Section: General Medicine

Original Research Article

A STUDY OF SERUM ELECTROLYTES IN ACUTE CORONARY SYNDROME

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Abstract

Background: To study the serum electrolytes in patients with acute coronary syndrome. **Materials and Methods:** The present study included all patients presenting with acute coronary syndrome in the IPD of General Medicine Department, Government Medical College and Hospital Haldwani. After enrolling patients for the study their socio-demographic data (name, age, sex, education status, etc.) and clinical data (family history of AMI, duration of AMI) was recorded. Blood samples were collected on the day of admission within 12 hours and at 24 hours, and then at the 4th day for Sodium [Na^+], Potassium [K^+], Calcium [Ca^{++}] and Magnesium [Mg^{++}] ions. **Result:** Among the serum levels significant correlation of mortality was found for serum Na^+ at day 4 (p=0.027), Ca^{++} at day 4 (p= 0.004), and Mg^{++} at day 0 (p=0.028), 24 hours (p=0.010), and day 4 (p <0.001). **Conclusion:** The present study concludes that levels of Serum Sodium, Potassium, Calcium and Magnesium were significantly correlated with acute coronary symptoms. They could prove as a good marker in predicting the cardiac injury in ACS patients at an early stage of disease.

INTRODUCTION

Acute Coronary Syndrome (ACS) is a broad term used to define an abrupt decrease in blood supply to the coronary arteries of heart and myocardium. It primarily comprises of three disorders: Unstable Angina, ST Elevated Myocardial Infarction (STEMI) and Non-ST Elevated MI (NSTEMI).[1] The hallmark of unstable angina is rupture of plaque and thrombus formation, which leads to partial occlusion of blood vessels and infarct of myocardium, with angina pain for a short duration. During STEMI, blood vessels are completely occluded leading to transmural infarct of the myocardium, while in NSTEMI, partial occlusion of blood vessels occur due to plaque rupture and thrombus formation, resulting in subendocardial infarct of myocardium. Being one of the manifestations of coronary heart disease (CHD), ACS is a major cause of morbidity and mortality across the globe.[2] These cardiovascular diseases have been declared as modern epidemic by World Health Organization (WHO).[3]

Electrolytes play an important role in normal functioning of heart cells and myocardium. Chemically, electrolytes are substances that become ions in solution and acquire the capacity to conduct electricity.[4] The cardiac function is mainly influenced by sodium (Na), potassium (K) and chloride (Cl) ions. The Na+-K+ ATPase pump is a key regulator of the cardiac action potential alongside Ca2+ levels. These serum electrolytes have been regarded as the major determinants of the electrophysiological properties of the myocardial membrane.[5]

In addition, Calcium plays a role in the physiological and biochemical processes that are involved in the study of heart electrophysiology. These processes include muscle contraction, blood coagulation, the release of neurotransmitters, the regulation of enzyme activity, and the control of blood pressure.[6] Another divalent cation. Magnesium is an essential component in the regulation of the tone of vascular smooth muscle, the activity of endothelial cells, and the excitability of the myocardium.[7]

It is absolutely necessary for the healthy operation of the heart to maintain the correct balance of these electrolytes. Electrolyte imbalance is prevalent following an episode of acute coronary syndrome (ACS), and it is possible that electrolyte imbalance plays a significant role in determining the outcome of ACS. An imbalance in these electrolytes is another factor that contributes to arrhythmias and can even lead to cardiac arrest. Potassium disorders, including hyperkalemia, in which the potassium level is increased, and disorders of serum Calcium and Magnesium are related with life-threatening

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arrhythmias less frequently. Potassium disorders are connected with life-threatening arrhythmias more frequently.[8]

Therefore, it is highly likely that any derangement in their levels or their relative ratios may hint at an underlying pathology. The present study was conducted to determine the levels of serum electrolytes in patients with ACS and study their association with disease severity. Further, our study aims to establish the potential role of these electrolytes as biochemical markers in the prognosis and mortality risk assessment of ACS patients.

MATERIALS AND METHODS

After obtaining approval from Institutional Ethics Committee, the present Cross-sectional Observational Study was conducted at Government Medical College and associated Dr. Susheela Tiwari Government Hospital, Haldwani. This study was conducted from January 2021– September 2022.

Study Population

The present study included all adult patients presenting with acute coronary syndrome in the IPD of General Medicine Department, Government Medical College and Hospital Haldwani situated in Nainital district of Uttarakhand. An informed consent was obtained from all patients.

The study included Age >18 years, Patients clinically diagnosed (newly diagnosed cases or follow up cases of myocardial infarction) and willing to participate in the study. The study excluded patients suffering from renal failure, acute gastroenteritis, adrenal insufficiency and unwilling to participate in the study.

Sample size

Sample size calculation was based on to compare the means of different electrolytes at different time points between survivors and non survivors. With reference to previous studies, we assumed the difference of 1 in electrolytes: Calcium and Potassium levels at different time points between two groups as clinically significant, thus sample size of 90 total patients were considered necessary to detect statistical significances at alpha 0.05 and power of 90% with the mortality rate of 15% where the SD was 0.80 for both the groups. However, we took 100 patients.

Methodology

After enrolling patients for the study their socio-demographic data (name, age, sex, education status, etc.) and clinical data (family history of AMI, duration of AMI) was recorded. Blood samples were collected on the day of admission within 12 hours and then at 24hours and then at 4th day from antecubital vein with all aseptic precautions in supine position in plain containers for serum electrolytes, i.e., Na+, K+, Ca2+ and Mg2+. 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 all the Serum electrolytes (Na+, K+, Ca2+ and Mg2+)

Statistical analysis

After the Excel data was put into SPSS version 25.0, analysis was performed on it. The data for the quantitative variables were presented as the mean and standard deviation, whilst the data for the qualitative variables (those with categorical values) were presented as the frequency and the percentage. The student t-test was utilised in order to compare the mean values of the two groups, while the chi-square test was utilised in order to assess the frequency differences between them. It was statistically significant if the p0.05 threshold was met.

RESULTS

The mean age of the patient was 60.00±12.81 years with minimum age of 28 years and maximum age of 90 years. It was observed that 23% of the patients were Females while 77% of the patients were Males. It was observed that 35% of the patients had Hypertension while 30% of the patients had Type 2 -Diabetes Mellitus and 68% of the patients had a history of smoking. 77% of the patients had positive Troponin.

Table 1: showing distribution according to age, gender of patients, comorbidities, Troponin result, Killip classification.

		Frequency	Percentage
	Age (years)	60.00±12.81	28-90 yrs
Gender	Male	77	77.0%
	Female	23	23.0%
Co-morbidities	Smoking	68	68.0%
	Hypertension	35	35.0%
	Type 2 Diabetes Mellitus	30	30.0%
Troponin Positive		77	77.0%
Killip Class	1	27	27.0%
	2	43	43.0%
	3	19	19.0%
	4	11	11.0%

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Table 2: showing distributions of various electrolytes.

	Day 0	At 24 hrs	Day 4	p value
S. Na+	134.60 ± 4.849	133.68 ± 4.711	133.65 ± 3.166	0.014*
S. K+	4.285 ± 0.6528	3.924 ± 0.5339	3.929 ± 0.5238	< 0.001*
S. Ca2+	8.084 ± 0.7116	7.95 ± 0.763	8.02 ± 0.746	0.097
S. Mg2+	1.89 ± 0.246	1.981 ± 0.2602	2.191 ± 0.2482	< 0.001*

It was observed that there was a significant difference in mean S. Na^+, mean S.K^+ and S.Mg^{2+} levels when compared between the three time points (p value 0.014, <0.001 & <0.001, respectively). However, no significant difference was observed in mean S. Ca^{2+} when compared between the three time points (p value 0.097).

Table 3: showing distribution according to risk factors, blood pressure, Troponin value, Killip class.

		Survived (n=85)		Died (n=15)		p-value
		Frequency	%	Frequency	%	
Risk Factors	Smoking	55	80.9%	13	19.1%	0.134
	Hypertension	28	80.0%	7	20.0%	0.304
	Type 2 Diabetes Mellitus	23	76.7%	7	23.3%	0.127
Blood pressure	Hypertension	9	75.0%	3	25.0%	0.290
	Hypotension	9	75.0%	3	25.0%	
	Normal	67	88.2%	9	11.8%	
Troponin	Negative	20	87.0%	3	13.0%	0.363
	Positive	65	84.4%	12	15.6%	
KILLIP CLASS	1	25	92.5%	2	7.5%	0.446
	2	38	88.3%	5	11.6%	
	3	15	78.9%	4	21.1%	
	4	7	63.6%	4	36.3%	

It was observed that there was no significant correlation between risk factors i.e., HTN (p value 0.304), T2DM (p value 0.127) and Smoking (p value 0.134) with the Outcome. . It was observed that there was no significant correlation between BP and the Outcome (p-value = 0.29). It was observed that there was no significant correlation of Troponin level (p-value = 0.363) and Killip class (p-value = 0.446) with Outcome of the patients.

Table 4: showing distribution of variable electrolytes.

		Survived (n=85)	Died (n=15)	p value
S. Na+	Day 0	134.74 ± 4.776	133.8 ± 5.348	0.491
	At 24 hrs	133.82 ± 4.599	132.33 ± 5.809	0.370
	Day 4	133.81 ± 3.002	130.25 ± 5.058	0.027*
S. K+	Day 0	4.287 ± 0.6688	4.273 ± 0.5738	0.941
	At 24 hrs.	3.941 ± 0.5489	3.767 ± 0.3464	0.354
	Day 4	3.939 ± 0.526	3.725 ± 0.4924	0.428
S. Ca2+	Day 0	8.109 ± 0.6633	7.94 ± 0.9568	0.398
	At 24 hrs.	8 ± 0.744	7.57 ± 0.877	0.110
	Day 4	8.07 ± 0.724	6.98 ± 0.395	0.004*
S. Mg2+	Day 0	1.9232 ± 0.20118	1.6873 ± 0.36732	0.028*
	At 24 hrs.	2.02 ± 0.2134	1.61 ± 0.3708	0.010*
	Day 4	2.216 ± 0.2205	1.67 ± 0.2573	<0.001**

There was a significantly higher S. Na^+ level at Day 4 (p value 0.027) in the survived group compared to died group. However, there was no significant difference in S.Na^+ level at Day 0 (p value 0.491) and at 24 hours (p value 0.370) when compared between two groups.

DISCUSSION

Acute reduction in blood flow to the coronary arteries of the heart and myocardium is called acute coronary symptoms (ACS). Unstable Angina, ST Elevated Myocardial Infarction (STEMI), and Non-ST Elevated MI (NSTEMI) are the three main disorders that make up this condition.[1] Unstable angina is characterized by plaque rupture and thrombus development, which causes a temporary partial obstruction of blood arteries and myocardial infarction. While blood vessels in STEMI are entirely blocked, causing a transmural infarct to the myocardial, blood vessels in NSTEMI are only partially blocked by plaque rupture and thrombus formation, causing a subendocardial infarct to the myocardium. ACS, one of the symptoms of coronary heart disease (CHD), is a leading global cause of morbidity and mortality.[3] World Health Organization (WHO) has classified these cardiovascular disorders as a modern epidemic.[4]

The present study was conducted to determine the levels of serum electrolytes in patients with ACS and study their association with disease severity. Further, our study aimed to establish the potential role of these electrolytes as biochemical markers in the diagnosis and mortality risk assessment of ACS patients.

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In current study, 23% were females and remaining 77% were males. The mean age of the study population was 60.00±12.81 years. Male predominance (69%) was also seen in a study by Patil et al with mean age of patients 62.89±11.85 years.[8]

There are a number of well-established risk factors for coronary artery disease. Smoking, family history, hypertension, obesity, diabetes, inactivity, stress, and hyperlipidemia are among the most prevalent risk factors.[9] Smoking was the predominant risk factor among the study subjects of the present study (68%) followed by Hypertension (35%) and Type 2 Diabetes Mellitus (30%).

We also observed that in our study 12 % were hypertensive at presentation while 12 % of the cases were hypotensive and 76% were normotensive.

Approximately 77% of the patients in our study showed positive Troponin T. In a cross-sectional study by Khan F et al, in nearly half of the cases, Troponin T levels were positive (53%) with 57% of the positive results skewed towards the greater than 50 years age group.[5]

The Killip classification has been used to formally classify the existence and severity of heart failure at the time of initial presentation in acute myocardial infarction. The predictive significance of Killip classification in non-ST-elevation acute coronary syndromes is not well established, despite being thoroughly investigated in ST-elevation myocardial infarction.[10] The patients in the present study were also distributed according to Killip's class. Majority of the patients belonged to class I (43%) followed by class II (27%), III (19%), and IV (11%). In comparison to Killip Class I, patients with high Killip classes (II = 13%, III = 7%, and IV = 2%) were older in study by EL-Meyner and team and more likely to have experienced coronary artery disease, diabetes, hypertension, dyslipidemia, and renal impairment in the past.[11]

Levels of serum electrolytes for the patients with ACS were measured. Mean serum levels of Na and Ca did not show any difference at day 0 (134.60 ± 4.849 and 8.084 ± 0.7116, respectively), 24 hours (133.68 ± 4.711 and 7.95 ± 0.763, respectively), and day 4 (133.65 ± 3.166 and 8.02 ± 0.746, respectively). Mean serum levels of K and Mg showed a statistically significant difference at day 0 (4.285 ± 0.6528 and 1.89 ± 0.246, respectively), 24 hours (3.924 ± 0.5339 and 1.981 ± 0.2602, respectively), and day 4 (3.929 ± 0.5238 and 2.191 ± 0.2482, respectively). Walim and colleagues.[3] observed a statistically significant decrease in sodium and potassium levels in across all age groups & in both sexes of study group compared to control group (P <0.001 and P <0.01, respectively). Significantly high level of sodium was observed in AMI patients who are smokers (135.5 ± 2.10; P <0.001) as compared to AMI patients with diabetes (130.90 ± 4.32) whereas the level was even lower in AMI patients with hypertension (129.55 ± 4.62). Potassium levels were low in AMI patients with diabetes (3.69 ± 0.90) as compared to smoking and hypertension (4.06 ± 0.68 and 4.29 ± 0.71, respectively). However, the change was insignificant in association with smoking, diabetes and hypertension for potassium (P >0.05). Faraj HR.[12] found a significant increase in serum sodium and chloride levels in patients with ACS (P <0.01) and a significant decrease in serum potassium levels in ACS patients than in controls (P <0.01).

The mortality rate in the present study was also found low during the course of study (15%) and 85% patients survived. The mean age of patients who survived was found to be 60.19 ± 12.971 years and those who died was 58.93 ± 12.198 years, p=0.728. No significant difference was found in patients' mortality and survival rate on basis of gender (p=0.302). It was noted that the mean Pulse Rate for the group that survived was 88.18± 2.788 while the mean Pulse Rate for the group that died was 92.2±36.618, p=0.680. Risk variables such as Hypertension (p value 0.304), Type2 Diabetes Mellitus (p value 0.127), and Smoking (p value 0.14) were shown to have no meaningful link with the survival outcome. The survival outcome and blood pressure were having no significant correlation in our study (p value 0.290). Correlation between Troponin level and the survival Outcome was also non-significant (p=0.363).

Most of the patients that survived belonged to Killip's class I (92.5%) and those who died belonged to class IV (36.3%). However, the difference was not statistically significant (p=0.446). Similarly, higher Killip class was associated with higher mortality at 30 days in a study by Khot et al (2.8% in Killip class I vs 8.8% in class II vs 14.4% in class III/IV; P<.001) and 6 months (5.0% vs 14.7% vs 23.0%, respectively; P<.001).

Mudaraddi R et al,[13] found a statistically significant decreased levels of serum sodium (p <0.001), serum potassium (p <0.001) and in patients with Acute Myocardial Infarction as compared to controls. Rathore V et al,[14] found that both sodium and potassium were significantly reduced in patients of Acute Myocardial Infarction as compared to controls (131.48±6.31meq/L vs. 139.32±3.09meq/L, p<0.001 and 3.57±0.81meq/L vs. 4.36±0.45meq/L, p<0.001, respectively).

Ranjan R et al,[15] concluded that there were statistically significant lower levels of serum Na, K and Ca (total) found in ACS patients compared to healthy controls. In our study, Day 4 S. Na^+ levels were found to be considerably lower in the group with fatal outcome compared to the survival group (p value 0.027). S.Na^+ levels between the two groups did not differ significantly at Day 0 (p value 0.491) or at 24 hours (p value 0.370). Similar to S. Na^+ levels, Day 4 S. Ca^{2+} levels were found to be considerably lower in the group with fatal outcome compared to the survival group (p value 0.004). However, when comparing the S. Ca^{2+} levels between the two groups at Day 0 (p value 0.398) and at 24 hours (p value 0.110), there was no

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discernible difference seen. S. Mg^{2+} levels were found to be considerably lower in the group with fatal outcome compared to the survival group at Day 0 (p value 0.028), at 24 hours (p value 0.010), and at Day 4 (p value 0.001). However, S. K^{+} did not show any statistical significance across all time points.

CONCLUSION

The present study concludes that levels of serum potassium and magnesium were significantly correlated with acute coronary symptoms. They could prove as a good marker in predicting the cardiac injury in ACS patients at an early stage of disease. Serum potassium, calcium, sodium and magnesium levels could also be used as prognostic markers and accessing mortality risk in these patients. However, our findings were primary which needs some other trials to validate our results as study subjects are restricted.

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