CASE REPORT

IMPROVEMENT IN ELECTROLYTE IMBALANCE IN CRITICALLY ILL PATIENT AFTER MAGNESIUM SUPPLEMENTATION – A CASE REPORT

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ABSTRACT

Hypomagnesaemia is common finding in current medical practice mainly in critically ill, post-operative patients and patients admitted to ICU in tertiary cancer cases. Magnesium has been directly implicated in hypokalemia, hypocalcaemia and dysrhythmias. We report a case of 60 year old patient, suffering from rectal carcinoma for a period of one year with confirmed hypokalemia, hypocalcaemia and hyponatremia. Magnesium supplementation corrected the underlying multiple electrolyte disturbances in the patient thus, establishing a positive correlation of magnesium with sodium, potassium and calcium.

KEY WORDS

Hypomagnesaemia, Hypokalemia, Hypocalcaemia, Hyponatremia.

A known case of rectal carcinoma, 60yr. old female, was admitted in the ICU, Sri Guru Ram Das Charitable Hospital, Vallah with the chief complaint of anal incontinence and chronic diarrhoea for the last 2 months. She was on chemotherapy and radiotherapy. There was no history of diabetes mellitus, asthma, hypertension, tuberculosis, stools with blood, vomiting and fever. The vitals of the patient on admission were as follows: Pulse- 82/min; BP- 120/80 mm of Hg and Respiratory Rate- 20/min.

A number of tests were performed in the Clinical Biochemistry Laboratory, Sri Guru Ram Das Charitable Hospital, Vallah, Amritsar. A positive correlation was observed between Mg and Na ($r = +0.96$); Mg and K ($r = +0.94$) and Mg and Ca ($r = +0.93$) where 'r' is the coefficient of correlation (Table 1).

The patient's investigation reports showed hypokalemia, which was accompanied by hyponatremia and hypocalcaemia. Meanwhile the patient was given intravenous KCl and Ca

gluconate but the hypokalemia and hypocalcaemia still persisted. On the 7th day of admission the patient was administered 2 ampoules of $MgSO_4$ along with KCl and Ca gluconate. On the 8th day the investigations were repeated and the hypokalemic, hypocalcaemic and the hyponatremic state of the patient started improving. The investigations were repeated on 10th day which showed the improvement in Na, K and Ca levels in the patient and thus, the patient was ready for operation. The patient was operated on 10th day of admission. The investigations were repeated for the follow up of the patient.

A positive correlation was observed between Mg and Na ($r = +0.82$); Mg and K ($r = +0.94$) and Mg and Ca ($r = +0.96$) where 'r' is the coefficient of correlation (Table 2).

In the post-operative investigations it was observed that with Mg supplementation the hypokalemic and hypocalcaemic states of the patient improved. As soon as the Mg supplementation to the patient stopped, the patient developed hypokalemia and hypocalcaemia; this improved again after the supplementation of Mg, along with K and Ca. Thus, it was observed that it was only after Mg supplementation, the blood levels of Na, K and Ca reached the near normal levels. Normal levels of the electrolytes are Na: 135-148 mEq/l; K: 3.5-5.3 mEq/l; Ca: 8.5-10.5 mg/dl and Mg: 1.3-2.5 mEq/l.

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Table 1: Pre-Operative Investigations

DAY	1 st	2 nd	3 rd	4 th	5 th	6 th	7 th	8 th	9 th	10 th
Serum Na ⁺ (meq/l)	125	124	128	127	129	125	125	140	139	138
Serum K ⁺ (meq/l)	2.8	2.5	2.4	2.9	2.8	3.0	2.8	3.5	3.6	4.0
Serum Ca ⁺ (mg/dl)	9.2	8.0	7.8	8.0	7.8	8.0	7.5	9.0	8.8	9.2
Serum Mg ²⁺ (meq/l)	-	-	-	-	1.0	0.9	0.7	1.1	1.3	1.5
KCl sol.	-	-	1 amp	1 amp	1 amp	1amp	2amp	1amp	1amp	1amp
MgSO ₄ sol.	-	-	-	-	-	-	2amp	1amp	1amp	1amp
Ca Gluconate sol.	-	-	1 OD	1 OD	1 OD	1 OD	1 OD	1 OD	1 OD	1 OD

Table 2: Post-Operative Investigations

DAY	10 th	11 th	12 th	13 th	14 th	15 th	16 th	17 th
Serum Na ⁺ (mEq/l)	134	129	130	132	130	120	124	140
Serum K ⁺ (mEq/l)	3.8	3.0	3.5	3.9	2.7	2.8	3.3	3.8
Serum Ca ⁺ (mg/dl)	9.0	8.3	9.0	9.2	9.2	8.8	9.0	9.4
Serum Mg ²⁺ (mEq/l)	1.3	1.1	1.4	1.6	1.8	1.3	1.5	1.9
KCl sol.	-	1 amp	1 amp	1 amp	1 amp	1 amp	1 amp	1 amp
MgSO ₄ sol.	-	1 amp	1 amp	1 amp	-	1 amp	1 amp	1 amp
Ca Gluconate sol.	-	1 OD	1 OD	1 OD	1 OD	1 OD	1 OD	1 OD

DISCUSSION

In this case report we have described the improvement in K and Ca levels after Mg supplementation in a patient suffering from rectal carcinoma. The patient developed hypokalemia, hypocalcaemia and hyponatremia, the hypokalemia and hypocalcaemia did not improve on intravenous K and Ca administration alone. However, a resolution was achieved when the patient was administered Mg intravenously and the hypokalemic, hypocalcaemic and hyponatremic conditions improved both pre and post operatively.

Hypomagnesaemia is a common finding in current medical practice, mainly in critically ill, post-operative patients (1) and patients admitted to an ICU in tertiary cancer cases (2). The etiology of Mg deficiency includes gastrointestinal and renal wasting, drug induced loss, endocrine disorders, metabolic disease, redistribution of magnesium stores and other conditions (3). Mg regulates hundreds of enzyme systems especially reactions that involve Adenosine Triphosphate (ATP), have an absolute requirement for magnesium. By regulating enzymes controlling intracellular Ca, magnesium

affects smooth muscle vasoconstriction, important to the underlying pathophysiology of several critical illnesses. Mg has been directly implicated in hypocalcaemia, hypokalemia and dysrhythmias (4).

The patient included in this case report developed hypomagnesaemia due to chronic diarrhoea and inadequate intake which resulted in electrolyte imbalance. Hypokalemia is a common event in hypomagnesaemic patients occurring in 40% to 60% of cases (5) and this relationship is in part due to diarrhoea, inadequate intake and surgery conducted later on. Isolated disturbances of K balance do not produce secondary abnormalities in Mg homeostasis. In contrast, primary disturbances in Mg balance particularly Mg depletion produce secondary K depletion. Potassium secretion from the cell of thick ascending limb and cortical collecting tubule is mediated by ATP inhibitable luminal K channels (6). Hypomagnesaemia is associated with reduction in the cell magnesium concentration which may then lead to decline in ATP activity and due to removal of ATP inhibition; there is an increase in the number of open K channels (7). These changes would promote K secretion from the cell into the lumen and enhanced urinary losses. The hypokalemia in this setting is relatively refractory to K supplementation and requires correction of Mg deficit (8). Because of the inhibition of Na⁺K⁺ - ATPase, there occurs depletion of Na along with K. Thus, in our case report we observed that the patient was administered KCl intravenously but the condition of the patient did not improve. However, after Mg supplementation alongwith K supplementation the levels of serum K and Na started improving and finally reached the normal limits and the condition of the patient improved.

Hypocalcaemia is another common manifestation in hypomagnesaemia. Symptomatic hypocalcaemia is usually seen in moderate to severe deficiency and there is a positive correlation between serum Mg and Ca concentration. A proportion of circulating Mg is protein bound, such that only

70% of total plasma Mg is ultrafilterable (9). In adults, the thick ascending limb of the loop of Henle is the main site of magnesium reabsorption. The $\text{Ca}^{2+}/\text{Mg}^{2+}$ - sensing receptor (CASR), a member of G-protein coupled receptor family, is an important regulator of magnesium homeostasis (10). In hypomagnesaemic and hypocalcaemic states, the rates of calcium and magnesium reabsorption in the loop of Henle are increased via CASR mediated stimulation of $\text{Na}^+ \text{K}^+ 2\text{Cl}^-$ cotransporter and apical Renal Outer Medulla Potassium (ROMK) channel (11). Thus, in our patient because of low calcium level, calcium was administered I/V but the levels of Ca in serum never improved. By administering Mg along with Ca I/V both pre and post operatively, levels of Ca in the patient started improving and finally reached the normal levels.

Thus, in the present case report, the patient suffering from rectal carcinoma developed electrolyte imbalance in both pre and post operative conditions. It was observed that despite the supplementation of K and Ca in the patient, the condition of the patient did not improve but with Mg supplementation, K, Ca and Na levels in the patient improved. Thus, the case report has established a correlation of Mg with K, Ca and Na and proves that Mg supplementation is necessary in a critically ill patient. Therefore, the case demonstrates unless Mg is routinely performed, consideration should be given to treating hypokalemic and hypocalcaemic patients with Mg as well as K and Ca to avoid the problem of refractory K and Ca repletion due to coexisting Mg deficiency.

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