

# Hypokalemic Periodic Paralysis with Arrhythmia

## A Case Report and Review of Literature

Robert S. Shires, MD  
Des Moines, Iowa

Hypokalemic paralysis and/or arrhythmia must be treated cautiously and replacement therapy given slowly. The differential diagnosis should include familial periodic paralysis, an autosomal dominant disorder, which may present as hypokalemia, normokalemia, or hyperkalemia.

### Case Report

The following is a case report of C. W., a 19-year-old white male, who was admitted to the hospital with the complaints of profound weakness and inability to move his legs. He had no muscle pain. During the preceding year, he had been suffering similar episodes almost monthly with a gradual onset of weakness in the extremities over four to six days. That condition would then spontaneously resolve. Each episode would begin with increasing weakness of extremities, fatigue, prolonged sleeping, occasional vomiting, frequency of urination, occasional enuresis, and increasing nocturia. At the peak of the episodes he was barely

able to move in bed. Prior to several episodes he did recall a large intake of beer. A routine physical examination at age 13 had been normal and excess weight was noted at another examination two years later. Past history was unremarkable. Family history revealed that a grandmother had adult onset diabetes, but no relatives had problems similar to C.W.'s.

Physical examination revealed an overweight white male of 104 kilograms and 193 centimeters tall. He lay in bed, unable to move his lower extremities, and his voice was weak. Blood pressure was 158/68 mm Hg, pulse 112 beats per minute and irregular, respirations 16 per minute, and temperature 37 C. He was alert, anxious, quite cooperative, and in no respiratory distress. His skin was normal. Examination of head, ears, eyes, nose, and throat was normal. Lungs were clear to percussion and auscultation. Cardiac examination showed an irregular rhythm without murmur. Deep tendon reflexes were barely present. While unable to move his legs, he could move his arms but was unable to hold them outstretched in front of his body. His hand grip was 25 percent of nor-

---

From the Family Practice Residency Program, Iowa Lutheran Hospital, Des Moines, Iowa. Requests for reprints should be addressed to Dr. Robert S. Shires, Iowa Lutheran Hospital, Family Practice Residency, 840 East University Avenue, Des Moines, IA 50316.

mal. Babinski sign was absent. Pin prick and light touch were intact. No muscle tremors or atrophy were noted.

### *Admission Laboratory Data*

Laboratory tests revealed the following values: sodium, 142 mEq/liter; potassium, 1.5 mEq/liter; chloride, 97 mEq/liter; carbon dioxide concentration, 27 mEq/liter; hemoglobin, 19.4 gm/100 ml; hematocrit, 54 percent, indices normal; WBC, 18,200/cu mm with 84 percent neutrophils and 13 percent lymphocytes; platelets were normal; blood glucose, 126 mg/100 ml; blood-urea nitrogen (BUN), 16 mg/100 ml; and creatine phosphokinase (CPK), 300 IU/liter (with a normal range of 30 to 170 IU/liter). An ECG revealed sinus rhythm with runs of premature auricular contractions (PACs), multifocal atrial tachycardia, occasional premature ventricular contractions (PVCs), nonspecific ST-T wave changes, and first-degree heart block. A chest x-ray was within normal limits.

The assessment was that the patient was suffering from hypokalemic paralysis and arrhythmias, the etiology of which was not certain. A tentative diagnosis of intermittent hypokalemic periodic paralysis was made and further studies were ordered. He was placed in the Coronary Care Unit where careful cardiac monitoring could be obtained, and 5 percent dextrose in 1/2 normal saline plus 50 mEq potassium-chloride/liter were started intravenously at a rate of 125 ml/hr. A lidocaine drip at 2 mg/min was also begun.

Within 12 hours the strength in his legs was returning and the ectopic activity on ECG had disappeared, but the ST-T wave changes remained. His eosinophil count was normal. Urine pH was 7.0, specific gravity was 1.016 with a trace of protein and negative microscopic examination. Urine myoglobin was negative. Random urine sodium and potassium values were normal as was the serum magnesium level.

Approximately 24 hours after admission, his serum potassium level was up to 2.3 mEq/liter, hemoglobin level was 16.2 gm/100 ml, WBC level had reached 20,600 cu mm with the same differen-

tial as before, prothrombin and partial thromboplastin times were normal. An SMA-12 was normal. Protein electrophoresis was normal as were cryoglobulins, aldolase, T<sub>3</sub>, T<sub>4</sub>, ANA, RA, and serum cortisols. A 10 percent potassium-chloride solution was begun orally and the intravenous rate was decreased. Skull x-rays and a repeat chest x-ray were within normal limits.

On the second hospital day, the patient was sitting up in a chair by himself. The following levels were noted: serum potassium, up to 2.6 mEq/liter; alkaline phosphatase, normal; hemoglobin, 15.4 gm/100 ml; and WBC, decreased to 12,200 mm Hg. An ECG was unchanged from the previous day with a sinus rhythm.

At the end of the third day, his potassium level was 3.3 mEq/liter, and the creatine phosphokinase (CPK) isoenzymes were positive for skeletal and cardiac muscle. A 24-hour urine test revealed a value for 17-ketosteroids of 4.5 mg (with a normal range of 7 to 20 mg/24 hr), and for 17-hydroxycorticosteroids, a value of 53 mg (with a normal range of 12 to 20 mg/24 hr). A muscle biopsy of the gastrocnemius was normal without evidence of vacuolation. Creatinine clearance was normal.

The patient was transferred out of the Coronary Care Unit on the fourth hospital day and was ambulating well. Serum potassium level was 3.3 mEq/liter. The intravenous administration of potassium-chloride was discontinued and oral potassium-chloride continued. A diet low in carbohydrates with four grams potassium was started. Subsequent intravenous pyelogram was normal and the patient was discharged on his diet and has done well.

### **Discussion**

No attempt will be made here to discuss the wide variety of neuromuscular disorders which can cause muscle weakness. The differential diagnosis of hypokalemia in this case can be categorized into gastrointestinal loss, metabolic disorders, renal loss, and internal shifts between intra and extracellular compartments (Table 1). Vomiting, diarrhea, or fistulae usually are associated with a chronic loss of both potassium and

Table 1. Causes of Hypokalemia<sup>1\*</sup>

Gastrointestinal	Metabolic	Renal
Vomiting	Diabetic acidosis	Renal tubular acidosis
Diarrhea	Adrenocortical excess	Diuretic therapy
Gastrointestinal fistulae	ACTH-producing tumors	Potassium-losing nephropathy
Villous adenoma	Cushing syndrome	Acidosis
Ureterosigmoidostomy	Primary aldosteronism	Alkalosis
Ileostomy	Adrenal adenomas	Secondary aldosteronism
Chronic laxative ingestion	Adrenal hyperplasia	Cirrhosis
Prolonged absence of potassium intake	Steroid administration	Nephrosis
	Thyrotoxicosis	Bartter syndrome
	Familial periodic paralysis	

\*Reprinted with permission from Harvey A. McG: The Principles and Practice of Medicine, ed 19. New York, Appleton-Century-Crofts, 1976.

large volumes of fluid. Mineralocorticoid excess (eg, primary aldosteronism) or increased renal excretion of organic acids (eg, diabetic acidosis) are the basis of metabolic disturbances resulting in urinary potassium loss. Renal loss of potassium is seen in renal tubular acidosis in which the hydrogen-secreting mechanism fails. Diuretic agents produce potassium loss as the urinary sodium excretion increases or a hypochloremic alkalosis is produced. Internal shifts of potassium, as represented by familial periodic paralysis, occur with acute and profound decreases in serum potassium together with ascending paralysis, without any external loss of potassium.

As in all cases, a tentative diagnosis is necessary in order to organize a plan of action which can be altered as the data return. In the case of this patient, the diagnosis of familial periodic paralysis fit well with the patient's history and physical examination and as the laboratory data were substantiated by exclusion of the other causes of hypokalemia.

Regardless of the cause, profound hypokalemia should be treated cautiously and replacement therapy given slowly. If the gastrointestinal tract is functioning, this route of replacement is preferable

to intravenous administration due to the possibility of cardiac irregularities. Some principles of potassium replacement are as follows:<sup>1</sup>

(1) Use oral route whenever possible; (2) Give parenterally at less than 10 mEq/hr except in extreme emergency; (3) Never exceed 30 mEq/hr intravenously; (4) When parenteral potassium replacement exceeds 10 mEq/hr, ECG monitoring is indicated; and (5) Never give potassium parenterally to patients with renal failure (glomerular filtration rate less than 10 ml/min).

### Familial Periodic Paralysis

There are three types of familial periodic paralysis (FPP): hypokalemic, hyperkalemic, and normokalemic. The hypokalemic variant is the most common and all three have an autosomal dominant inheritance pattern.

Individuals with hypokalemic FPP have episodic attacks of weakness and flaccid paralysis usually involving the skeletal muscles of the ex-

tremities and often of an asymmetrical distribution.<sup>2</sup> Spontaneous abatement of the paralysis is common. Primary periodic paralysis is usually found in families but sporadic cases have been reported. With increasing age, the attacks tend to decrease in frequency and intensity and have been reported to cease spontaneously. The incidence in males is twice that in females, and the age of onset is usually in the second decade.

Symptoms usually start during the night or early morning and involve proximal limb and some trunk muscles. Facial and respiratory muscles are usually not involved, although ptosis and occasional death from respiratory paralysis or cardiac arrhythmia can occur.

Precipitating factors include high carbohydrate intake, vigorous exercise followed by a resting phase, exposure to cold, insulin, emotion, infection, trauma, alcohol, epinephrine, and hydrocortisone.

The mechanism of action in hypokalemic FPP focuses on an internal shift of potassium intracellularly into the muscle cells. Therefore, serum potassium falls and more sodium and water flow into the cells. Theoretically, this increase in intracellular potassium results in hyperpolarization of the cell membrane causing a block in transmission of any impulses along the plasma membrane and possibly explaining the weakness or paralysis.

Histologically, muscle cells reveal vacuoles appearing to be dilatations of either the T-tubules or the sarcoplasmic reticulum. Whether or not this is a structural defect and relates to the high intracellular concentration of potassium remains unexplained. The vacuoles appear to be permanent and do not increase or decrease with an attack.

The major laboratory finding during an attack of hypokalemic FPP is a low plasma concentration of potassium, with weakness and/or paralysis occurring sometimes at potassium levels of 2.5 to 3.0 mEq/liter. Between attacks, the serum level of potassium returns to normal. Other findings include elevated urinary 17-hydroxycorticosteroids, 17-ketosteroids, and aldosterone. ECG changes consistent with hypokalemia can occur, but periodic paralysis with arrhythmia is a rare subgroup of periodic paralysis.

In a case reported by Levitt et al,<sup>3</sup> the arrhythmias were not influenced by changes in serum electrolytes and were independent of attacks of paralysis.

Treatment of hypokalemic FPP has varied among a diet of high potassium, low sodium, low carbohydrate, and avoidance of precipitating factors, plus oral potassium supplements. Lately, acetazolamide, a carbonic anhydrase inhibitor, has been used successfully in dosages of 250 to 750 mg/day in divided doses.<sup>4</sup> Individual treatment varies as far as reducing the frequency of attacks and increasing muscle strength between attacks.

Hyperkalemic FPP, *adynamia episodica hereditaria*, as the name implies, has elevated levels of potassium during episodes of weakness and paralysis. The characteristic feature of this variant is myotonia primarily seen in the tongue, in a slowness in relaxing the hand grasp, and in an eyelid lag. Permanent weakness and atrophy of the muscles may occur, especially in the proximal muscles. Chlorthiazide and acetazolamide as well as diets low in potassium and high in carbohydrates have been used successfully in treatment.

Normokalemic FPP, the rarest of the three types, has its onset at an early age and has no sex preference. Symptoms are similar to those in the other types, but serum potassium levels are found to be normal. Acetazolamide has been tried as therapy in several cases.

In summary, when a patient presents with episodes of weakness or paralysis and is found to have potassium imbalance, a detailed clinical and family history should be obtained along with a thorough physical examination. Management of hypokalemia should be undertaken slowly and with caution, and further studies to differentiate the noninherited causes of hypokalemia should be ordered. If a diagnosis of familial periodic paralysis is made, the patient should be instructed in the nature of the disease and its genetic implications.

## References

1. Harvey A McG: *The Principles and Practice of Medicine*, ed 19. New York, Appleton-Century-Crofts, 1976, pp 98, 100
2. Meyers KR: A summary review of the diagnosis and pathology of the primary familial periodic paralyses. *Ann Clin Lab Sci* 5:216, 1975
3. Levitt LP: Hypokalemic periodic paralysis with arrhythmia. *N Engl J Med* 286:253, 1972
4. Griggs RC: Acetazolamide treatment of hypokalemic periodic paralysis. *Ann Intern Med* 73:39, 1970