

An observational study on serum electrolytes among patients with acute exacerbations of chronic bronchial asthma at a tertiary care hospital of Bihar

Naresh Kumar Suman¹, Md. Haroon Rashid², Sude Kumar Singh^{3*}

¹Junior Resident, Department of Biochemistry, DMC, Laheriasri, Bihar, India

²Junior Resident, Department of Biochemistry, DMC, Laheriasri, Bihar, India

³Professor, Department of Biochemistry, DMC, Laheriasri, Bihar, India

Received: 28-11-2021 / Revised: 25-12-2021 / Accepted: 05-01-2022

Abstract

Introduction: Abnormal electrolyte levels in patients with bronchial asthma can be attributed to either low dietary intake or to adverse effects of asthma medications. Hypokalemia has been reported as an electrolyte disturbance in acute asthma. This study was aimed at assessing the levels of serum electrolytes in patients with acute exacerbation of bronchial asthma and comparing them against non-asthmatic controls. **Materials and Methods:** This observational study was conducted on Department of Biochemistry of, Darbhanga Medical College & Hospital, Laheriasri, Bihar, India from June 2021 to May 2022. The study population comprised of samples obtained in the department from patients who presented with complaints of acute exacerbation of bronchial asthma in the Emergency Department of the hospital. During the study period, samples from a total of 100 asthmatic patients were included. For comparison, I obtained samples from the Emergency department from 100 age and gender matched controls that were not asthmatics. The study was approved by the institutional ethics committee. The data collected were analyzed by SPSS version 20. **Results:** A total of 200 patients were included in the study, 100 in each group, cases and controls. Both the groups were age and gender matched. The mean (SD) age of cases was 38.9 (14.7) years for cases and 40.4 (12.9) years. There was male preponderance noted in both the groups. T test for age and gender showed a p value of >0.05, that means the groups were comparable. Except for mean serum chloride, all the electrolytes had mean value lower among cases as compared to controls. Among cases, the mean serum sodium, calcium and magnesium were significantly lower than that of control population. **Conclusion:** The present study showed that there was a significant decrease of sodium, magnesium and calcium levels during exacerbations in asthmatics.

Key Words: Serum electrolytes, chronic bronchial asthma

This is an Open Access article that uses a funding model which does not charge readers or their institutions for access and distributed under the terms of the Creative Commons Attribution License (<http://creativecommons.org/licenses/by/4.0>) and the Budapest Open Access Initiative (<http://www.budapestopenaccessinitiative.org/read>), which permit unrestricted use, distribution, and reproduction in any medium, provided original work is properly credited.

Introduction

Abnormal electrolyte levels in patients with bronchial asthma can be attributed to either low dietary intake or to adverse effects of asthma medications[1]. Hypokalemia has been reported as an electrolyte disturbance in acute asthma by numerous authors, and it was related to the use of β_2 -agonists and aminophylline. Recently, hypomagnesemia, hypophosphatemia, and hypocalcemia have also been reported after administration of β_2 -agonists in asthmatic patients and normal controls as well[2]. In acute asthma, an increase in the urinary excretion of calcium has also been reported in asthmatic patients treated with intravenous aminophylline. Magnesium and calcium play multiple roles in the pulmonary anatomy and physiological function. When magnesium is deficient, the action of calcium is enhanced, while an excess of magnesium blocks calcium and vice versa. These interactions are important for patients with respiratory tract diseases because the intracellular influx of calcium or decreased magnesium levels can result in hyperreactivity of bronchial smooth muscles. Additionally, the mortality rate in patients with asthma has also been linked to the adverse effects of agents given in the management. Hypokalemia, hypomagnesemia and hypocalcemia are wellknown causes of cardiac arrhythmia[3] and hypophosphatemia can worsen respiratory failure in severely ill asthmatic patients through impairment of respiratory muscle performance[4].

This study was aimed at assessing the levels of serum electrolytes in patients with acute exacerbation of bronchial asthma and comparing them against non-asthmatic controls.

*Correspondence

Dr. Sude Kumar Singh

Professor, Department of Biochemistry, DMC, Laheriasri, Bihar, India.

E-mail: sudekumarsingh@gmail.com

Materials and methods

This observational study was conducted on Department of Biochemistry of, Darbhanga Medical College & Hospital, Laheriasri, Bihar, India from June 2021 to May 2022. The study population comprised of samples obtained in the department from patients who presented with complaints of acute exacerbation of bronchial asthma in the Emergency Department of the hospital. The study was approved by the institutional ethics committee. Samples from patients who had respiratory complaints due to causes other than bronchial asthma, patients with a past medical history of cardiac diseases, renal disorders, malignancies, alcohol abuse, diuretic use or thyroid related disorders were excluded. During the study period, samples from a total of 100 asthmatic patients were included. For comparison, I obtained samples from the Emergency department from 100 age and gender matched controls that were not asthmatics.

Demographic information of the patients like age, gender was obtained. Laboratory investigations for biochemical parameters like serum sodium, potassium, calcium, magnesium and chloride were measured by using automated chemistry analyzer. Two milli litres of blood samples were collected from each participant while taking care of standard infection control practices. The serum samples were then used to measure electrolyte levels using the Beckmann Coulter auto analyser. Magnesium levels were measured by Xylidyl blue method and calcium levels by Arsenazo III method in the auto analyser. Normal serum sodium level was taken as 135 to 145mEq/L, serum potassium level as 3.5 to 5.5mEq/L, normal serum ionized calcium level as 1.07 to 1.27 mg/dl and normal serum magnesium level as 1.9 to 2.5 mg/dl.

The data collected were analyzed by SPSS version 20. Quantitative data were expressed as mean and standard deviation and were compared using t-test. Qualitative data were expressed as number and

percentage and compared using chi-square test. All these tests were used as tests of significance at $P < 0.05$.

Results

A total of 200 patients were included in the study, 100 in each group, cases and controls. Both the groups were age and gender matched. The mean (SD) age of cases was 38.9 (14.7) years for cases and 40.4 (12.9) years. There was male preponderance noted in both the groups.

T test for age and gender showed a p value of >0.05 , that means the groups were comparable.

Table 1 & Figure 1 summarize the biochemical results of both the groups. Except for mean serum chloride, all the electrolytes had mean value lower among cases as compared to controls. Among cases, the mean serum sodium, calcium and magnesium were significantly lower than that of control population.

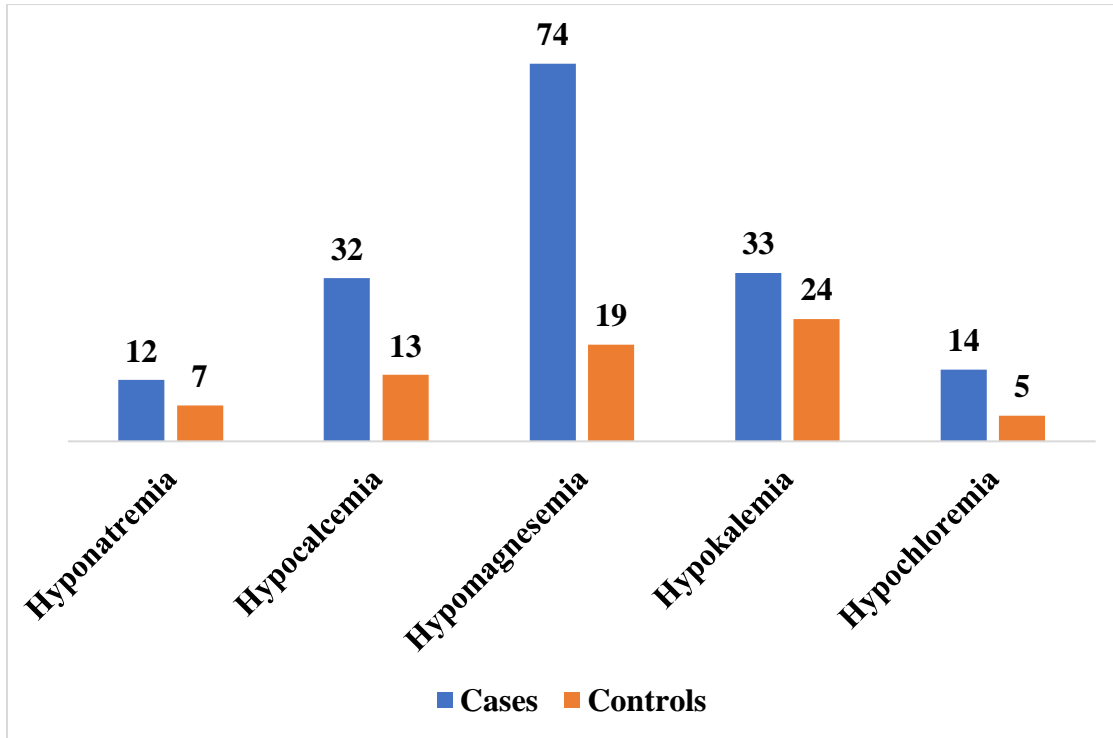


Fig. 1: Distribution of patients according to the type of electrolyte disturbance

Table 1: Distribution of mean value of various serum electrolytes of the patients included in the study

Serum electrolyte (mEq/L)	Cases	Controls	P value
Serum sodium	136.7 ± 11.3	143.4 ± 8.1	<0.05
Serum calcium	8.1 ± 2.3	9.8 ± 1.1	<0.05
Serum magnesium	1.7 ± 0.9	2.7 ± 0.7	<0.05
Serum potassium	3.9 ± 1.6	4.4 ± 0.9	>0.05
Serum chloride	95.8 ± 18.4	94.4 ± 19.9	>0.05

Discussion

The present study found that patients with acute asthma had a significantly lower mean serum sodium, magnesium and calcium levels as compared to non-asthmatic controls. Concurring with results of the present study, Alamoudi[5] and Oladipo et al[6] showed that serum magnesium levels were significantly decreased in asthmatic patients compared to their controls. The authors further observed that hypomagnesemia was a common disorder in patients with chronic asthma. Although the cause of hypomagnesemia in patients with chronic asthma is unclear, it may be linked to either low dietary intake of magnesium asthmatics or increased urinary loss of magnesium because of long term use of β_2 - agonist, corticosteroid and theophylline[7]. Additionally, Ahmed et al observed that magnesium levels were significantly decreased in patients with exacerbation than in stable asthmatics. This was demonstrated previously by Mohammad et al as well[8].

Alamoudi, further observed that serum magnesium levels were found to be low in both stable as well as acute exacerbations of bronchial asthma and found serum magnesium levels to be significantly correlated with severity of asthma. The authors explained this as an

association between magnesium deficiency and an increased airway hyper-reactivity. Studies have shown that magnesium ions play a role in various biochemical and physiological processes which influence the lung function and respiratory symptoms. These mechanisms include altering airway smooth muscle function, immune function and oxidative stress. Furthermore, hypomagnesemia may make patients susceptible to bronchial spasms by increasing the neuromuscular irritability[9]. One possible explanation for this is that hypomagnesemia may increase influx of calcium into the smooth muscle cells of the airway. Alternatively hypomagnesemia may increase responsiveness of the bronchial smooth muscles through increased histamine release from mast cells[5]. Replacement of magnesium has not found to be effective in chronic asthmatic patients in previous studies. Britton et al found that reduced intake of magnesium was associated with hyper-reactivity to methacholine and the authors concluded that decreased intake of magnesium may therefore be involved in the etiology of asthma[10]. Additionally, magnesium sulphate has shown to improve pulmonary function in severe asthma[11]. In the present study, only one control had hypocalcemia, while there were 24% of the asthmatics with

hypocalcemia. Emad et al[12] and Alamoudi[5] reported normal serum calcium levels among stable asthmatic. The authors further explained this observation by the absence of β_2 - agonists or aminophylline that are known to cause an increased urinary excretion of calcium. Additionally, excess of magnesium blocks the action of calcium, and this may further explain these interactions. Proportion of hypokalemic patients were similar in both the groups in our study. Studies have observed that hypokalemia is common among patients with acute asthma exacerbations and that there was a significant decrease in potassium level in these patients than those with stable bronchial asthma[13]. Whang et al reported that magnesium depletion causes impaired Na/K ATPase activity, impaired K⁺-Na⁺- Cl⁻ transport and increased efflux through K channels, which in turn lead to an increased renal potassium loss, resulting in hypokalemia[14].

Conclusion

The present study showed that there was a significant decrease of sodium, magnesium and calcium levels during exacerbations in asthmatics. However, no statistical decrease in serum potassium and chloride levels were observed. Thus calcium channel blockers and calcilytics may have a role in treatment of asthma and its symptoms. Further, multi-centric Indian studies are required to establish the therapeutic benefit of these drugs in the management of bronchial asthma.

References

- Randell J, Saarinen A, Walamies M, Vahteristo M, Silvasti M, Lähelmä S. Safety of formoterol after cumulative dosing via Easyhaler® and Aerolizer. *Respiratory medicine*. 2005; 99(12):1485- 93.
- Kassimi MA, Kawthar A, Khan AS, Khalid AS. Hypokalaemia in acute asthma in the western region of Saudi Arabia. *Saudi medical journal*. 1990; 11(2):130-3.
- Crane J, Burgess CD, Graham AN, et al. Hypokalemia and electrocardiographic effects of aminophylline and salbutamol in obstructive airway disease. *N Z Med J*. 1987; 100:309–311.
- Aubier M, Murciano D, Lecocguic Y, et al. Effects of hypophosphatemia on diaphragmatic contractility in patients with acute respiratory failure. *N Engl J Med*. 1985; 313:420-424.
- Alamoudi OS. Electrolyte disturbances in patients with chronic, stable asthma: effect of therapy. *Chest*. 2001; 120(2):431-6.
- Oladipo OO, Chukwu CC, Ajala MO, Adewole TA, Afonja OA. Plasma magnesium and adult asthmatics at the Lagos University Teaching Hospital, Nigeria. *East African medical journal*. 2003; 80(9):488-91.
- Haffner CA, Kendall MJ. Metabolic effects of β_2 -agonists. *Journal of clinical pharmacy and therapeutics*. 1992; 17(3):155-64.
- Mohammad HA, Abdulfattah MT, Abdulazez AO, Mahmoud AM, Emam RM. A study of electrolyte disturbances in patients with chronic stable asthma and with asthma attacks. *Egyptian Journal of Chest Diseases and Tuberculosis*. 2014; 63(3):529-34.
- Vittal BG. A study of magnesium and other serum electrolyte levels during nebulised salbutamol therapy. *J. Clin. Diagn. Res*. 2010; 4:3460-4.
- Britton J, Pavord I, Richards K, et al: Dietary magnesium, lung function, wheezing, and airway hyperreactivity in a random adult population sample. *Lancet* 1994; 344:357–362.
- Silverman RA, Osborn H, Runge J, et al: IV magnesium sulfate in the treatment of acute severe asthma: a multicenter randomized controlled trial. *Chest* 2002; 122:489–497.
- Ibrahim EH, Yousery A. Electrolytes disturbance: the effect of different forms of b-stimulants. *Chest*. 2020; 128(4):246S-.
- Yurina TM, Kupriyanova TA, Chereiska YA. Macroand trace elements of blood in aged patients with bronchial asthma. *Kliničeskaa Med*. 2021; 80(11):30-4.
- Whang R, Whang DD, Ryan MP. Refractory potassium repletion: a consequence of magnesium deficiency. *Archives of internal medicine*. 2022; 152(1):1.

Conflict of Interest: Nil Source of support: Nil