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Research Article

Study of Serum Electrolytes and Total Calcium Status in Patients with Acute Myocardial Infarction

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ABSTRACT

Background and objectives: Electrolyte imbalances are often seen following acute myocardial infarction (AMI). Since these electrolyte levels can be altered, they have significant effect on the prognosis of people with AMI. Among these, some studies have discovered a serum sodium imbalance in the initial phases of AMI. Thus, the aim of this study was to correlate the electrolytes level with cardiac parameters in Myocardial Infarction.

Materials and Methods: The present study was an analytical cross-sectional study conducted on patients with AMI who visited the inpatient (Emergency and medicine) Department at NMCTH, Birgunj and Parsa, Nepal. A total of 100 patients with AMI were enrolled during the four-month study period from March 2025 to June 2025**.** The cardiac profile and serum electrolytes of the patients were measured using a Beckman Coulter AU 480, SENSA CORE ST 200 PRO and Getein 1100 immunofluorescence quantitative analyzer.

Results: The non-parametric correlation analysis revealed that CK-MB and Troponin I had a strong negative correlation with sodium, potassium, calcium and age but CK-MB has strong positive correlation with Troponin-I and vice versa. Additionally, CK-MB was significantly correlated with sodium, calcium and Troponin-I but was not significantly correlated with potassium and age. Troponin-I was significantly correlated with potassium, Calcium and CK-MB but Troponin-I was not significantly correlated with sodium and age.

Conclusions: This study revealed that electrolyte concentrations varied among patients with acute myocardial infarction (AMI). Serum level of sodium and potassium are correlated with cardiac

biomarkers CKMB & troponin-I. Moreover, monitoring the serum sodium & potassium levels are can be helpful clinically for the treatment of AMI. Furthermore, serum calcium is also associated with CKMB & troponin I in AMI patients.

Keywords: Acute Myocardial Infarction, Calcium, CK-MB, Electrolyte level, Troponin I

INTRODUCTION

Among hospitalized patients, acute myocardial infarction (AMI) is a leading cause of morbidity and mortality. Every year, it causes over 3 million sudden cardiac deaths worldwide [1]. Key electrolytes that affect the electrical characteristics of the cardiac membrane are serum levels of calcium, potassium, and sodium. Both morbidity and mortality are significantly influenced by their patterns in individuals who present with AMI [2]. The sarcolemma is impermeable to sodium ions (Na^+) while it is at rest. By actively moving K^+ into the cell and Na^+ out of the cell across concentration gradients, the Na^+/K^+-ATPase pump is essential for preserving the resting membrane potential [3]. The flow of sodium, potassium, and calcium ions determines each of the four different phases that make up the cardiac action potential. After an episode of AMI, electrolyte abnormalities involving these ions are frequently seen [4].

After an AMI, electrolyte abnormalities are frequently observed. These electrolyte levels have a major impact on the prognosis of individuals suffering from AMI since they can be changed. Among these, a number of investigations have found a serum sodium imbalance in the early stages of AMI [6]. Hospitalized patients with myocardial infarction frequently experience hyponatremia; these include the non-osmotic release of vasopressin in reaction to significant physiological stress, pain, and nausea [7].

Potassium is essential for preserving healthy heart function. Both hyperkalemia and hypokalemia are closely linked to potentially fatal arrhythmias and may be cardiotoxic. Stress-induced catecholamine surges, which encourage greater intracellular uptake of potassium and lower its serum levels, are frequently blamed for hypokalemia [8]. Both the cardiac and systemic vasculature depends on calcium ions, which are crucial for the excitation-contraction process of the heart muscle fibers. Cell membrane dysfunction brought on by ischemia will raise cytosolic calcium levels and result in hypocalcemia [9].

The sufficient studies defining the electrolyte imbalances in myocardial infarction has not been done so far in our context. So, this study was carried with the aim to correlate the cardiac biomarkers (CKMB and Troponin I) with the serum electrolyte levels in acute myocardial infarction patients.

MATERIALS AND METHODS

This analytical cross-sectional study conducted on patients with AMI who visited the inpatient (Emergency and medicine) Department at NMCTH, Birgunj, Parsa, Nepal. A total of 100 patients with AMI were enrolled during the four-month study period from March 2025 to June 2025**.** Verbal and written informed consent were obtained from all participants prior to enrollment. A distinct ST-segment elevation of more than 1 mm on the electrocardiogram (ECG) indicates acute ST-segment elevation myocardial infarction (STEMI) in patients who arrive with chest discomfort lasting longer than 20 minutes were included. However, patients who refused to take part were not allowed to participate. The study also excluded people with severe renal illness, liver failure, adrenal insufficiency and potassium sparing diuretics.

Sampling was employed for the selection of study participants. The study variables included Troponin-I, CK-MB, serum sodium, potassium, calcium age and gender.

The cardiac profile and serum electrolytes of the patients were measured using a clinical chemistry analyzer (Beckman Coulter AU480), an ion-selective electrode (ISE) analyzer (SENSA CORE ST 200PRO), and the Getein1100 immunofluorescence quantitative analyzer. Data analysis and interpretation were performed using MS Excel version 10 and SPSS version 22. Prior to the commencement of the study, ethical approval was obtained from the Institutional Review Committee (IRC) of National Medical College and Teaching Hospital, Birgunj, Nepal (Ref no: F-NMC/714/080-081).

Before being imported into SPSS version 22 for analysis, all collected data was first entered into Microsoft Excel 2010. Descriptive statistics, including frequency, mean and standard deviation (SD), were calculated. The data's normality was evaluated using the Kolmogorov-Smirnov test. The association between CK-MB and Troponin-I and the variables serum sodium, potassium, calcium, age and gender were assessed using Spearman's correlation. Statistical significance was defined as a p-value of < 0.05.

RESULTS

The mean age of the participants was 61.55 ± 13.78 years. The mean values for key CK-MB, Troponin-I are 15±11.98 and 4.79±7.41 respectively, indicating inadequate cardiac control. The electrolytes showed a mean Serum Sodium level of 133.20 ± 5.15 meq/L, Potassium of 3.81±0.69 meq/L. The Serum total calcium showed mean value of 8.45±0.69, suggesting a narrow variation among patients.

Table 1: Descriptive statistics of the variables in acute myocardial infarction (n=100)

Variables	Mean	Std. Deviation
Age	61.55	13.78
CK-MB (<5) U/L	15.00	11.98
Troponin-I (<0.1) ng/ml	4.79	7.41
Na^+ (135-145) meq/L	133.20	5.15
K^+ (3.5-5.5) meq/L	3.81	0.69
Ca^{++} (8.6-10.5) mg/dl	8.45	0.69

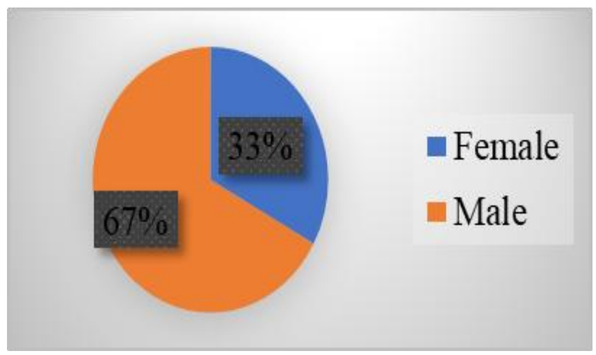

Figure 1: Gender wise distribution of patients (n=100)

In this study, among 100 Participants, 33% was female and 67% was male as shown in figure 1 above.

The Frequency of hyponatremia & hypokalemia was 29%, hyponatremia & normal potassium was 33%, normal electrolyte level was 36% and normal sodium & hypokalemia was 2% among 100 participants. (Table 2). Among 100 participants 48% hypercalcaemic and 52% had normal calcium level. (Figure 2)

Table 2: Electrolyte status in the patients (n=100)

Electrolyte status	Frequency (%)
Hyponatremia & hypokalemia	29
Hyponatremia & normal potassium	33
Normal electrolyte level	36
Normal sodium & hypokalemia	2

Table 3: Correlation of CK-MB with other variables (n=100)

Variables	Correlation coefficient (r)	P value*
Age	-0.77	0.45
Troponin I	0.07	<0.01**
Sodium	-0.24	<0.01**
Potassium	-0.15	0.11
Calcium	-0.47	<0.01**

Table 4: Correlation of troponin I with other variables (n=100)

S. No.	Variables	Correlation coefficient (r)	P value*
1	Age	0.07	0.45
2	CKMB	0.67	<0.01**
3	Sodium	-0.15	0.13
4	Potassium	-0.24	<0.01**
5	Calcium	-0.47	<0.01**

** Correlation is significant at 0.01 levels (two tailed)
* Correlation is significant at 0.05 levels (two tailed)

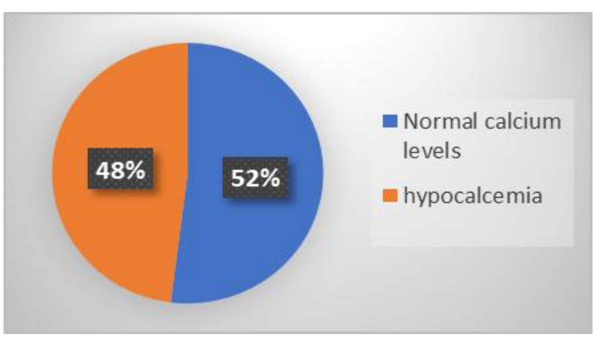

Figure 2: Distribution of the participants based on serum calcium levels (n=100)

Table 3 depicts Spearman's Correlation for the non-parametric correlation analysis revealed that CK-MB had a strong negative correlation with sodium (r = -0.24, p < 0.01), potassium (r = -0.15, p < 0.11), Calcium (r = -0.47, p < 0.01) and age (r = -0.77, p < 0.45) but CK-MB which had a strong positive correlation with Troponin-I (r = 0.07, p < 0.01). Additionally, CK-MB was significantly correlated with sodium (r = -0.24, p < 0.01), Calcium (r = -0.47, p < 0.01) and Troponin-I (r = 0.07, p < 0.01) but CK-MB was not significantly correlated with potassium (r = -0.15, p < 0.11) and age (r = -0.77, p < 0.45).

Table 4 shows Spearman's Correlation for the non-parametric correlation analysis revealed that Troponin-I had a strong negative correlation with sodium (r = -0.15, p < 0.13), potassium (r = -0.24, p < 0.01) and Calcium (r = -0.47, p < 0.01) but Troponin-I had a strong positive correlation with CK-MB (r = 0.67, p < 0.01) and age (r = 0.07, p = 0.45). Additionally, Troponin-I was significantly correlated with potassium (r = -0.24, p < 0.01), Calcium (r = -0.47, p < 0.01) and CK-MB (r = 0.67, p < 0.01) but Troponin-I was not significantly correlated with sodium (r = -0.15, p < 0.13) and age (r = 0.07, p < 0.45).

DISCUSSIONS

This study carried out among 100 participants demonstrated that patients with acute myocardial infarction had considerably higher concentrations of CK-MB and Troponin-I. CK-MB and Troponin I had a strong negative correlation with sodium, potassium, calcium and age but CK-MB has strong positive correlation with Troponin-I and vice versa. Additionally, CK-MB was significantly correlated with sodium, calcium and Troponin-I but was not significantly correlated with potassium and age. Troponin-I was significantly correlated with potassium, Calcium and CK-MB but Troponin-I was not significantly correlated with sodium and age.
In contrast to the results of studies by Hadeel and Vamne in 2015, we found that individuals with acute myocardial infarction (AMI) had significantly lower serum sodium levels [10, 11]. Because of the sudden beginning of left ventricular failure in AMI, which can be brought due to pain, stress, or the use of analgesics or diuretics that lower sodium levels, vasopressin may be released by non-osmotic processes. Furthermore, one study proposed that the observed hyponatremia may be caused by hypoxia, ischemia, and infarction increasing the sarcolemma's permeability to sodium [12, 13].

Stress-induced catecholamine release, which encourages higher cellular absorption of potassium, may be the cause of the observed hypokalemia [14]. Through the activation of beta2-adrenoceptors connected to the sodium-potassium ATPase pump, this acute stress response results in a transfer of potassium from the extracellular to the intracellular compartment [15].

Additionally, this study showed a significant reduction in serum total calcium levels ($p < 0.01$), which is comparable with what Ramasamy R. et al. (2013) found [17]. They found that individuals with AMI had a significantly lower total calcium level ($p < 0.001$). The normal operation of the heart and systemic vasculature depends on calcium ions because they are necessary for the excitation-contraction coupling of cardiac muscle fibers [18].

In contrast to the findings of Nikhil Rathi et al., who found that elevated serum calcium was related to myocardial infarction and identified serum calcium as an independent prospective risk factor for MI, but our study demonstrated a significant decrease in serum total calcium, which suggests a role for extracellular calcium in the atherosclerotic process [25].

As indicated in Table 3 and Figure 2, out of 100 patients with acute myocardial infarction (AMI), 29% had both hyponatremia and hypokalemia, 33% had hyponatremia with normal potassium, 36% had normal electrolyte levels, and 2% had normal sodium with hypokalemia. In terms of serum calcium, 52% of participants had normal calcium levels and 48% had hypocalcemia (Table 4/Figure 3). These results are similar to those of Soubhagya P. et al. (40%) and Amita Gandhi et al. (14%) [9]. Shubhangi verma, on the other hand, observed that 12.5% of AMI patients had hyponatremia [21]. The Soubhagya P et al [18], study found that about 27% of patients had hypokalemia, which is comparable to the Ketan et al. study, which found that 30% of 274 AMI patients had hypokalemia [22]. The majority of patients (53%) had hypocalcemia for calcium, which is consistent with the results of other research, such Shilpa Patil et al., who found that 49% of AMI patients had hypocalcemia [5].

Soubhagya P. et al [18], reported a mean sodium level of 135 ± 4.9 mEq/L, which is similar to the mean serum sodium level of 133.20 ± 5.15 mEq/L among AMI subjects in our study. However, Amita Gandhi et al [9], reported a higher mean value of 137.64 ± 9.08 mEq/L, while Vinod Wali et al [19], found a lower mean value of 129.47 ± 4.87 mEq/L.

AMI patients in our study had a mean serum potassium level of 3.81 ± 0.69 mEq/L. This result is comparable to the mean potassium level reported by Soubhagya P. et al [18], (3.9 ± 0.59 mEq/L) and Esha Mati et al. (3.66 ± 0.56 mEq/L) [16]. On the other hand, Vinod Wali et al [19], (4.18 ± 0.63 mEq/L) and Amita Gandhi et al. (4.21 ± 0.79 mEq/L) observed higher mean potassium levels [9].

The mean total serum calcium concentration among AMI patients in our study was 8.45 ± 0.69 mg/dL, which is similar to the mean calcium level of 8.51 ± 0.66 mg/dL reported by Shilpa Patil et al [5]. But in AMI cases, Lamia Fazil et al [20], reported a reduced mean total calcium concentration of 7.51 ± 1.41 mg/dL. The small sample size from a single hospital set up does not represent the broader population for the study. Our study predominantly focuses on sodium, potassium and calcium, frequently neglecting other electrolytes such chloride, phosphate, magnesium and bicarbonate.

CONCLUSIONS

The study showed variations in electrolyte concentrations in AMI patients. Serum level of sodium and potassium was correlated with cardiac biomarkers (CKMB & troponin I). Moreover, monitoring the serum sodium & potassium levels are can be helpful clinically for the treatment of AMI. Furthermore, serum calcium was also associated with CKMB & troponin I in AMI patients.

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Author's Contribution: Literature review, conceptualizing and designing the study- **NY, SM, SG, SP, SKS, ACJ, and RS;** - Data collection- **NY, SKS, ACJ, RS;** Data analysis**- NY, SM;** Data interpretation and preparation of results**- NY, SM, SG, SKS.** Preparation of the first draft of the manuscript- **NY, SM, SKS, SG**; Revision of the second draft, referencing, and final manuscript revision**-NY, SP, SG** All authors reviewed and approved the final version of the manuscript and take full responsibility for all aspects of the work**.**

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