DOI: 10.21276/sjams.2017.5.3.79

Scholars Journal of Applied Medical Sciences (SJAMS) **ISSN 2320-6691 (Online)**
Sch. J. App. Med. Sci., 2017; 5(3F):1131-1136 **ISSN 2347-954X (Print)**

(An International Publisher for Academic and Scientific Resources)
www.saspublisher.com

Original Research Article

The inverse correlation of serum Magnesium level with the stage of Pulmonary Tuberculosis

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Abstract: The progress of an infectious condition is partly affected by the overall nutrition of the host. Many of the essential trace elements like copper, zinc, magnesium influence the function of the immune system. Tuberculosis and malnutrition is well recognized to go hand in hand as one can lead to the other. The present study included 50 newly detected adults who were both sputum positive and chest radiograph positive for pulmonary tuberculosis were included in the study. 20 healthy controls were taken from the hospital employees. Serum magnesium levels in control group range from 1.85-2.12 mg/dL and that of the study group range from 1.45-1.73 mg/dL. The study showed with increasing duration of the illness serum magnesium levels progressively decreased. It was observed that in far advanced disease (1.537±0.054) the serum magnesium levels were lower than in moderately advanced (1.606±0.023) and minimal disease (1.675±0.026). Serum magnesium level was significantly lower in cavitary type (1.571±0.052 mg/dL) than the non-cavitary type (1.675±0.026 mg/dL). Serum magnesium levels were lower in patients with hemoptysis (1.59±0.057 mg/dL) and loss of weight (1.59±0.059 mg/dL). Conclusion: The study observed that a significant inverse relationship existed between the level of serum magnesium with the duration of illness, extent of the disease and symptoms like hemoptysis and weight loss.

Keywords: Pulmonary Tuberculosis, Serum Magnesium, Chest Radiograph, Hemoptysis, weight loss

INTRODUCTION:

Magnesium is one of the important minerals present in the human body as its role in enzymatic reactions and as a co-factor. Magnesium is the fourth most abundant cat ion present in the body [1]. The discovery of magnesium dates back to 1808, it was first identified by Sir Humphrey Davy [2]. J. Loeb demonstrated its importance in rhythmical contractions of the muscle in 1900[3].

Magnesium is extremely essential for life and is present as intracellular ion in all living cells and tissues [4]. The importance of magnesium in disease processes is being increasingly recognized now a day. The use of magnesium in therapy of diabetes mellitus and myocardial infarction exemplified this [5, 6]. Hypomagnesaemia has been reported in fasting condition, after operation, malabsorption syndrome, cirrhosis of liver, renal disease, Chronic Obstructive Pulmonary Disease, Congestive Cardiac Failure etc. [7-9].

There are not many reports of such studies in pulmonary tuberculosis (TB). Some workers (Jain et al., 1976, Narang et al., 1984) [10, 11] have found the serum magnesium level to decrease in cases of pulmonary tuberculosis, which rises towards normal with specific treatment. The purpose of the present study was to correlate severity of pulmonary tuberculosis with serum magnesium.

Serum magnesium level is rigorously maintained within normal limits of 1.7 to 2.1 mg/dL [12]. The progress of an infectious condition is partly

affected by the overall nutrition of the host. Many of the essential trace elements like copper, zinc, magnesium influence the function of the immune system [13]. The pathophysiology of tuberculosis is very closely linked to delay immune response of the host and alterations in T-lymphocyte and macrophage functions contribute to the natural course of the disease [14]. Previous reports have studied the levels of these elements in serum in patients of pulmonary tuberculosis [11, 15].

Patients with hypomagnesaemia usually presents with personality changes, gastro intestinal disturbances, gross tremors, hyporeflexia, abnormal electromyograph, positive chovstek's sign, and epileptiform convulsions [4]. Tuberculosis and malnutrition is well recognized to go hand in hand as one can lead to the other [16]. TB has been found to coexist with malnutrition among patients at the time of starting treatment in both developed and developing countries [17-21]. TB is also associated with various socioeconomic factors and often occurs in populations suffering from poverty, poor housing and economic deprivation and these are also major factors predisposing to poor nutritional status and impaired immune function [16, 22, 23].

AIMS AND OBJECTIVES:

The study aimed at estimating serum magnesium in pulmonary tuberculosis, to correlate its levels with increasing duration and severity of the disease, clinical symptoms and signs of pulmonary tuberculosis and to compare it with healthy controls. Objective of the study was to prove that the severity of pulmonary tuberculosis and increased duration of illness are associated with significantly low serum magnesium levels.

MATERIALS AND METHODS:

Study Group and Sample Collection:

The study was carried out in the Department of Respiratory Medicine, Yenepoya Medical College, Deralakatte (2009-2011). The study included 50 newly diagnosed adult pulmonary tuberculosis patients and 20 healthy controls from hospital employee in the age group of 20 to 60 years. They were recruited for the study after taking their due written consent. Patients included in the study had both sputum and chest radiograph positive for pulmonary tuberculosis. Conditions known to cause hypomagnesaemia like chronic alcoholism malabsorption syndrome, prolonged diarrhea, diabetes mellitus, congestive cardiac failure, chronic obstructive pulmonary disease were excluded. Detailed clinical history and examination were recorded in all cases before including in the study.

Measurement of Different Biochemical Parameters:

The included subjects had to undergo blood investigations for complete blood count, Erythrocyte Sedimentation rate, blood sugars, serum electrolytes and liver function test.

Sputum for AFB:

2 samples (spot and early morning sample) of sputum were obtained for detection of Acid Fast Bacilli by Ziehl-Neelsen Technique and all newly diagnosed sputum smear positive cases were included in the study.

Chest Radiograph:

All cases included in the study were classified as minimal, moderately advanced and far advanced disease according to the classification by National Tuberculosis and Respiratory Disease Association, America, after Postero-Anterior view Chest radiograph [24].

Minimal Disease*:* Lesions that are of slight to moderate density but do not contain demonstrable cavitation. They may involve a small part of one or both lungs, but the total extent, regardless of distribution, should not exceed the volume of lung on one side that occupies the space above the second chondrosternal junction and the spine of the fourth or the body of the fifth thoracic vertebra.

Moderately Advanced Disease: Lesion may be present in one or both lungs, but the total extent should not exceed the following limits: disseminated lesions of slight to moderate density that may extend throughout the total volume of one lung or the equivalent in both lungs; dense and confluent lesions limoited in extent to one-third the volume of one lung; total diameter of cavitation, if present, must be less than 4cm.

Far Advanced Disease*:* Lesions more extensive than moderately advanced.

Estimation of serum magnesium:

Serum magnesium levels are considered normal within the range of 1.7-2.1mg%. The serum magnesium levels were estimated at the time of first visit.

The estimation of serum magnesium was done by modified spectrophotometric method of Neill and Neely by using titan yellow dye. Magnesium was determined photometrically in tungstic acid filtrate of serum by forming red lake with titan yellow in alkaline

solution. Color formation was stabilized by polyvinyl alcohol. 3 test tubes were taken and marked Blank (3 ml water), Standard (2 ml of working standard with 1 ml water) and Unknown (0.5 ml serum with 2.5 ml water). Then 1 ml of Sodium Tungstate and 1 ml of H_2SO_4 were added to each tube and mixed, and the unknown was centrifuged. 2.5 ml from each tube is transferred to new tubes and 1 ml of Polyvinyl Alcohol and 0.5 ml titan yellow, 1 ml of NaOH is added to each tube and mixed.

The readings of absorbance of standard (AS) unknown (Ax) and blank at 540 nm were taken and were calculated as follows:

Magnesium mg/dL = AS/Ax

STATISTICAL ANALYSIS:

Descriptive statistics that included the mean, standard deviation, minimum and maximum values were calculated for each group. The results are expressed as mean ± 1 SD. The student t-test was used for intra (paired t-test) and inter (unpaired t-test) group comparisons. One factor ANOVA (Analysis of Variance) was used for multiple categories comparisons. Significance of all the statistical tests was predetermined at a probability level of 0.05 or less.

RESULTS:

In the present study, 50 cases and 20 controls were included. Serum magnesium levels did not show any significance among the controls (Table-I and Table-II) on the basis of gender (p-value>0.05) and age (p-value>0.05). Serum magnesium levels in control group range from 1.85-2.12mg/dL and that of the study group range from 1.45-1.73mg/dL (Table-III) and it was highly significant (p-value <0.001) statistically. The study showed with increasing duration of the illness (Table-IV) at first presentation to the clinic there was evidence that serum magnesium levels progressively decreased with duration of illness (p-value<0.01). In the study (Table-V) it was observed that in far advanced disease (1.537±0.054mg/dL) the serum magnesium levels were lower than in moderately advanced (1.606±0.023mg/dL) and minimal Disease (1.675±0.026mg/dL) (p-value<0.01).

It was evident in the study (Table-VI) that the mean serum magnesium level was significantly lower in cavitary type (1.571±0.052mg/dL) than the non-cavitary type (1.675±0.026mg/dL), (p-value<0.01) and was statistically significant. In the study group mean serum magnesium level lower in low socio economic group than middle socioeconomic group (Table-VII) but it is not statistically significant (p-value>0.05). Table-VIII shows the serum magnesium levels in study group with different clinical features. As it is evident, serum magnesium levels were lower in patients with hemoptysis (1.59±0.057mg/dL) and loss of weight (1.59±0.059mg/dL) showing p-value of <0.01 which is significant.

Table 1: Sex Wise Distribution of Serum Magnesium in Control Group

Sex	No. of cases	Serum Magnesium Level (mg/dL)	
		Range	Mean ± SD)
Male	12	1.85 - 2.11	2.037 ± 0.088
Female	8	1.9 - 2.12	2.024 ± 0.07
Both males & females	20	1.85 - 2.12	2.0315 ± 0.079

Table 2: Age Wise Distribution of Serum Magnesium in Control Group

Age	No. of cases	Serum Magnesium Level (mg/dL)	
		Range	Mean ± SD
20-29	6	1.95 - 2.1	2.032 ± 0.064
30-39	5	2.01 - 2.12	2.054 ± 0.052
40-49	5	1.85 - 2.1	1.972 ± 0.115
50-59	4	2.0 - 2.1	2.076 ± 0.052

Table 3: Serum Magnesium Levels in Control and Study Groups

Groups	No. of cases	Serum Magnesium Level (mg/dL)		t-value	p-value
		Range	Mean ± SD		
Control Group		1.85 - 2.12	2.0315 ± 0.0798	8.17	< 0.001

Study group		**1.45 - 1.73**	**1.633 ± 0.065**	-	-

Table 4: Correlation between Serum Magnesium and Duration of Illness

Duration of illness (months)	No. of cases	Serum Magnesium Level (mg/dL)	
		Mean	SD
1	14	1.695	0.02
2	18	1.656	0.017
3	11	1.592	0.024
4	5	1.542	0.015
5	2	1.455	0.007

Table 5: Correlation between Severity of Pulmonary Tuberculosis and Serum Magnesium

Severity	No. of cases	Serum Magnesium Level (mg/dL)		p-value*
		Range	Mean ± SD	
Minimal Disease	30	1.62 – 1.73	1.675 ± 0.026	< 0.01
Moderately Advanced Disease	10	1.57 – 1.64	1.606 ± 0.023	< 0.01
Far Advanced Disease	10	1.45 - 1.64	1.537 ± 0.054	< 0.01

Table 6: Serum Magnesium and Different Radiological Lesions

Type of Lesion	No. of cases	Serum Magnesium Level (mg/dL)		p-value*
		Range	Mean ± SD	
Cavitary	20	1.45 – 1.64	1.571 ± 0.052	<0.001
Non-Cavitary	30	1.62 – 1.73	1.675 ± 0.026	<0.001
Cavitary Vs. Non-Cavitary	50			<0.01

Table 7: Serum Magnesium in Different Socio-Economic Groups

Socio-Economic Status	No. of cases	Serum Magnesium Level (mg/dL)		p-value
		Range	Mean ± SD	
High	_	_		_
Middle	22	1.55 – 1.73	1.66 ± 0.0526	_
Low	28	1.45 – 1.71	1.612 ± 0.066	< 0.3 NS

Table 8: Serum Magnesium in Patients with Different Symptoms and Signs

Symptoms and signs	Symptoms present		Symptoms absent		p-value*
	No. of cases	Mean ± SD	No. of cases	Mean ± SD	
Cough	42	1.632 ± 0.068	8	1.639 ± 0.046	NS
Hemoptysis	27	1.59 ± 0.057	23	1.68 ± 0.022	< 0.01 S
Weight loss	29	1.59 ± 0.059	21	1.69 ± 0.023	< 0.01 S
Clubbing	24	1.58 ± 0.056	26	1.68 ± 0.024	NS

DISCUSSION:

The present study was done to estimate serum magnesium levels in pulmonary tuberculosis to correlate with the extent of the disease, duration of illness and symptoms. Our study (Table-III) showed that the mean magnesium levels are lower in the study group (1.633±0.065) than in the control group (2.0315±0.0798). Our study (Table-IV) also shows serum magnesium level decreases with the increasing duration of the illness. The study (Table-V) also showed the mean magnesium of 1.675, 1.606 and 1.537 mg/dL in minimal, moderately advanced and far advanced groups respectively. This finding is consistent with the Narang et al., where the study showed similar finding. The lower serum magnesium levels could be explained in relation to tissue destruction in pulmonary tuberculosis, which could be an important factor leading to hypomagnesaemia.

Our study (Table-VII) showed low levels of serum magnesium in lower socio economic group. This could be explained by either due to poor diet and anorexia, or presentation of the patients with more severe extent of tuberculosis due to late consultation.

This is consistent with the Agarwal *et al.;* [25] study in 1986 where 46 cases were studied and showed mean serum magnesium levels were significantly lower in test group than the control group. They also showed the value was significantly lower in the lower socio economic group.

Our study (Table-VI) showed that the mean serum magnesium levels were significantly lower in cavitary type (1.571mg/dL) than the non-cavitary type (1.675mg/dL). Our results are consistent with the findings of Jain *et al.;* [10] 1976 where 40 cases of pulmonary tuberculosis studied and found that cases with cavitary lesions had a lower magnesium level than non-cavitary lesion. This could be explained as the amount of lung destruction increases from no cavity through small cavity to medium or large cavity, the serum magnesium value falls significantly.

Our study (Table- VIII) showed serum magnesium levels were significantly lower in patients with hemoptysis, loss of weight and clubbing. Narang *et al.;* [11] and Agarwal *et al.;* [25] have reported that serum magnesium level has no relation with hemoptysis but significant relationship with clubbing and loss of weight. Estimation of serum magnesium was thus found to be a reasonable indicator of severity of disease (tissue necrosis). But its routine employment requires for a larger trial report and simplification of the technique of serum magnesium estimation.

CONCLUSION:

Serum magnesium levels were studied in 50 newly detected cases of pulmonary tuberculosis before treatment with anti-tubercular drugs. The study observed that a significant inverse relationship was observed between the level of serum magnesium with duration of illness, extent of the disease and symptoms like hemoptysis and weight loss.

Thus, serum magnesium was found to, be a reasonable indicator of severity of pulmonary tuberculosis. There is also a need to consider magnesium supplementation in the diet of tuberculosis patients.

ACKNOWLEDGEMENTS:

We thank all of the patients who participated in the study and Dr Sukesh Rao, Mr Mubeena, Mr Zameer P, Mrs Rajini UK, and Mrs Shiny Jackline, for facilitating smooth conduct of the study.

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