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RESEARCH ARTICLE

Impact of blood pressure and serum electrolytes level on ejection fraction in acute myocardial infarction patients

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ABSTRACT

Background: Various factors such as age, body mass index (BMI), blood pressure (BP), and serum electrolytes affect ejection fraction (EF) improvement in acute myocardial infarction (AMI) patients after percutaneous coronary intervention (PCI). Many studies have been done to assess effect of these factors on long-term basis, but none of the studies showed effect of these factors on efficacy of PCI. **Aims and Objectives:** This study aims to find out the role of BP and serum electrolytes in patients of AMI and to assess the efficacy of PCI as well as to predict the prognosis in AMI patients. **Materials and Methods:** It is a longitudinal, interventional study. EF of 52 patients of AMI was measured by echocardiography before and after angioplasty who had been admitted in cardiology emergency. Statistical software IBM Statistical Package for the Social Sciences trial version 16 was used for analysis of data. **Results:** We found that as the age advances, there is less improvement in EF ($P = 0.38$) also as the BMI increases, improvement in EF decreases ($P = 0.53$). Tachycardia leads to improvement in EF ($P = 0.13$), while those patients who had initial abnormal BP showed less improvement in EF ($P = 0.93$). Serum electrolytes analysis showed that as serum sodium and potassium level increase, improvement decrease ($P = 0.06$), while those patients who had normal serum calcium level showed less improvement in EF ($P = 0.76$). Only serum sodium and serum potassium showed some significance statistically ($P = 0.06$). **Conclusion:** Increased serum sodium and potassium level are associated with poor prognosis, while lesser age and normal BMI are associated with improved prognosis in AMI patients after PCI.

KEY WORDS: Acute Myocardial Infarction; Percutaneous Intervention; Ejection Fraction; Serum Electrolytes

INTRODUCTION

Efficient heart pumping is necessary to meet the body demand. For instance, in physical exercise, body needs increased level of oxygen in comparison to resting state for increased muscular activity. Ejection fraction (EF) is an important parameter to measure efficiency of heart.

When blood flow decreases to a part of the heart, it causes damage to the heart muscle and leads to acute myocardial infarction (AMI).[1] High blood pressure (BP), paucity of exercise, obesity, smoking, and diabetes Mellitus are various risk factors for AMI.[2,3] Percutaneous coronary intervention (PCI) is used to treat narrowing of coronary arteries of the heart in AMI patients. PCI is an alternative to coronary artery bypass grafting. The blood flow in the coronary artery improves after angioplasty. Many patients

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get relieved of their symptoms and their work efficiency gets increased.

The cardiac contractility depends on various factors. Serum calcium level is one of the important factors which can alter myocardial contractility. The force of contraction of cardiac muscle depends on binding of myosin with actin. The degree of binding depends on calcium ion concentration in the cardiac myocytes. Furthermore, the sympathetic nervous system stimulation indirectly increases calcium ion concentration by releasing catecholamine. The myocardial contractility can also be altered by altering preload, afterload, and heart rate.[4]

Systemic hypotension occurs very commonly in patients of AMI. Some studies found that mortality in AMI patients can be predicted on the basis of hypotension at the time of admission in the hospital.[5] In such patients, mortality rate is high despite thrombolytic therapy. Some studies postulated that success of thrombolytic therapy depends on systemic BP.[6] Some studies suggest that pulse pressure can also affect the mortality in patients of AMI.[7,8] A recent study showed that higher systolic, diastolic, and pulse pressure were associated with an increased rate of adverse events in AMI patients. Hence, BP control is very important in such population.[9]

The aim of this study was to examine the role of BP and serum electrolytes in patients with acute MI and to assess the efficacy of PCI as well as to predict the prognosis because the role of BP and serum electrolytes is uncertain, especially on outcome of PCI.

MATERIALS AND METHODS

A total of 52 patients of AMI were included in this study. We included those patients who visited to cardiology department of King George's Medical University (KGMU), Lucknow, for treatment. All patients were male. This study was a longitudinal, interventional study. Patients with any of the conditions such as anemia, valvular heart disease, myocarditis, and cardiac tamponade, endocrinal disorders such as thyroid dysfunction, vitamin deficiency such as Vitamin B_1 deficiency, pericardial effusion, and atrial fibrillation were excluded to minimize the possibility that these conditions may influence the outcome of study. This study was done after obtaining ethical clearance from the Institutional Ethical Committee and Review Board of KGMU and written, informed consent from the patients.

Serum calcium, sodium, and potassium level were measured after admission in the cardiology emergency. In general examination, pulse rate and BP (sphygmomanometer) were measured. Echocardiography (ECHO) method was used to measure EF within 6–8 h of diagnosis of AMI. Coronary angiography was done and then patients underwent coronary angioplasty (PCI). After angioplasty, EF was measured with the help of ECHO. The EF obtained before and after PCI was analyzed.

Improvement in these patients is defined by two criteria – (1) relieved chest pain and discomfort and (2) improvement in EF from the baseline value. Statistical software Statistical Package for the Social Sciences trial version 16 was used for analysis of data. "$P < 0.05$" was considered to be statistically significant at two-tailed test.

RESULTS

In this study, 52 male patients with AMI were enrolled. The mean age is 57.92 years with standard deviation of 10.68 years. Data from all the patients were collected and analyzed.

Table 1 shows that 71.2% of cases were above 50 years and as the age advances, there is less chance of improvement in EF ($P = 0.38$). The patients having age >50 years, only 75.7% showed improvement after PCI while 86.7% of patients with age up to 50 years showed improvement in EF. It is also evident that 63.5% of the admitted patients were overweight and obese while 28.8% have normal body mass index (BMI) and few patients are underweight too (7.7%). It is found that as the BMI increases, improvement in EF decreases ($P = 0.53$). Patients who have BMI ≥23 kg/m^2 showed less improvement in comparison to those patients who have normal BMI and BMI <18.5 kg/m^2. All the four underweight patients showed improvement in EF.

It has been noticed [Table 1] that 50% of patients have normal systolic BP while 40.4% have high SBP and few (9.6%) have low SBP. All patients have normal diastolic BP. About 80.8% of patients with normal SBP showed improved EF after PCI while 80% of patients with low SBP and 76.2% of patients with high SBP showed improvement in EF. Hence, it is found that those patients who had abnormal SBP showed less improvement in EF ($P = 0.93$). Pulse rate of 78.8% of patients was in normal range while some of them have tachycardia (15.4%) and some have bradycardia (5.8%). About 80.5% of patients who have normal pulse rate showed improvement while 33.3% of patients having bradycardia and 87.5% of patients having tachycardia showed improvement. Hence, it can be said that as the pulse rate (PR) increases, improvement in EF increases ($P = 0.13$) [Figure 1].

Table 2 shows that 55.8% of cases have normal serum calcium level, while 42.3% of cases showed hypocalcemia and only 1 case (1.9%) had hypercalcemia. We found that 75.9% of patients who have normal serum calcium level showed improvement in EF and 81.8% of hypocalcemia patients showed improved EF after PCI. There was only one patient with hypercalcemia and he showed improvement in EF. Hence, it is found that those patients who had normal serum calcium level showed less improvement in EF ($P = 0.76$).

Table 1: Baseline characteristics of patients categorized by improvement in EF after coronary angioplasty

Baseline characteristics	Improved status		Total no. of cases	χ^2	*P*-value
	Yes	No			
BMI* (kg/m^2)					
<18.5 (underweight)	4 (100)	0 (0)	4 (7.7)	1.27	0.53
18.5–22.9 (normal weight)	12 (80)	3 (20)	15 (28.8)		
≥23 (overweight and obese)	25 (75.76)	8 (24.24)	33 (63.5)		
Age group (years)					
21–50	13 (86.7)	2 (13.3)	15 (28.8)	0.77	0.38
51–80	28 (75.7)	9 (24.3)	37 (71.2)		
SBP (mmHg)					
≤108 (low SBP)	4 (80)	1 (20)	5 (9.6)	0.15	0.93
110–130 (normal range)	21 (80.8)	5 (19.2)	26 (50)		
132–160 (high SBP)	16 (76.2)	5 (23.8)	21 (40.4)		
PR (/min)					
<60 (bradycardia)	1 (33.3)	2 (66.7)	3 (5.8)	4.15	0.13
60–90 (normal range)	33 (80.5)	8 (19.5)	41 (78.8)		
>90 (tachycardia)	7 (87.5)	1 (12.5)	8 (15.4)		

*WHO criteria of BMI for Indian population have been used. BMI: Body mass index

Table 2: Blood parameters of patients categorized by improvement in EF after coronary angioplasty

Blood parameters	Improved status		Total no. of cases	χ^2	*P*-value
	Yes	No			
S. Na+ (mEq/lt)					
<135 (hyponatremia)	7 (100)	0 (0)	7 (13.5)	5.67	0.06
135–145 (normal range)	34 (77.3)	10 (22.7)	44 (84.6)		
>145 (hypernatremia)	0 (0)	1 (100)	1 (1.9)		
S. K+ (mEq/lt)					
<3.5 (hypokalemia)	5 (100)	0 (0)	5 (9.6)	5.67	0.06
3.5–5 (normal range)	30 (83.3)	6 (16.7)	36 (69.2)		
>5 (hyperkalemia)	6 (54.5)	5 (45.5)	11 (21.2)		
S. Ca++ (mEq/lt)					
<4.3 (hypocalcemia)	18 (81.8)	4 (18.2)	22 (42.3)	0.54	0.76
4.3–5.3 (Normal range)	22 (75.9)	7 (24.1)	29 (55.8)		
>5.3 (hypercalcemia)	1 (100)	0 (0)	1 (1.9)		

EF: Ejection fraction

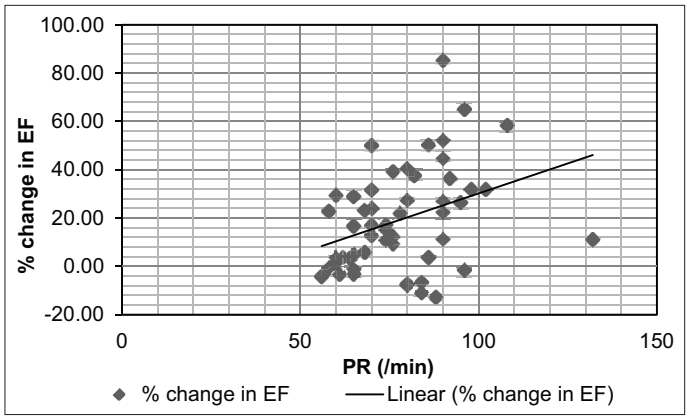

Figure 1: Graph showing relation between PR and % change in ejection fraction

It has been noticed [Table 2] that 69.2% of cases have normal serum potassium level, while 21.2% of cases have hyperkalemia and 9.6% of cases have hypokalemia. It has been found that all the five hypokalemia patients showed improvement in EF while 83.3% of the patients having normal serum potassium level showed improvement in EF. Only 54.5% of hyperkalemia patients showed improved EF after PCI. Hence, it can be said that as serum potassium level increases, improvement decreases within the group ($P = 0.06$).

It is also evident [Table 2] that 84.6% of patients have normal serum sodium level, while few cases (13.5%) have hyponatremia and only 1 case (1.9%) has hypernatremia.

Patients having low and normal serum sodium level showed improvement in EF after PCI. About 100% of patients who have low serum sodium level showed improved EF while 77.3% of patients who have normal serum sodium level showed improvement in EF. Only one patient had hypernatremia and he did not show improvement in EF. Hence, it can be said that as serum sodium level increases, improvement decreases within the group ($P = 0.06$) [Figure 2].

DISCUSSION

This is an exploratory study and after analyzing the data, we found that EF is affected by the factors under investigation though only serum sodium and serum potassium level showed some significance ($P = 0.06$).

Lip *et al*. (2007) found in a study that hypertensive patients have poor prognosis.[10] In our study, it is found that hypotensive and hypertensive patients showed slightly less improvement in EF in comparison to those patients who had normal BP ($P = 0.93$). Hence, we can say that results are equivocal in reference to BP. It is also found that as the PR increases, improvement in EF increases within the group ($P = 0.13$). Hence, tachycardia has a positive effect on improvement in EF, though it is not statistically significant.

Increased sodium consumption leads to increased BP. This increased BP put extra load on arterial wall and hence affecting blood flow. Hence, we can say that serum sodium level can affect outcome after PCI indirectly by affecting BP. In our study, we found that increasing serum sodium level decreases improvement ($P = 0.06$). Serum potassium level plays an important role in regulation of BP. When serum potassium level increases, it reduces BP but hyperkalemia can disturb the heart rhythm. It has been found in our study that increasing serum potassium level deteriorates the improvement in EF ($P = 0.06$).

It is a well-known fact that serum calcium plays an important role in cardiovascular physiology. Normal serum calcium level is important for adequate myocardial contractility. Contrary to the previous findings, in this study, we found that the patients with normal serum calcium level showed less improvement in comparison to the patients with abnormal serum calcium level.

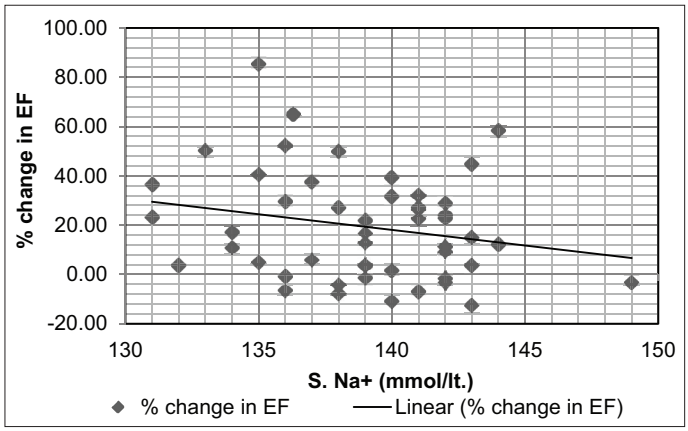

Figure 2: Graph showing relation between S. Na+ and % change in ejection fraction

It is clear from the findings that age has adverse effect on outcome of coronary angioplasty, especially over 50 years, though it is statistically not significant ($P = 0.38$). Starr *et al*. (1934) found that the average cardiac index slowly declines after 50 years.[11] Few studies also suggested that elderly population with AMI, who received a conservative treatment, have a higher mortality in comparison to the younger population.[12-14] In a study, Singh *et al*. (2018) found that AMI patients who had age more than 40 years showed less improvement after PCI.[15]

It is a well-known fact that overweight and obese patients have poor prognosis after coronary intervention. In this study, we found that as the BMI increases, improvement in EF decreases ($P = 0.53$). Interestingly, all the four underweight patients showed improvement in EF. However, there is a controversial finding termed as "obesity paradox," which tells that obese AMI patients have improved outcomes after PCI, in comparison to normal BMI patients.[16-19]

This study has some limitations. First of all, we did not record serum parathyroid hormone and Vitamin D level to find more accurate correlation between serum calcium level and improvement in EF. Hence, we are not able to exclude confounding factors such as primary and secondary hyperparathyroidism. Second, we have done serum electrolytes level measurement only at the time of admission in emergency. Third, the sample size is small, so to predict the outcome accurately we need a larger sample size. Finally, it is a hospital-based study so it is vulnerable to sample selection bias.

CONCLUSION

Based on the findings of this study, it can be concluded that increased serum sodium and potassium levels are associated with poor prognosis, while lesser age and normal BMI are associated with improved prognosis in AMI patients after PCI.

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