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Original Research Article

Electrolyte dysfunction in myocardial infarction patients

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ABSTRACT

Background: Myocardial Infarction (MI) is the term given for a state of myocardial necrosis which is secondary to an acute interruption of the coronary blood supply. Severity is dependent on level of occlusion, length of time of occlusion and presence or absence of collateral circulation. Myocardial infarction is now considered part of a spectrum referred to as acute coronary syndrome. It is a spectrum of acute myocardial ischemia that also includes unstable angina (STEMI) and non-ST segment elevation myocardial infarction (NSTEMI). The changes in serum electrolytes were studied in this study with a special focus on sodium and potassium serum levels in patients suffering from AMI. Hence, the aim of the study was to examine the changes in serum electrolytes among AMI patients and then comparison was done with the healthy persons.
Methods: The study comprised of 80 subjects, which were divided equally into study group and control group. The study group comprised cases of confirmed diagnosis of recent onset of AMI. Clinical data was collected using interviewing questionnaires. The blood samples of both groups were analysed for serum electrolytes (Na^+, K^+, Cl^-, Ca^+ and Mg^+) with the help of ion sensitive electrode analyser along with quality control sera.
Results: There was statistically significant decrease in sodium and potassium levels in AMI patients. It was found that there was decrease in sodium serum levels in AMI patients suffering with hypertension. Potassium levels were increased in AMI patients suffering from Diabetes Mellitus and Hypertension, which was found to be statistically significant.
Conclusions: Hyponatremia and hypokalemia are indicators of acute myocardial infarction. Serum sodium and potassium levels are prognostic indicators, i.e., rise in sodium levels after initial fall was indicative of clinical improvement. Therefore, estimation of sodium and potassium level in acute MI patients can help assess their prognosis.

Keywords: Acute MI, Hypokalemia, Hyponatremia, Serum electrolytes

INTRODUCTION

Cardiovascular disease is a global public health problem contributing to 30% of global mortality and 10% of the global disease burden. In 2005, from a total of 58 million deaths worldwide, 17 million were due to cardiovascular disease and, among them 7.6 million were due to coronary heart disease. Myocardial infarction (MI) is one of the five main manifestations of coronary heart disease, namely stable angina pectoris, unstable angina pectoris, MI, heart failure and sudden death.[1]

The burden of cardiovascular disease is increasing both in high-income countries and low- and middle-income countries (LMICs) because of ageing populations, but the burden is greater in LMICs because of much larger population sizes and widespread exposure to increasing levels of risk factors such as unhealthy diet, physical inactivity, obesity, tobacco use, diabetes, raised blood pressure and abnormal blood lipids. Often in LMICs there is a lack of information on the role of risk factors.

It has been shown that risk factors for cardiovascular disease are largely similar in high-income countries as in LMICs. The consequences of globalization and urbanization are also contributory factors. In order to track the trends of this global epidemic, the incidence, prevalence and mortality of coronary heart disease need to be monitored. MI is the demonstration of myocardial cell necrosis due to significant and sustained ischemia. It results from either coronary heart disease, which implies obstruction to blood flow due to plaques in the coronary arteries or, much less frequently, to other obstructing mechanisms (e.g. spasm of plaque-free arteries).[2]

In India, the prevalence of ischemic heart disease among adults (based on clinical and ECG criteria) was estimated at 96.7 per 1000 population in the urban and 27.1 percent in rural areas. Thrombotic occlusion, in association with varying degrees of plaque disruption and coronary artery spasm, represents the major cause of acute myocardial infarction (AMI). Chemically, electrolytes are substances that become ions in solution and acquire the capacity to conduct electricity. Electrolytes are present in the human body and balance of these is essential for normal function of our cells and organs. The functioning heart is dependent upon normal levels of calcium, magnesium, phosphorus, potassium and sodium. The electrical activity of the heart is regulated by calcium, potassium and sodium whereas contraction of the heart requires calcium, magnesium and phosphorus.[3,4]

Calcium maintains cell wall integrity and cell permeability. Several electrolyte changes have been reported to follow AMI. These electrolyte levels, being modifiable hold an important role in altering the prognosis of such myocardial infarction (MI) patients. An electrolyte is a substance that conducts electricity when dissolved in water. There are several common electrolytes found in the body, each serving a specific and important role, but most of them are responsible for maintaining the balance of fluids between the intracellular (inside the cell) and extracellular (outside the cell) environments.[5]

Potassium is the major cation inside the cells and is hugely important for regulating heartbeat and muscle function. It forms the other half of the electrical pump that keeps electrolytes in balance and allows conductivity between the cells, also making potassium a critical part of neuron transmission. An overall potassium level in body is found to be 3500 mmol, out of which 75% is in skeletal muscle. It is the major intracellular cation which maintains intracellular osmotic pressure. The depolarization and contraction of heart require potassium. During transmission of nerve impulses, there is sodium influx and potassium efflux; with depolarization. After the nerve transmission, these changes are reversed.[6]

Hypokalemia occurs in which serum potassium levels are less than 3 mmol/L and occurs as a determinant of excessive morbidity in such patients, particularly malignant ventricular arrhythmia. Several studies have shown association between hypokalemia with increased occurrence of cardiac arrhythmias in AMI patients. Hyperkalemia occurs when plasma potassium levels are above 5.5mmol/L, even minor increase in the value of K^+ is life threatening.

Sodium is the most abundant extracellular cation, a positively charged electrolyte that helps to balance fluid levels in the body and facilitates neuromuscular functioning. Hyponatremia is decreased sodium level (<135mmol/lit) in blood which is commonly seen in patients hospitalized with AMI. Hypernatremia is increased sodium in blood.

Calcium maintains depolarization and is involved in myocardial contractility. Magnesium stabilizes the cell membrane and acts in concert with potassium and is calcium antagonist. It dilates coronary arteries, peripheral systemic arteries and reduces afterload. Few studies have been done till now and less information is available in the literature about prognostic value of serum electrolytes in ischemic heart diseases.[7] Therefore, the present study was conducted with the aim to assess the serum potassium and sodium levels in acute myocardial infarction and also to evaluate the prognostic value in the severity and outcome of acute myocardial infarction.

METHODS

This study was a descriptive study and started in April-2018 and was completed in June- 2018. The population of the study comprised of 40 AMI cases and 40 healthy controls. Out of 40 AMI cases, 26 cases were hypertensive and 14 were diabetic. A written informed consent was taken from the patients and ethical approval was taken from the Institutional Ethical Committee of RIMS, Raichur before the start of study. Study was carried out for the duration of 3 months. The questionnaire was taken which consisted of two parts: socio-demographic data (name, age, sex, education status, etc.) and clinical data (family history of AMI, duration of AMI).

Blood samples were collected from both the groups on the day of admission within 12 hours from anticubital vein with all aseptic precautions in supine position in plain containers for serum electrolytes, i.e., Na^+ and K^+ Blood was allowed to clot at room temperature for half an hour and then centrifuged at 3000 rpm for 10 minutes. The serum separated was used for the estimation of Serum electrolytes (Na^+, K^+). Electrolytes were measured by ISE analyser along with Quality control. Also, a study was carried out to evaluate the variations in serum electrolyte levels in AMI patients of age below 50 years and above 50 years.

Statistical analysis

The data was analyzed with the help of SPSS software, version 21. The descriptive analysis results were interpreted as mean and standard deviation. The independent t -test was applied to compare the difference between cases and controls and p value of <0.05 is statistically significant.

RESULTS

In the present study, AMI cases were observed in intensive cardiac care unit and their serum electrolytes value were estimated and these values were compared with normal healthy control group. Mean age of male patients was found to be 64.12±12.34 and female patients was 46.21±10.24. There was statistically significant decrease in serum sodium and potassium levels in study group among both the ages compared to normal healthy control group. In Table 1 the serum sodium, potassium, chloride, calcium levels were significantly lower in the AMI patients and magnesium levels were slightly raised among cases than controls.

Table 1: Comparison of different electrolytes between case and control.

Serum (mmol/L)	Case	Control	p-value
Sodium	82.641±6.412	94.612±5.241	0.001
Potassium	4.234±1.156	4.562±1.214	0.728
Chloride	72.421±6.561	78.432±6.112	0.134
Calcium	3.431±0.456	4.428± 1.141	0.005
Magnesium	6.624±2.562	2.431±1.124	0.001

In Table 2, it was found that levels of serum sodium, potassium, chloride, calcium and magnesium levels were significantly increased among AMI patients suffering from Diabetes Mellitus. In Table 3 levels of serum sodium were decreased in AMI with hypertension than AMI without hypertension. No significant change was observed in serum potassium level in AMI with hypertension and AMI without hypertension.

Table 2: Comparison of mean and SD of electrolyte levels in cases with diabetes and without diabetes.

Serum (mmol/L)	Diabetic	Non- Diabetic	p value
Na^+	134.32±12.21	124.2±14.31	0.69
K^+	14.262±4.84	13.241±10.841	0.02
Cl^-	84.41±4.72	80.14±6.424	0.72
Ca^{2+}	6.124±2.132	5.132±2.241	0.61
Mg^{2+}	8.161±3.921	6.452±4.141	0.62

It was observed that chloride and magnesium levels were found to be decreased among hypertensive patients of AMI whereas calcium levels were increased during hypertension in AMI patients. This decrease in sodium level was due to hypoxia and ischaemia, which increase the permeability of sarcolemma to sodium whereas decrease in potassium level was influenced by the catecholamine levels which are elevated in early acute myocardial infarction.

Table 3: Comparison of mean and SD of electrolyte levels in cases with hypertension and without hypertension.

Serum (mmol/L)	Hypertensive	Non-hypertensive	p value
Na^+	126.4±8.21	128.9±7.89	0.56
K^+	16.23±7.41	14.21± 5.47	0.02
Cl^-	107.41± 16.43	112.24±19.46	0.45
Ca^{2+}	6.42±2.621	6.05±2.452	0.67
Mg^{2+}	7.272±1.51	8.112±2.139	0.04

DISCUSSION

Acute myocardial infarction occurs when there is an abnormal ischemic alteration of the myocardium due to an inability of the coronary perfusion to meet the myocardial contractile demand. The predilection for male gender in present study is in agreement with the studies done by Ketan et al.[8] In the present study, the serum sodium, potassium and magnesium levels were significantly lower in the AMI patients. The possible mechanism for the low concentrations of sodium and potassium in AMI is the impairment of the Na/K pump and the Na/Ca exchanger. The active transport of these ions across cell membrane involves ATPase, which in turn is dependent on Mg for its activity.

From this study, authors can conclude that there was statistically significant decrease in serum Sodium in study compared to normal healthy control group (p-value = 0.00) in Table 2, which was similar to finding was observed by Vamne A et al, who reported hyponatremia in cases of AMI patient when compared with control, decrease in sodium level was due to hypoxia and ischaemia, which increase the permeability of sarcolemma to sodium but there was no significant difference between control and case in serum potassium level (p-value = 0.626).[9]

The decrease of magnesium level is common in AMI patients. The present study, however, showed that there was increase in magnesium level in AMI patients as compared to the control with p-value = 0.001 in Table 3. The increase of magnesium level was due to admission of magnesium as the first step of treatment. This study also showed that there was decrease in total serum calcium and with p-value = 0.00 and it was similar to the study done by Ramasamy R et al, who reported significantly lowering in AMI with p-value <0.001. Chloride ion had no significant value in this study as similar as to Mati E et al, study.[10,11]

The decrease in potassium level is common in hypertensive patients of AMI. Present study showed that there is increase of potassium level in hypertensive patients when compared with non-hypertensive p-value = 0.05. This decrease of potassium level was influenced by lowering in magnesium level. The present study showed that serum potassium electrolyte was more in diabetic patients when compared with non-diabetic patients and was found to be statistically significant (p-value = 0.02). The increase of potassium level in AMI patient is due to diabetes mellitus disease due to disorder of insulin level. The present study also showed that hypertension and diabetes mellitus is common in case with AMI with p-value = 0.00 as compared with controls. Hypertension is regarded as risk factor for AMI disease.[12]

MI patients were found to have hyponatremia which could be attributed to the fact that non osmotic secretion of vasopressin impairs the water secretion causing dilutional hyponatremia. AVP or vasopressin is known to regulate tone and cardiac contraction and may adversely affect cardiac hemodynamics and myocardial remodelling. Hyponatremia on admission or early development of hyponatremia in patients with acute ST-elevation myocardial infarction is an independent predictor of 30-day mortality, and prognosis worsens with the severity of hyponatremia.[13]

Further studies are required to determine if plasma sodium levels may serve as a simple marker to identify patients at high risk. Hypokalemia prolongs ventricular repolarization, often with prominent U waves. The incidence of ventricular fibrillation has been found to be five-fold higher in patients with low serum potassium. This hypokalemia is mainly due to the stress induced catecholamine response that functions as hormones, in such patients causing increased K^+ uptake into cells.[14]

There is statistically significant increase in Magnesium and that is due to admission of magnesium as the first step of treatment, before taking sample. There is statistically significant decrease in serum magnesium levels in AMI with hypertensive when compared to cases without hypertension and lowering of serum potassium level in hypertensive cases with AMI, with no significant change in Ca^{+2}, Na^+ and Cl^+ levels. Low magnesium levels may be a cause or effect of hypertension. Maintaining the normal serum levels of magnesium can prevent the development of hypertension.[15]

Hyponatremia is an indicator of Acute Myocardial Infarction. Serum sodium level is prognostic indicators, i.e., rise in sodium levels after initial fall was indicative of clinical improvement. Therefore, estimation of sodium and potassium levels in AMI patients can help assess their prognosis.[16-20]

CONCLUSION

The reduction in sodium level was assessed only in patients with AMI as compared to healthy persons. Estimation of serum electrolyte is of utmost importance for diagnosis and prognosis of AMI. Maintaining the normal serum levels of magnesium can prevent the development of hypertension. The estimation of serum sodium level in patients with AMI should be done as early as possible on arrival of the patients in emergency department.

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REFERENCES

1. Goldberg A, Hammerman H, Petcherski S, Zdorovyak A Yalonetsky S Kapeliovich M Prognostic importance of hyponatremia in acute ST elevation myocardial infarction. Am J Med. 2004;117(4):242-8.
2. Myoishi M, Kitakaze M. A role of magnesium: magnesium in the therapy for cardiovascular diseases. Clin Calcium. 2005;15(2):265-70.
3. Singla I, Zahid M, Good CB, Macioce A, Sonel AF. Effect of hyponatremia (<135mEq/L) on outcome in patients with non-ST-elevation acute coronary syndrome. Am J Cardiol. 2007;100(3):406-8.
4. Alizadehasl A, Sepasi F, Azarfarin R, Ghaffari S. Hypokalemia, arrhythmias and early outcomes in acute myocardial infarction. Res J Bio Sci. 2008;3(9):1130-2.
5. Solomon RJ, Cole AG. Importance of potassium in patients with acute myocardial infarction. Acta Med Scand. 1981 Jan 12;209(S647):87-93.
6. Patil S, Gandhi S, Prajapati P, Afzalpurkar S, Patil O, Khatri M. A study of electrolyte imbalance in acute myocardial infarction patients at a tertiary care hospital in western Maharashtra. Inrter J Contemp Med Resear. 2016;3(12):3568-71.
7. Flear CT, Hilton P. Hyponatraemia and severity and outcome of myocardial infarction. Br Med J. 1979 May 12;1(6173):1242-6.
8. Herlitz J, Hjalmarson Å, Bengtson A. Occurrence of hypokalemia in suspected acute myocardial infarction and its relation to clinical history and clinical course. Clinical Cardiol. 1988 Oct;11(10):678-82.
9. Vamne A, Pathak C, Thanna RC, Choudhary R. Electrolyte changes in patients of acute myocardial infarction. IJABR. 2015;5(1):78-80.
10. Ramasamy R, Murugaiyan SB, Gopal N, Shalini R. The prospect of serum magnesium and an electrolyte panel as an adjuvant cardiac biomarker in the management of acute myocardial infarction. JCDR. 2013 May;7(5):817.
11. Mati E, Krishnamurthy N, Ashakiran S, Sumathi ME, Prasad R. Dyselectrolytemia in acute myocardial infarction-a retrospective study. J Clin Biomed Sci. 2012;2(4):167-74.
12. Chaudhary P, Agarwal N, Kulshrestha M, Kumar A, Chaudhary S, Gupta S. Assessment of Myocardial

Infarction in Young Patients. J Contemp Med Res. 2016;3(12):3467-70.
13. Kast DL. Prevalence of hypokalaemia in acute myocardial infarction patients. Int J Contem Med Surg Radiol. 2018;3(2):B41-B43.
14. Tada Y, Nakamura T, Funayama H, Sugawara Y, Ako J, Ishikawa SE, et al. Early development of hyponatremia implicates short-and long-term outcomes in ST-elevation acute myocardial infarction. Circulation J. 2011;75(8):1927-33.
15. Xianghua F, Peng Q, Yanbo W, Shigiang L, Weize F, Yunfa J. The relationship between hypokalemia at the early stage of acute myocardial infarction and malignant ventricular arrhythmia. Heart. 2010;96:196.
16. Das B, Mishra TK. Prevention and Management of Arrhythmias in Acute Myocardial Infarction. Int J Contemp Med Res. 2016;3(5):1401-5.
17. Gupta S, Lakhani KK, Munshi H. A study of risk factors in young patients of acute coronary syndrome. Int J Contemp Med Res. 2017;4(10):2144-7.
18. Renuga P, Bharath J, Heber Anandan. Risk factors of myocardial infarction in pre and post menopausal women. Int J Contemp Med Res. 2018;5(2):B1-B3.
19. Garg P, Mittal MK, Rathi N, Grover SB. Computed Tomography (CT) findings in imminent cardiac failure. Int J Contemp Med Surg Radiol. 2018;3(2):B89-B91.
20. Prasad S, Vijayakumar DH. Detection of coronary artery anomalies using 64 slice MDCT angiography. Radiology. 2017;2(3):75-9.

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