein shake containing avocado, banana and nuts.

When paralytic episodes emerge

The patient can experience paralytic attacks arise by slight numbness in the extremities. In these situations, the patients consume 1500 mg/20 mEq potassium chloride orally. Additionally, he consumes a potassium rich shake consisting of avocado, milk, and almonds.

Additional prophylactic strategies

The patient consumes daily 1 x oral potassium chloride tablet (750 mg/10 mEq) first thing in the morning, 1-2 oral potassium chloride (1500 mg/20 mEq) prior to physical training (training days only), as well as 2 x oral potassium chloride tabs (1500 mg/20 mEq) at nighttime.

Current medical treatment

As per recommendation, in acute disabling attacks, hypokalemia should be reversed after hypokalemia is verified and patient should be in cardiac monitoring. Potassium level should be monitored under admission for potential rebound hyperkalemia for 24 hours. As per previous recommendations, potassium infusion 30 mEq every 30 minutes until hypokalemia and weakness resolve [7]. Non-pharmacologic measure plays essential role in the maintenance of daily lifestyle [23,24] and prophylactic strategies with carbonic anhydrase inhibitors, dichlorphenamide, potassium sparing diuretics have shown satisfactory effects on these patients [25-27]. Our patient has not received prophylactic treatment since he is aware of his condition and administer potassium supplement as per need, received balanced dietary management and potassium rich meals.

DISCUSSION

This case report describes a successful experience with lifestyle modifications including detailed nutritional description in the prevention of paralytic attacks in a patient with familial hypoPP conducting strenuous exercise and keeps a physically demanding job. A lifestyle

modification with focus on a stable daily rhythm, 5-6 meals per day, low carbohydrate diet rich in potassium containing foods, reduced stress and improved mental well-being has most likely prevented paralytic attacks for this patient. The patient makes use of a range of prophylactic actions to prevent attacks triggered by strenuous physical activity, including oral supplement of potassium, carbohydrate rich meal (pre-workout) and potassium rich protein shake (post-workout) as well as consumes an additional 2 L of fluids.

One of the main suspected triggers of paralytic attacks include hard physical activity, why patients often are instructed to avoid strenuous physical activity. Such avoidance may though lead to a higher risk of sarcopenia characterized by low muscle mass and strength [28]. In fact, there have been reports of progressive myopathy in 29 % and increased fat infiltration in 73 %, accompanied by loss of muscle strength during a 3-year period in a cohort of 37 patients with hypoPP [29]. Progression of weakness and fat infiltration was observed in patients with and without attacks [29]. Some hypoPP patients are even found to have permanent myopathy [12-29]. Permanent muscle weakness, defined as difficulty in walking stairs, weaker than age-matched peers, severe walking challenges or wheelchair bound, was found in all familial hypoPP patients at older age, regardless of history of paralytic attacks [25]. Mild or severe muscle weakness seems to be more prominent in patients with mutations in the calcium channels, than in patients with mutations in natrium channels or in patients without mutations [8].

The progressive prevalence of muscle weakness and fat infiltration in muscle tissue can impact patients' activity of daily living. With increasing age and in disease, muscle mass and muscle strength are highly predictive to falls and fractures, surgical complications, higher morbidity and mortality, leaving these patients in a poor situation in case of old age and disease [30]. Beyond a favorable impact on the health, body composition and muscle strength following strenuous physical activity, some patients may have a personal desire to conduct hard physical activity. Identifying prophylactic actions to prevent attacks induced by hard physical activity is therefore highly relevant for this patient group.

There is currently no known treatment to prevent myopathy in this patient group, but avoidance of physical activity might exaggerate muscle loss, strength and function. Subsequently, there are no studies to date that have thoroughly assessed the physical activity level in this patient group; hence, potential preventative or causative effects of various types and intensity of physical training

in the development of myopathy and altered muscle composition with fat infiltration is unknown.

Typical recommendations in preventing attacks include avoidance of nutritional and lifestyle triggers; however, none of the case reports and small cohort studies to date have described nutritional or lifestyle triggers in details. Hence, patient information cannot be other than superficial and non-specific, potentially leading patients to be less physically active and eliminating or reducing the intake of more foods than necessary. For example, our case also experienced specific fruits as triggers of attacks, but these fruits are easily replaced by potassium rich fruits. The most reported triggers are carbohydrate rich meals (or likewise, i.e. sweets or oral glucose tolerance test) and strenuous physical activity, but are other potential nutritional or lifestyle factors neglected due to poor anamnesis or case descriptions? Our case has successfully prevented attacks despite being physically active by pre-workout carbohydrate loading which is otherwise advised against and securing a meal containing of potassium rich foods and additional 2 L of fluid post-workout. If triggers are preventable by manipulating fluid and nutritional intake, these patients can embrace a more physically active lifestyle which may have physical, social and psychological impact. Being able to promote a physical active lifestyle is important as attacks in patients with hypoPP typically occurs in teenagers and young adults.

The lack of scientific literature of potentially modifiable lifestyle triggers in familial hypoPP calls for more in-depth descriptions of future case reports and clinical trials to improve our understanding of the prevention of attacks and securing a healthy lifestyle including physical training.

STATEMENTS AND DECLARATIONS.

The patient has consented to the case report. The authors declare that they have no conflict of interest.

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