

RESEARCH PAPER

## Serum potassium and calcium level in patients with post myocardial infarction ventricular fibrillation

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### Abstract

**Background:** Arrhythmias are common in the first hours after myocardial infarction. Electrolytes imbalance often contribute to the development of cardiac arrhythmias. Aims of the study to show the correlation between serum potassium and calcium and development of post myocardial infarction ventricular fibrillation and to assess the effect of different age groups and gender in the development of this arrhythmia.

**Methods:** Ninety-three patients, 66(70.96%) males and 27 (29%) females were studied. The mean age was  $57.13 \pm 11.86$  years. Patients included were those who were admitted to the cardiac care units with acute myocardial infarction in 4 hospitals in Basra (southern of Iraq), blood samples for Potassium and Calcium were taken upon admission.

**Results:** Forty (43%) patients had developed primary ventricular fibrillation. The incidence of primary ventricular fibrillation was greater among patients with serum Potassium  $\leq 3.5$ mmol/L and  $>4.5$ mmol/L (p value=0.002). Age was not associated with increased frequency of primary ventricular fibrillation in patients with abnormal serum Potassium, but the incidence of primary ventricular fibrillation as caused by abnormal serum Potassium level was higher among females. No increase in primary ventricular fibrillation was found in patients with abnormal serum Calcium.

**Conclusion:** The incidence of post myocardial ischemic primary ventricular fibrillation was very common in patients with serum Potassium  $\leq 3.5$ mmol/L and  $>4.5$ mmol/L.

**Keywords:** myocardial infarction, serum potassium, serum calcium.

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### Introduction

About 90% of patients who have an acute myocardial infarction (AMI) develop some form of cardiac arrhythmias during or immediately after the event. In 25% of patients, such rhythm abnormalities manifest within the first 24 hours. In this group of patients, the risk of serious arrhythmias, such as ventricular fibrillation, is

greatest in the first hour and declines thereafter. The incidence of arrhythmia is higher with an ST-elevation myocardial infarction (STEMI) and lower with a non-ST-elevation myocardial infarction (NSTEMI).<sup>1</sup>

The incidence of primary ventricular fibrillation is greatest in the first hours after the onset of infarction (4.5%) and declines rapidly thereafter. Approximately 60% of episodes occur within 4 hours, and 80% occur within 12 hours.<sup>2</sup>

Primary ventricular fibrillation (PVF) during acute myocardial infarction (AMI) is conventionally defined as ventricular fibrillation that is not preceded by signs or symptoms of

heart failure or cardiogenic shock. PVF is the most frequent cause of death related to AMI because it often occurs before monitoring.<sup>3</sup>

Potassium plays an essential role in maintaining myocardial electrical stability. In the setting of myocardial ischemia, adrenergic stimulation activates the Na-K ATPase pump, lowering plasma potassium levels.<sup>4</sup> As a result, both professional guidelines and experts have recommended a target potassium level of at least 4.0 mEq/L in the setting of acute coronary syndrome (ACS).<sup>5-7</sup>

Calcium is involved in the physiological and biochemical processes of heart electrophysiology and contraction, blood coagulation, neurotransmitter release, enzyme activity regulation, and blood pressure regulation.<sup>8,9</sup>

## Methods

This is a cross-sectional study. A total of 93 patients, 66(70.96%) males whose ages ranged between 25-90years (mean 57.5 years), and 27(29%) females whose ages ranged between 35-81years (mean 58years), were included in 18months study conducted from the 9th of December 2015 to the 9th of June 2017.

Primary VF in this study refers to fibrillation occurring in the absence of shock or pulmonary edema.

According to the age, patients were classified in to; young age (25-45years), middle age (46-65years) and old age (>65 years) groups.

As for S.K level, patients were classified as having abnormal S.K (low or high) ( $\leq 3.5$ mmol/L or  $>4.5$ mmol/L respectively), and normal S.K (3.6-4.5mmol/L).

According to S.Ca level, patients were classified in to; those with low S.Ca ( $<2$ mmol/L), normal S.Ca (2-2.6mmol/L), and high S.Ca  $>2.6$ mmol/L.

Inclusion criteria:

Patients included in this study were those who were admitted to the cardiac care unit of Al Basrah General Hospital, Al Faihaa General Hospital and Al Sadir Teaching Hospital and diagnosed as acute myocardial infarction according to criteria that made by ACCF/AHA Guideline in 2013 [10] and AHA/ACC Guideline in 2014 [11].

Blood samples were taken from all patients with acute MI (STEMI and NSTEMI) to measure serum electrolytes (K and Ca) at the time of admission. Samples were collected using plan tube and analyzed by Architect plus machine. Patients who had developed VF on admission, blood samples for electrolytes were taken just after successful resuscitation.

Exclusion criteria: patients excluded were those with:

- Evidence of left ventricular dysfunction either clinically or by echocardiography.
- Cardiogenic shock.
- Non survival post AMI primary-VF

## Statistical analysis

All data were analyzed by SPSS (Statistical Package for Social Science – version 15). P value  $<0.05$  was considered to be significant.

## Results

Table 1 show the demographic features for both groups of patients. There were no significant differences among patients who developed VF (cases) from those who didn't (control). The mean age for the cases was  $57.13 \pm 11.86$  years.

Twenty five percent of the patients who developed VF had hypertension, and 22.5% had DM. Twenty five percent of the cases had previous attacks of IHD and there was no significant difference between them and those who didn't developed VF.

TABLE 1: DEMOGRAPHIC FEATURES FOR CASES AND CONTROLS			
Variable	Patients with VF 40 N (%)	Patients without VF 53 N (%)	P value
Age Mean ± SD (years)	57.13 ± 11.86	61.38 ± 14.49	0.13
Gender (male)	28 (70)	38 (71.7)	0.85
Smoking status			
smoker	15 (37.5)	15 (28.3)	0.49
Ex-smoker	7 (17.5)	14 (26.4)	
Non-Smoker	18 (45)	24 (45.3)	
Chronic diseases			
DM	9 (22.5)	13 (24.5)	0.82
Hypertension	10 (25)	18 (34)	0.35
COPD	1 (2.5)	1 (1.9)	0.84
History of previous IHD	10(25)	11(20.8)	0.62
COPD; chronic obstructive pulmonary disease, DM; diabetes Mellitus, IHD; ischemic heart disease.			

From a total of 93patients, 40(43%) developed VF; 28(70%) of them were males, while from 53(56.98%) didn't develop VF; 38(71.7%) were males. [Table 2]

So the probability of post AMI- primary VF was equal among patients regardless of gender (p value=.858).

TABLE 2: DISTRIBUTION OF PATIENTS BY VF AND GENDER					
sex	No VF		VF		total
	Number	Percentage	Number	Percentage	
male	38	71.7 %	28	70.0 %	66
female	15	28.3 %	12	30.0 %	27
total	53	100.0 %	40	100.0 %	93
Chi square= 0.032 P value= .858					

There was no statistical difference among patients who developed VF and those who didn't regarding the site of acute MI [table 3].

TABLE 3: CORRELATION OF VF AND SITE OF ACUTE MI					
Site of acute MI	No VF		VF		
	No.	%	No.	%	
Anterior	11	20.8	8	20	
Double wall	3	5.7	2	5	
Extensive	14	26.4	14	35	
Inferior	20	37.7	13	32.5	
Lateral	5	9.4	1	2.5	
NSTEMI	0	0	2	5	
Total	53		40		
Calculated Chi square= 5.108, df=5, Tabulated chi square= 11.0705 ,p value= 0.403					

From table 4 it was clear that most patients who developed post AMI-primary VF had low S.K (22(55%)) patients, also the percentage of post AMI-primary VF in patients who had abnormal high S.K level constituted 25% compared to 28.3% of those who didn't developed VF. The overall association between risk of post AMI-primary VF and S.K level was statistically significant (p value= .002).

**TABLE 4: VENTRICULAR FIBRILLATION AND SERUM POTASSIUM LEVEL**

S.K(mmol/L)	No VF		VF	
	No.	%	No.	%
<3	0	0.0	4	10.0
3-3.5	10	18.9	18	45.0
3.6-4	18	34.0	7	17.5
4.1-4.5	10	18.9	1	2.5
4.6-5	8	15.1	7	17.5
>5	7	13.2	3	7.5
total	53	100.0	40	100.0

Chi square= 18.704,P value= .002

This study had shown an interesting finding that abnormal S.K induced post AMI-primary VF significantly affected females (11(91.6%)) patients, p value= .017). [Table 5]

**TABLE 5: VENTRICULAR FIBRILLATION AND SERUM POTASSIUM LEVEL AND GENDER**

S.k(mmol/L) Gender		<3	3-3.5	3.6-4	4.1-4.5	4.6-5	>5	P value
	VF	3 10.7 %	13 46.4 %	6 21.4 %	1 3.6 %	3 10.7 %	2 7.1 %	
female	No VF	0 0%	1 6.7%	7 46.7 %	3 20 %	1 6.7 %	3 20 %	.017
	VF	1 8.3 %	5 41.7 %	1 8.3 %	0 0.0 %	4 33.3 %	1 8.3 %	

This study had shown no statistically significant difference in development of post AMI-primary VF in patients with abnormal (high or low) S.K among different age groups (p value= .199 in

young age, .081 in middle age, and .245 in old age group). [Table 6]

**TABLE 6: VENTRICULAR FIBRILLATION AND SERUM POTASSIUM LEVEL AMONG AGE GROUPS**

S.K(mmol/L) Age(year)		<3	3-3.5	3.6-4	4.1-4.5	4.6-5	>5	P value
	VF	1 11.1%	6 66.7%	1 11.1%	0 0.0%	0 0.0%	1 11.1%	
46-65	No VF	0 0.0%	4 17.4%	10 43.5%	5 21.7%	2 8.7%	2 8.7%	.081
	VF	2 8.0%	10 40.0%	6 24.0%	1 4.0%	5 20.0%	1 4.0%	
>65	No VF	0 0.0%	4 20.0%	6 30.0%	3 15.0%	5 25.0%	2 10.0%	.245
	VF	1 16.7%	2 33.3%	0 0.0%	0 0.0%	2 33.3%	1 16.7%	

From the 40 patients who developed post AMI-primary VF, 10(25%) patients had low S.Ca, and 3(7.5%) patients had high S.Ca. This difference was statistically insignificant (p value= .340). [Table 7]

**TABLE 7: VENTRICULAR FIBRILLATION AND SERUM CALCIUM LEVEL**

S.Ca(mmol/L)	No VF		VF	
	No.	%	No.	%
<2	7	13.2	10	25.0
2-2.6	42	79.2	27	67.0
>2.6	4	7.5	3	7.5
total	53	100.0	40	100.0

Chi square=2.158, P value=.340

## Discussion

Potassium is the most abundant intracellular cation and is necessary for maintaining a normal charge difference between intracellular and extracellular space. The normal level of plasma potassium is 3,8 – 5,1 mmol/l. The deviations to

both extremes (hypo- and hyperkalemia) are related to the risk of cardiac arrhythmias<sup>12</sup>

In this study post AMI-primary VF occurs more frequently in patients with S.K  $\leq 3.5$ mmol/L and  $>4.5$ mmol/L this was consistent with study of Michaud, et al.<sup>13</sup> Mia Ravn Jacobsen, et al<sup>14</sup>, and Abhinav Goyal, et al.<sup>15</sup> who found that post MI ventricular fibrillation and mortality was more in patients with serum K  $<3.5$ mmol/dl or  $>5$ mmol/dl. Mia Ravn and et al. also found that highest risk of VF among patients with severe hypokalemia [2.1–2.7 mmol/L] and the association between hypokalemia and VF may be independent of the measurement of potassium before or after VF.

Female gender was a risk factor for VF induced by abnormal S.K level; this was corresponding to the study of Vinod WaliM and Singi Yatiraj<sup>16</sup>, but inconsistent with study of Jenordrehaug,<sup>17</sup> who found that the increased risk of VF in the abnormal S.K level was about the same for males and females.

There were no significant differences in development of post MI VF among different age groups.

Isolated abnormalities of calcium concentration produce clinically significant EP effects only when they are extreme in either direction.[18] This study had shown that; there was no significant association between post AMI-primary VF and S.Ca abnormality (p value=.340). Acute myocardial infarction affects the balance of calcium ions in the body through the metabolism of neurohormones, kidneys, and gastrointestinal tract, causing occurrence of hypocalcemia.<sup>19</sup> To the best of our knowledge there is no other study that show the effect of serum calcium on development of post AMI primary VF, but Xingbo Gu and et al.<sup>20</sup> found that

patients with reduced serum calcium levels had a significantly higher incidence of midterm mortality, and the lowest risk of mortality was associated with approximately 2.32 mmol/l serum calcium and serum calcium levels added to the established risk factors model could improve the prediction of midterm mortality. Also, two studies in China reported that decreased baseline serum calcium levels were associated with a high risk of in-hospital mortality in myocardial infarction patients.<sup>21,22</sup>

In this study there was no difference in the presence of comorbidities like hypertension, DM and previous attacks of IHD in the risk of development of post AMI primary VF. This was conflicted with study of Mia Ravn and et al.<sup>14</sup> who found that Prior myocardial infarction and diabetes mellitus was independently associated with reduced risk of VF among patients with STEMI; who explain their finding as that these patients may have more severe coronary artery disease which may influence the formation of collateral blood flow. However, this may not applicable for patients with DM.

## Conclusion

Post AMI-primary VF occurs more in patients with S.K $\leq 3.5$ mmol/L and  $>4.5$ mmol/L, which was more common in females. The effect of calcium in development of post MI primary VF needs to be studied extensively.

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الخلاصة