

# Hypomagnesemia Correction Improves Airflow

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## Abstract

**Background:** Hypomagnesemia is commonly associated with neuromuscular irritability expressed as muscle fasciculations, cardiac dysrhythmias, seizures, etc. It is frequently encountered concomitant with hypocalcemia and hypokalemia. Previous studies reported increased bronchial reactivity in hypomagnesemic patients. Moreover, magnesium sulfate has been used in bronchial asthma with modest success; however, there has not been any report about spirometrical values in normocalcemic normokalemic hypomagnesemic patients.

**Objectives:** The main goal of our study was to evaluate the bronchodilatory effect of the correction of hypomagnesemia in terms of the change in forced expiratory volume during first second (FEV1) .

**Methods:** We conducted a study in 15 hypomagnesemic patients with normal serum calcium and potassium, in whom we performed spirometry and electrolytes measurements, before and after the administration of 1 gm of magnesium sulfate diluted in 100 cc. 5% dextrose in water, infused intravenously over an hour.

**Results:** The following results are shown in the following table:

PARAMETERS	PRE Mg <sup>++</sup>	Post Mg <sup>++</sup>	p value
Mg <sup>++</sup> level	1.5+/-0.2	2.1+/-0.3	<0.001
FEV1 (L)	2.6+/-0.3	3.1+/-0.4	<0.05
FVC (L)	3.8+/-0.4	4.4+/-0.6	<0.05
FEV%	67+/-5	69+/-6	NS

**Conclusions:** Normocalcemic normokalemic hypomagnesemic patients may present with some inherent airflow limitation, which is partly corrected with magnesium replacement, and this finding concurs with previous hypotheses that magnesium may play an important role in calcium handling and beta adrenergic receptor-mediated action of the bronchial smooth muscle.

## INTRODUCTION

Magnesium is the fourth most abundant cation in the body and the second most prevalent cation in intracellular fluid. Magnesium is an important cofactor for about 300 cellular enzymes, many of which involve energy metabolism. All enzyme reactions that involve ATP show an absolute requirement for magnesium.

Hypomagnesemia is commonly associated with

neuromuscular irritability expressed as muscle fasciculations, tremors, positive Chvostek's sign, positive Trousseau's sign, dysphagia, seizures, and cardiac arrhythmias (1,7). Termination of Prinzmetal's angina and cold-pressor-induced pulmonary hypertension, and Raynaud's phenomenon prevention have also been reported (2).

Previous studies have shown that magnesium decreases

bronchial reactivity (3), improved peak expiratory flow rates, and asthma quality of life questionnaire mean scores (10), as well as a significant dose-dependent relaxation of bronchial smooth muscle at rest, when stimulated by histamine, betanechol, or electrical impulse (4).

Other reports in rats indicate that Mg<sup>++</sup> treatment can prevent development of experimental chemically-induced pulmonary hypertension (8).

In a randomized, prospective trial to correlate magnesium levels with asthma activity; a statistically significant association was found between hypomagnesemia and severity of asthma as quantified by the average respiratory rate, and the use of bronchodilators and corticosteroids. (9)

Previous reports however have failed to document spirometrical changes in hypomagnesemic and hypocalcemic patients. There have been no reports about spirometrical values in normocalcemic, normokalemic, hypomagnesemic patients.

The current hypothesis suggest that magnesium acts in the smooth muscle of the airways as a voltage-sensitive calcium channel blocker (4,5,6). This might explain why hypocalcemic patients have a decreased response to magnesium-induced bronchodilatation. Consistent with this idea is the finding that calcium chloride was unable to reverse magnesium-induced relaxation.

Moreover the route of administration is also relevant because in a study comparing intravenous (IV) with nebulized administration, the IV use of magnesium sulfate was proved beneficial in terms of pulmonary function and reduction of hospital admission, whereas the nebulized route did not (11).

In this study, we investigated the spirometric changes in normocalcemic normokalemic hypomagnesemic patients before and after IV magnesium administration.

### MATERIAL AND METHODS

Computerized list of serum magnesium levels were obtained from inpatients at the Alexandria Home VA Medical Center. Immediately upon recognition of hypomagnesemia (serum Mg<sup>++</sup> levels less than 1.8 mg/dl), patients were proposed to participate in the study and informed consent was obtained.

Subsequently, spirometry was performed before and Mg<sup>++</sup> replacement, using a Multispiro SA/100 Spirometer, Medical Equipment Design, Inc., Louisville, KY. The magnesium replacement consisted of a solution of 1 g of

magnesium sulfate in 100 cc dextrose in water administered intravenously over 1 hour with monitoring of the vital signs.

Statistical analysis was done using the student t-test and considering a p value of <0.05 significant.

This study was approved by the Clinical Research Committee of the Alexandria VA Medical Center.

### RESULTS

We performed spirometry in 14 hypomagnesemic patients with normal serum calcium and potassium, before and after the administration of 1 gm of magnesium sulfate and obtained the following results:

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PARAMETERS	PRE Mg <sup>++</sup>	Post Mg <sup>++</sup>	p value
Mg <sup>++</sup> level	1.41+/-0.06	1.86+/-0.08	<0.05
FEV1 (L)	2.61+/-0.11	2.96+/-0.12	<0.05
FVC (L)	3.77+/-0.21	4.08+/-0.33	NS
FEV1%	69+/-6	72+/-5	NS
FEF25-75 (L/sec)	1.77+/-0.37	1.99+/-0.6	NS

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As it is shown in fig. 1, 12 out of 14 patients (85.7%) experienced an increase in their baseline FEV1, 4 patients (28.5%) showed no increase in their FEV1, moreover, 2 of these experienced a fall in their FEV1. Interestingly enough, the 4 patients, who had no increase or a had a decline in FEV1, failed to have correction of their hypomagnesemia.

In fig.2 we attempted to correlate the magnesium increase with the response in FEV1, but obtained a relatively poor correlation (r=0.47) and a predictability factor of only 22%. The explanation for this, bears on the fact that magnesium is an intracellular cation.

### CONCLUSIONS

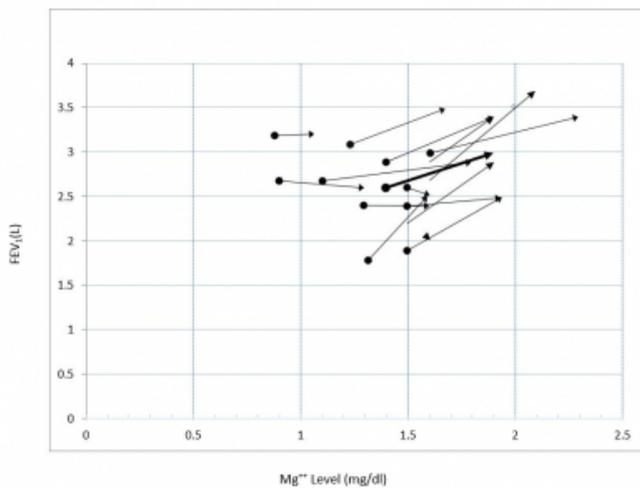
1. Hypomagnesemia may promote airflow limitation in normocalcemic, normokalemic patients.
2. Mg<sup>++</sup> replacement improves that inherent airway obstruction.
3. The bronchodilatory response obtained with Mg<sup>++</sup> replenishment is unpredictable, but it may not take place unless serum Mg<sup>++</sup> levels are normalized.

- This study corroborates the hypotheses that  $Mg^{++}$  plays an important role in the regulation of the beta-adrenergic receptors and  $Ca^{++}$  channels in the bronchial smooth muscle.
- If revalidated, the concept of correcting hypomagnesemia should be of utmost importance when managing patients with airflow limitation, thereby changing the paradigm of the current clinical practice.

Dr. Huaranga is responsible for the initial inception, the measurements, data acquisition, and final writing. Drs. Francis and Haro performed the literature review and contributed in the writing of the manuscript.

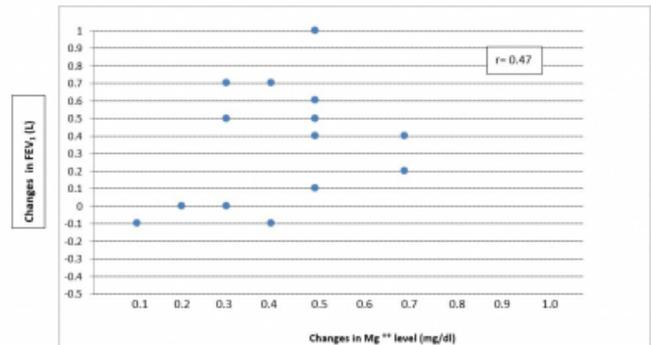
**Figure 1**

FEV<sub>1</sub> RESPONSE AFTER  $Mg^{++}$  REPLETION



**Figure 2**

Relationship between  $Mg^{++}$  increase and FEV<sub>1</sub> Response



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