Screening of Magnesium, Potassium and Calcium Status among Sulfur Mustard Inducing Chronic Small Airway Diseases

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A R T I C L E I N F O

Article Type:
Original Article

Article History:
Received: 15 Feb 2012
Revised: 25 Feb 2012
Accepted: 30 Feb 2012

Keywords:
Magnesium
Calcium
Potassium
Sulfur Mustard
Small Airway Diseases
Adults
Iran
Victim

A B S T R A C T

Background: Magnesium is an abundant intracellular divalent cation, and has significant efficacy on the respiratory system. Its homeostasis links with calcium and potassium electrolytes. Small airway diseases (SAD) of the lung can be induced among sulfur mustard gas-exposed victims(SM). The purpose of the present study was to determine status of magnesium, calcium and potassium among SM victims in Iran.

Method: The current study followed design of the protocol. Victims of the SM gas-exposed were sequentially enrolled among patients with defined criteria of SAD.

Results: A total of 145 victims completed criteria of the study. Means of total Mg, Ca and K serum concentrations were 1.96 ± 0.2 SD, 9.42 ± 0.53 SD and 4.16 ± 0.36SD, respectively. Frequency of hypomagnesemia, hypocalcemia and hypokalemia was found 16.6%, 9.7% and4.8%, respectively.

Conclusion: Noticeable deficiency of magnesium, calcium and potassium was disclosed among sulfur mustard-induced chronic SAD. Evaluation of recent electrolytes improves the outcome management of SAD.

►*Implication for health policy/practice/research/medical education:*
Evaluation of recent electrolytes improves the outcome management of small airway diseases.

► *Please cite this paper as:* Agin K. Screening of Magnesium, Potassium and Calcium Status among Sulfur Mustard Inducing Chronic Small Airway Diseases. *International Journal of Medical Toxicology and Forensic Medicine*. 2012; 2(2):71-76.

1. Introduction:

Magnesium (Mg) is a micronutrition trace element, fifth electrolyte and second abundant intracellular divalent cation (1). It contributes as a cofactor in over 300 enzymatic reactions and every body requires its integral function (2). Mg has significant effects on the respiratory system stability (3). Homeostasis of Mg requires action of potassium and calcium (4). Serum Mg measurement is the only routine evaluation accepted in the world. The serum assay of Mg is sensitive and reflects Mg deficiency but not specific. It cannot disclose body store of Mg (5). Hypomagnesemia is defined as a serum

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Mg concentration of less than 1.8 mg/DL and is often presented clinically as the acquired feature (6).

Sulfur mustard (SM) is a serious and toxic vesicant warfare agent (7). It was used as mass production on the veterans in combat of Iraq-Iran since 1980-1988, and remained over 50,000 veterans in Iran (8). Respiratory system which is one of the most prevalent target systems is exposed to SM action (9). Pathology of airways is dosed -depended. Low to moderate dose exposure effect on the upper respiratory tract and high dose can influence on the lower part of respiratory airway, and damages the paranchemal lungs. The small airway diseases of the lung (SAD) consist of pathological changes of inflammation and fibrosis restricted to airways less than 2 mm in diameter; respiratory and terminal bronchioles (10). A number of SAD has been induced by SM (11, 12). Hypomagnesemia was reported in a number of common respiratory diseases (13). Serum Mg status and related effective electrolytes on its homeostasis have not been reported among SM induced diseases as yet.

The aim of this study was to determine serum magnesium, calcium and potassium concentrations among sulfur mustard-induced chronic small airway diseases.

2. Materials and Methods:

This is a is cross-sectional study conducted in Shaheed Beheshti University of Medical Sciences (SBUMS), Loghman Hakim general teaching hospital, Tehran– Iran.

Target population sequentially enrolled in the study was among veterans exposed to SM concomitant with small airway diseases. The date of chemical contact was between 1980 -1985 years. Inclusion criteria consisted of adults, male sex, confirmed SM contact in accordance with following defined criteria and chronic small airway pulmonary diseases induced by SM based upon literature review. SM exposure accepted if veterans' documents based history taking, having review of medical records and Janbazan foundation ID as well as known sequels of SM.

History taking was performed at two levels; in person interview and questionnaire. Highlight topics considered include: the areas of contact, initial date of exposure, hospitalization period and early signs of chemical contact. In addition, they are having at least one of the prevalent contact sequels as: ocular lesions and or SM induced dermatopathy. SM induced chronic SAD based on the searching database including; bronchial asthma (14, 15), bronchiectasis (16-18), bronchiolitis and interstitial lung fibrosis associated with SAD (19-21). Small airway diseases were defined based on the standard -definition criteria, imaging and pulmonary function testing.

Any subjects that caused omission from the continuance of the study were as following backgrounds; using magnesium supplement and Loop and thiazide-type diuretics, alcohol consumption ,small bowel bypass surgery, Neoplasia, cardiovascular, acute or chronic diarrhea, malabsorption and steatorrhea syndrome , acute pancreatitis, renal diseases and convulsive disorders. Further evaluation performed if the patient information was not sufficient in chest clinic.

Blood samples were obtained in the following conditions; at the morning with fasting state eight hours, sitting position, using tourniquet, vein blood. Measurements were carried out in the unique laboratory. The cut point for Mg, K, Ca and IgE were 1.8 mg/dl, 3.5 mEq/dl, 8.5 mg/dl and >180 unite/dl. Measurements of laboratory data performed with commercial kits including Mg (Pars Azemon Co Ltd), Ca (Darman Kave Res Lab. Isfahan, Iran) and IgE (Padtan Elm co).

Collected data was analyzed with SPSS program - software16. The variables were summarized as Mean±SD and frequency. ANOVA test was performed between different variables. Significant value was <0.05 (two tailed).

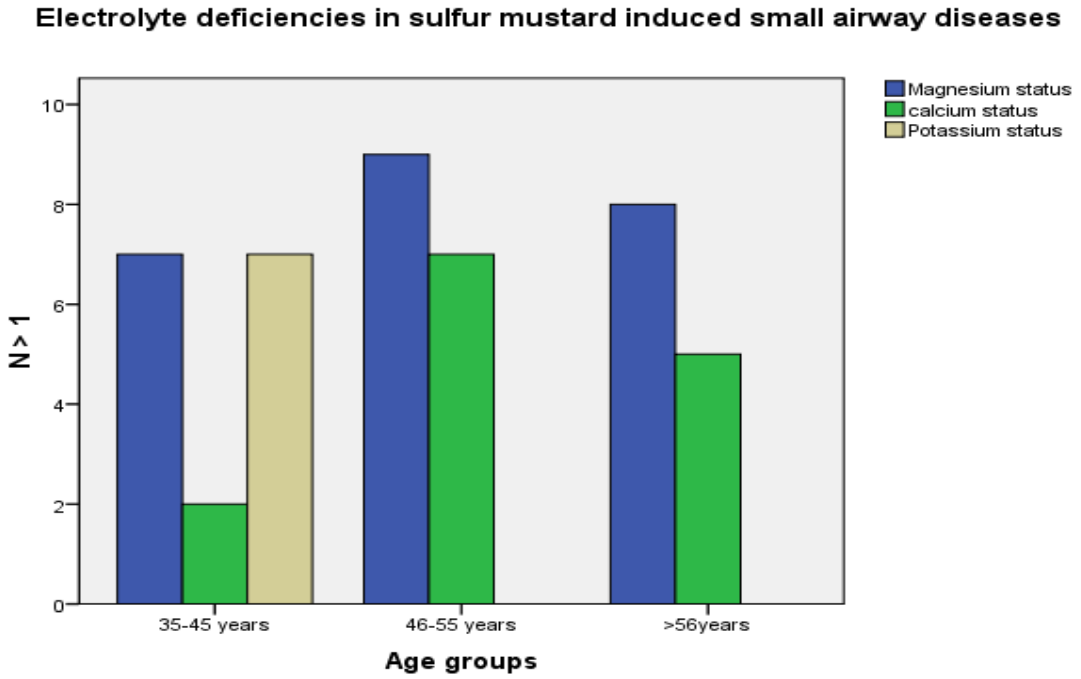

Fig. 1. It reveals age distribution and serum magnesium, calcium and potassium deficiency in the sulfur mustard induced small airway disease.

3. Results:

A total of 145 victims completed criteria of the present study. Mean age ± SD was 47.7±7.8 years, ranged between 35-60 years; Median= 48. Entire victims were male. Figure 1 shows age distribution and electrolyte deficiency in SM induced SAD. Means of total serum Mg, Ca and K concentrations were 1.96±0.2 SD, 9.42±0.53 SD and 4.16±0.36 SD, respectively. Frequencies of hypomagnesemia, hypocalcemia and hypokalemia were found 16.6%, 9,7% and 4.8%, respectively. Table 1 reveals characterizations of subset groups with Mg, Ca and K deficiencies in sample population. Mg and Ca deficiencies were better presented in the 2nd age class.

One-way ANOVA test was carried out between factor of Mg concentrations and depended lists of age, Ca and k. statistically no significant differences were found between them.

4. Discussion:

The outcome of the study revealed that prevalence of Mg deficiency was noticeable in chronic SAD induced by SM. The clinical feature of hypomagnesemia is nonspecific. Symptomatic threshold level of Mg deficiency manifests in less than 1.2 mg/dl (22). We had not below the recent cut of point in the study. Prevalence of hypomagnesemia was reported among few respiratory diseases with airflow limitation (13, 23, 24). Chronic hypomagnesemia was detected in the pulmonary diseases. Prevalence and frequency of Mg deficiency was reported in population of the prolonged care patients (3.5% and 12.5%, respectively) (25). Population at risk of Mg deficiency is relatively more common (26, 27). Detection of Mg deficiency is often missed clinically. A survey of evaluation of mg status among patients coming to the primary care hospital indicated that 47% of serum Mg was lower than the normal set point. Request of Mg level measurement was performed by an initial physician visiting 10% of the study population whereas 90% of them were missed (28). Mg status is a risk factor in cardiovascular diseases and

Table 1: It shows characterizations of serum magnesium, calcium and potassium subsets deficiencies of sample population among sulfur mustard induced small airway diseases.

Subsets	Number	Mean ± SD of age	Mean ± SD of value	Frequency%
Magnesium	24	50.12 ± 7.56	1.67 ± 0.04	16.6
Calcium	14	51.43 ± 7.29	8.2 ± 0.16	9.7
Potassium	7	42.7 ± 2.62	3.42 ± 0.18	4.8

has beneficial effects on the pulmonary function (29), development of bronchial hyper-responsiveness, mast cell stabilization, stimulation of synthesis of nitric oxide and prostacyclin and inhibition of cholinergic transmission in the limited airway diseases (30).

The causes of Mg deficiency are related to dieting, intestinal absorption, Mg loss and internal redistribution.

Magnesium is an intracellular electrolyte, and only 1% of the total body Mg is found in serum. Mg homeostasis is regulated by kidney. The recommended dietary allowance (RDA) of Mg is 280-350 mg daily (31). We don't study the regular diet of target population. However, asymptomatic Hypomagnesemia was observed among Iranian urban population (4.6%) (32). In general diet consumption, Medications are the causal factor in inducing Mg deficiency. The more frequent medications which are used in the management of airway limited pulmonary diseases are corticosteroids, theophylline, aminophylline (33) and beta-two agonist bronchodilators. The most popular beta-two agonists are salbutamol. It causes to shift Mg into the cells (34). Another mechanism of induced hypomagnesemia is excretion through kidney, which developed by aminophylline (35).

Stress associated with any sources can increase cathcholamine levels. It can increase the uptake of Mg by adipocytes and releases free fatty acid into circulation, and produces a complex with plasma Mg (36).

Mg homeostasis is regulated with ATPase-ion pump action and is integrated with intracellular sodium, potassium and alterations in calcium flux. Post-traumatic stress disorders (PTSD) follow the combat veterans. It was reported among Iranian veterans as a chronic state (37).

Hypomagnesemia can be associated with another common electrolyte deficiency. It contributes 40% to hypokalemia and 22-32% in hypocalcemic patients (38). Potassium and Mg have close homeostasis relation, and hypokalemia predicts the presence of hypomagnesemia .The exact mechanism of manifestation of hypokalemia in the hypomagnesemia status has not been understood, but may be related to transporter systems (30).

There is positive correlation between hypocalcemia and hypomagnesemia (39). Our finding revealed noticeable hypocalcemia in target population. Mg is an agonist of CaR and modulates transport and intracellular Ca concentration (40). However, hypomagnesemia can influence on the ionized Ca level through changed-end organ responsiveness to PTH (41). Rising of ionized Ca induces Mg wasting via kidney rout.

In conclusion, noticeable deficiencies of magnesium, calcium and potassium were disclosed among sulfur mustard induced chronic SAD. Evaluation of recent electrolytes improves the outcome management of SAD.

Acknowledgments:

I hereby extend my gratitude to every one of sulfur mustard Iranian victims for all their help and support during the study.

References

1. Elin RJ. Magnesium: the fifth but forgotten electrolyte. Am J Clin Pathol. 1994;102(5):616-22.
2. Takaya J, Higashino H, Kobayashi Y. Intracellular magnesium and insulin resistance. Magnes Res. 2004;17(2):126-36.
3. Alamoudi OS. Hypomagnesaemia in chronic, stable asthmatics: prevalence, correlation with severity and hospitalization. Eur Respir J. 2000;16(3):427-31.
4. Guerrera MP, Volpe SL, Mao JJ. Therapeutic uses of magnesium. Am Fam Physician. 2009;80(2):157-62
5. Naderi AS, Reilly RF Jr. Hereditary etiologies of hypomagnesemia. Nat Clin Pract Nephrol. 2008;4(2):80-9
6. Kehe K, Szinicz L. Medical aspects of sulphur mustard poisoning. Toxicology. 2005;214(3):198-209.
7. Falahati F, Soroush MR, Salamat AA, Khateri S, Ali Reza Hosseini AR. A 20 Year Cancer-Related Mortality Follow-up Study of Mustard Gas Exposed Iranian Veterans. Janbazan Medical and Enginearing Research Center JMERC19615/616 Tehran – Iran.2002 Applied science and analysis inc.the ASA newsletter .available at 2007: www.asanltr.com/newsletter/044/newsletter.htm.
8. Khateri S, Ghanei M, Keshavarz S, Soroush M, Haines D. Incidence of lung, eye, and skin lesions as late complications in 34,000 Iranians with wartime exposure to mustard agent. J Occup Environ Med. 2003;45(11):1136-43.
9. Mead J. The lung's "quiet zone". N Engl J Med. 1970;282(23):1318-9.
10. -Balali-Mood M, Hefazi M, Mahmoudi M, Jalali E, Attaran D, Maleki M, Razavi ME, Zare G, Tabatabaee A, Jaafari MR. Long-term complications of sulphur mustard poisoning in severely intoxicated Iranian veterans. Fundam Clin Pharmacol. 2005;19(6):713-21.
11.Ghanei M, Moqadam FA, Mohammad MM, Aslani J. Tracheobronchomalacia and air trapping after mustard gas exposure. Am J Respir Crit Care Med. 2006;173(3):304-9.
12.Cerci Neto A, Ferreira Filho OF, Parreira Jde S. The relative frequency of hypomagnesemia in outpatients with chronic airflow limitation treated at a referral center in the north of the state of Paraná, Brazil. J Bras Pneumol. 2006;32(4):294-300.
13. Van den Berge M, ten Hacken NH, Cohen J, Douma WR, Postma DS. Small airway disease in asthma and COPD: clinical implications. Chest. 2011;139(2):412-23.
14. Emad A, Emad Y. Relationship between airway reactivity induced by methacholine or ultrasonically nebulized distilled cold water and BAL fluid cellular constituents in patients with sulfur mustard gas-induced asthma. Clin Toxicol (Phila). 2007;45(5):565-70.
15. Ooi GC, Khong PL, Chan-Yeung M, Ho JC, Chan PK, Lee JC, Lam WK, Tsang KW. High-resolution CT quantification of bronchiectasis: clinical and functional correlation. Radiology. 2002;225(3):663-72.
16. Stern EJ, Frank MS. Small-airway diseases of the lungs: findings at expiratory CT. AJR Am J Roentgenol. 1994;163(1):37-41.
17. Balali-Mood M, Mousavi Sh, Balali-Mood B. Chronic health effects of sulphur mustard exposure with special reference to Iranian veterans. Emerg Health Threats J. 2008;1:e7.
18. Saldías P F, Díaz P O, González B S, Osses A R. Bronchiolar disorders: clinical-radiological assessment and classification. Rev Med Chil. 2011;139(9):1218-28.
19. Wilcox AG. Small airway involvement in interstitial lung disease: radiologic evidence. Curr Opin Pulm Med. 2000;6(5):399-403.
20. Balali-Mood M, Afshari R, Zojaji R, Kahrom H, Kamrani M, Attaran D, Mousavi SR, Zare GA. Delayed toxic effects of sulfur mustard on respiratory tract of Iranian veterans. Hum Exp Toxicol. 2011;30(9):1141-9.
21. Elizabeth L. Tso, Robert A. Barish. Magnesium: Clinical considerations. Journal of Emergency Medicine. 1992;10(6):735-745.
22. Alamoudi OS. Electrolyte disturbances in patients with chronic, stable asthma: effect of therapy. Chest. 2001;120(2):431-6.
23. Rolla G, Bucca C, Bugiani M, Oliva A, Branciforte L. Hypomagnesemia in chronic obstructive lung disease: effect of therapy. Magnes Trace Elem. 1990;9(3):132-6.
24. Lum G. Hypomagnesemia in acute and chronic care patient populations. Am J Clin Pathol. 1992;97(6):827-30.
25. Schimatschek HF, Rempis R. Prevalence of hypomagnesemia in an unselected German population of 16,000 individuals. Magnes Res. 2001;14(4):283-90.
26. Fox CH, Ramsoomair D, Mahoney MC, Carter C, Young B, Graham R. An investigation of hypomagnesemia among ambulatory urban African Americans. J Fam Pract. 1999;48(8):636-9.

27. Whang R, Ryder KW. Frequency of hypomagnesemia and hypermagnesemia. Requested vs routine. JAMA. 1990;263(22):3063-4.
28. Landon RA, Young EA. Role of magnesium in regulation of lung function.. 1.
29.J Am Diet Assoc. 1993;93(6):674-7.
30. Britton J, Pavord I, Richards K, Wisniewski A, Knox A, Lewis S, Tattersfield A, Weiss S. Dietary magnesium, lung function, wheezing, and airway hyperreactivity in a random adult population sample. Lancet. 1994;344(8919):357-62
31.Nils-Erik L. Saris, Eero Mervaala, Heikki Karppanen, Jahangir A. Khawaja, Andrzei Lewenstam. Magnesium: An update on physiological, clinical and analytical aspects. Clinica Chimica Acta. 2000;294(1-2):1-26.
32. Syedmoradi L, Ghasemi A, Zahediasl S, Azizi F. Prevalence of hypo- and hypermagnesemia in an Iranian urban population. Ann Hum Biol. 2011;38(2):150-5.
33. Hagley MT, Traeger SM, Schuckman H. Pronounced metabolic response to modest theophylline overdose. Ann Pharmacother. 1994;28(2):195-6.
34. Haffner CA, Kendall MJ. Metabolic effects of beta 2-agonists. J Clin Pharm Ther. 1992;17(3):155-64
35. Knutsen R, Bøhmer T, Falch J. Intravenous theophylline-induced excretion of calcium, magnesium and sodium in patients with recurrent asthmatic attacks. Scand J Clin Lab Invest. 1994;54(2):119-25
36. Berkelhammer C, Bear RA. A clinical approach to common electrolyte problems: 4. Hypomagnesemia. Can Med Assoc J. 1985;132(4):360-8.
37. Nejad AG, Farahati H. Dissociative disorders and dissociative symptoms among veterans of the Iraq-Iranwar suffering from chronic post-traumatic disorder. Neurosciences (Riyadh). 2007;12(4):318-21.
38. R Swaminathan. Magnesium Metabolism and its Disorders. Clin Biochem Rev. 2003; 24(2): 47–66.
39. Fatemi S, Ryzen E, Flores J, Endres DB, Rude RK. Effect of experimental human magnesium depletion on parathyroid hormone secretion and 1,25-dihydroxyvitamin D metabolism. J Clin Endocrinol Metab. 1991;73(5):1067-72.
40. Kowal A, Panaszek B, Barg W, Obojski A. The use of magnesium in bronchial asthma: a new approach to an old problem. Arch Immunol Ther Exp (Warsz). 2007;55(1):35.
41. Cholst IN, Steinberg SF, Tropper Pl, *et al*: The influence of hypermagnesemia on serum
42.calcium and parathyroid hormone levels in human subjects. N Engl J Med. 310:7227-7225,7944.