



Case Report

Hypomagnesemia-A Rare Entity in Presentation of Refractory Hypokalemia

Authors

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Abstract

In this study we evaluate a case of refractory hypokalemia which is associated with hypomagnesemia and with other clinical features, characteristic ECG changes of ventricular bigeminy, prolonged PR interval, 'U waves and associated laboratory features. Intravenous magnesium therapy reverted the Hypokalemia, ECG changes and led to improvement in clinical symptoms. A brief review of literature is also highlighted.

Introduction

Magnesium is fourth most common extracellular and second most common intracellular cation of the body. It is pertinent for activation of various cellular enzymes and is responsible for neurotransmission, hormone receptor binding and post receptor activation. It plays a substantial role in maintenance of calcium and potassium homeostasis. Severe magnesium deficiency thus results in vagaries of manifestations ranging from ECG changes, neuromuscular abnormalities and defects in electrolyte and hormonal homeostasis.

Hypomagnesemia though relatively common in clinical practice, esp. in ICU setting, is often missed out, mainly due to low index of suspicion. This article highlights the clinical findings of hypomagnesemia and stress the need for proactive treatment.

Case Report

80 yr old female patient Mrs. XXX presented to ER (Emergency Room) with complaints of protracted vomiting for last 15 days associated with hyporesponsiveness, generalized weakness, abdominal pain and decreased appetite. Her vitals

were stable and no complaint of chest pain or palpitation was present. No history suggesting any chronic illness could be elicited.

On examination she was severely malnourished and CNS examination suggested decreased tone and decreased power of grade 4 of all 4 limbs with diminished reflexes. Other systemic examination did not reveal any significant abnormality. Her ECG showed ventricular bigeminy with transient prolonged PR interval, followed by persistent U waves. This lead us to look for electrolyte imbalance as the underlying cause. Further investigations revealed low serum potassium of 1.8 mEq/L (3.5-5.5) and normal Serum sodium 144mEq/L.

Patient continued to have refractory hypokalemia even after adequate replacement with potassium chloride. A 24 hr urinary K⁺ level of 57.22 mmol/24hrs (25-125) was found with metabolic alkalosis. Serum Magnesium was 0.5 mg/dl (1.6-2.8). Serum Ca⁺ was 7.8 mg (9 - 11). The patient's potassium levels and symptoms improved remarkably after i.v. magnesium replacement. Subsequently raised Parathyroid hormone (PTH) values of 198 pg/ml (15-68.30) and low normal

25-hydroxyl vitamin D (25-OHD) 34 ng/ml (11-70) were found. Also patient had low S. proteins. Liver and kidney functions and uric acid levels were unremarkable. Thyroid profile was normal.

Discussion

Magnesium is the fourth most abundant extracellular cation and second most abundant intracellular cation after potassium¹. A normal adult contains about 25 mEq/kg magnesium with only 1% of this magnesium present in the extracellular compartment. The rest of magnesium being present in bone (67%), and cells (31%)². Normal magnesium concentration is 1.7-2.1 mg/dl (0.7-0.9 mmol/l or 1.4-1.7 mEq/l)¹. Unbound intracellular magnesium is an integral part of the energy metabolism and catalyses phosphatases that hydrolyze and transfer organic phosphate and reactions that involve adenosine triphosphate (ATP). Magnesium acts as a cofactor for conversion of ATP to cyclic AMP by the enzyme adenylate cyclase. The substrate for adenylate cyclase is Mg^{+} -ATP and in addition, magnesium appears to have a catalytic effect on adenylate cyclase activity. As ATP has a pivotal role to play in metabolism, magnesium deficiency has a potential to impair many critical cellular functions².

Proximal small bowel is the major site of magnesium absorption. Vitamin D may increase magnesium absorption³. Renal excretion of magnesium occurs by glomerular filtration and tubular reabsorption, mainly in thick ascending limb (TAL) of the Loop of Henle (60-70%)³. Causes of hypomagnesemia can be due to gastrointestinal or renal losses. In gastrointestinal causes prolonged nasogastric suction or vomiting, acute or chronic diarrhea, malabsorption syndromes and protein calorie malnutrition may be responsible. 24hr urine Mg^{+} excretion is generally less in gastrointestinal diseases. Renal loss occurs due to renal tubular acidosis, pyelonephritis, Bartter's & Gitelman's syndrome, osmotic diuresis as present in diabetes, mannitol administration, and due to high urea levels. Also

increased renal losses may be due to alcohol or metabolic acidosis. Normal urinary excretion of magnesium in the normal range in presence of hypomagnesemia suggests a renal leak. Endocrine disorders like hyperthyroidism, hypercalcemia, hyperaldosteronism, phosphate depletion may be responsible.

Hypomagnesemia may coexist with hypokalemia, hypocalcemia & hypophosphatemia. Potassium depletion in hypomagnesemia may be multifactorial e.g. due to kaliuresis, altered cell membrane permeability, decreased Na^{+} - K^{+} ATPase activity, decreased inward rectification of K^{+} and decreased Na^{+} - K^{+} cotransport. Thus Mg^{+} has a pivotal role in maintaining K^{+} homeostasis⁵. Although, hypomagnesemia is usually associated with hypoparathyroidism, few cases with normal or high PTH values have been found in literature⁴. Our case has high PTH levels. In spite of high PTH levels, calcemic response of parathyroid hormone is not adequate. This may be due to end organ resistance to PTH at the level of bone and kidney. Due to low 25 hydroxy vitamin D, there is defective mineralization of osteoid tissue which leads to defective calcemic response of PTH. Even low magnesium levels are responsible for this end organ resistance. This may be explained by defective generation of cyclic AMP in kidney, bone and parathyroid gland resulting from magnesium deficiency as cyclic AMP is a mediator in the peripheral actions of PTH resulting in decreased renal and skeletal responsiveness to parathyroid hormone. In our case, there were low S. phosphorus levels, which may be due to low dietary phosphorus intake before admission and intravenous dextrose infusion given to patient after admission⁴. Hypothyroidism may be an isolated finding in this case. Thus prolonged protracted vomiting, led to loss of magnesium and low serum phosphorus levels were also responsible for low magnesium levels.

Severe symptomatic hypomagnesemia should be treated with intravenous magnesium. It can take up to 3 to 7 days to replenish the intracellular

stores. So after intravenous therapy, oral magnesium supplementation is required.

Our patient achieved normal magnesium levels followed by normal potassium & calcium levels subsequent to intravenous replacement⁶. After about 1 month, magnesium and calcium oral supplementation was continued and was then discontinued, and subsequent magnesium levels were evaluated and found to be within the normal limits. The presence of resistant hypokalemia & hypocalcemia should alert the physician to look for underlying hypomagnesemia as the cause.

References

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