



ASSOCIATION BETWEEN THE DISTURBED SERUM ELECTROLYTE LEVELS AND THE OCCURRENCE OF ARRHYTHMIAS AMONG CARDIAC SURGERY PATIENTS.

Saira Gul^a, Imran Hussain^b, Ajwad Farogh^c, Madiha Iqbal^a, Shamila Afsha^a

ABSTRACT

OBJECTIVE: To determine the association between disturbed electrolyte levels and the incidence of post-operative arrhythmias in patients undergoing cardiac surgery.

MATERIALS AND METHODS: After the approval of cardiac surgery department and written informed consent of the patients, the data of 82 patients undergoing cardiac surgery were analyzed. Serum potassium, sodium, magnesium, calcium, and phosphorus levels were measured before and after the cardiac surgery. Cardiac rhythm was monitored throughout the study.

RESULTS: The overall incidence of cardiac arrhythmia was 20(24.39%) among 82 patients undergoing cardiac surgery. There were 24(29.27%) hypertensive patients. CPR was done on 5(6.10%) patients with lethal arrhythmias and 100% mortality.

CONCLUSION: The incidence of cardiac arrhythmia after cardiac surgery remained high. Serum electrolyte concentration after cardiac surgery varies within normal ranges except potassium levels. Potassium level less than 3.5 mmol/L is strongly associated with cardiac arrhythmias.

KEY WORDS: Serum electrolytes, arrhythmias, cardiac surgery.

INTRODUCTION:

Electrolytes play an important roles in cellular metabolism, energy transformation and in the regulation of membrane potentials. The lack of electrolytes can induce a wide range of medical disorders like neuromuscular dysfunction and severe arrhythmias and also significantly increases the risk of ischemic heart disease.¹

Serious cardiac arrhythmias occur due to the changes in the normal balance between intracellular and extracellular potassium concentrations. During hospital stay low serum potassium levels are associated with the risk of ventricular tachycardia or fibrillation. It is reported that preoperative serum potassium level ≤ 3.5 mmol/L is a significant predictor of peri-operative mortality.²

Differences in potassium concentration in ischemic and non-ischemic myocardium can result in different degrees of depolarization, setting up electrical forces that can potentiate cardiac arrhyth-

(J Cardiovasc Dis 2015;13(2):55 -58)

mias.³ Severe hyperkalemia (potassium level > 7.0 mmol/L) reduces the resting membrane potential to the point in which conduction of electrical impulse ceases, but data regarding the effect of moderate levels of hyperkalemia on the development of post-operative arrhythmias are limited.

Hyponatremia resulting from hypotonic fluid is another most common electrolyte disorder. It has been reported to develop in approximately 30-40% of hospitalized patient. Hyponatremia can even develop if excessive near isotonic Lacted Ringers is administered in the post-operative period if urine tonicity is higher.⁴⁻⁷

Previously fewer studies were conducted regarding adverse effects of electrolytes concentration after cardiac surgery.⁸⁻¹⁰ One of the most important complications after cardiac surgery is post-operative cardiac arrhythmias as serum electrolytes are less frequently monitored. Thus in patients who received intravenous fluids (pharmacological agents) and isotonic saline, were monitored daily to prevent arrhythmias. To avoid severe outcomes after cardiac surgery, it is important to note the incidence of serum electrolyte changes and its association with cardiac arrhythmias.

MATERIALS AND METHODS:

This comparative prospective observational study was conducted at Cardiac Surgery Department, Punjab Institute of Cardiology, Lahore from

^aPunjab Institute of Cardiology, Lahore, Pakistan,

^bMadina Cardiac Center, KSA

^cBahawal Victoria Hospital, Bahawalpur

* Corresponding author:
Email: cabg120@hotmail.com

Date of Submission : 22-11-2016

Date of Revision: 04-03-2017

Date of Publication: 12-05-2017



30th November 2014 to 30th December 2015. 82 consecutive patients aged ≥ 18 years undergoing cardiac surgery for coronary artery disease and valvular disease were studied. Serum electrolytes concentration was measured.

The normal reference values for these electrolytes were as follows:

Sodium (Na): 134-154 mmol/L, Potassium (K): 3.4-5.0 mmol/L, Calcium (Ca): 8.5-10.3 mg/dl, Magnesium (Mg): 1.6-2.6 mg/dl and Phosphorous (P): 2.7-4.5 mg/dl.

Patients with normal liver, renal function serum creatinine < 1.5 mg/dl, and no other metabolic disorders, normal serum cholesterol values and normal sinus rhythm on preoperative electrocardiogram were included, while patients operated in an emergency and redo CABG, with chronic renal failure (serum creatinine level above 1.5mg/dl) were excluded from the study.

The method of standard bypass technique regarding CABG, valve replacement and congenital defect repair was the same for all patients. In all these cases, serum electrolyte levels including serum sodium, potassium, calcium, magnesium, and phosphorous levels were measured before the cardiac surgery and immediately after the surgery at the arrival to the ICU. Cardiac rhythm was monitored. Any episode of irregular cardiac rhythm was documented.

Preoperative medications were also considered, including beta-blockers, ACE Inhibitors and diuretics. Other variables included intraoperative data such as, height, weight, body surface area (BSA), flow rate, total bypass and cross-clamp time, total volume of priming solution, preoperative serum creatinine level and left ventricular ejection fraction(%).

The collected data was analysed statistically by using SPSS version 22. Continuous variables were presented in form of mean \pm S.D. Categorical variables were presented in form of frequency and percentages. Chi-square test was applied to test the association of the disturbed serum electrolyte levels with the occurrence of arrhythmias while, continuous variables were analysed by the independent sample t - test. P value < 0.05 was taken as significant.

RESULTS:

Out of total 82 patients undergoing cardiac surgery, 31(37.80%) were female while 51(62.20%) were male. The mean age of the patients was 46.39 ± 16.60 years. Other variables such as, height, age, weight, body surface area (BSA),

Table-1: Demographic variables in pre-operative patients.

Variables		Post-op arrhythmias		P value
		Yes	No	
Gender	Male	14(70.0%)	37(59.7%)	0.442
	Female	6(30.0%)	25(40.3%)	
Age		48.715.40	45.617.02	0.478
Height		1.6399.988	1.58316.02	0.146
Weight		63.610.51	63.1919.25	0.929
Hypertension		6(30.0%)	18(29.0%)	1.00
Priming solution		1.405187.7	1.383104.7	0.512
X-clamp time		65.832.93	61.8529.73	0.617
Bypass time		1.24250.16	1.09140.96	0.180
Flow rate		4.0430.367	3.9710.682	0.653
BSA		1.6700.150	1.6390.284	0.643
Pre-op creatinine		0.8950.315	0.9580.447	0.560
LV ejection fraction		50.9010.52	54.549.69	0.156

Table-2: Medications and post-operative mortality

Variables		Post-op arrhythmias		P value
		Yes	No	
anti-arrhythmic	Yes	5(25.0%)	21(33.9%)	.585
	No	15(75.0%)	41(66.1%)	
ACE Inhibitors	Yes	3(15.0%)	13(21.0%)	.749
	No	17(85.0%)	49(79.0%)	
Diuretics	Yes	10(50.0%)	26(41.9%)	.608
	No	10(50.0%)	36(58.1%)	
CPR	Yes	5(25.0%)	0(0%)	.001
	No	15(75.0%)	62(100.0%)	
Death	Yes	5(25.0%)	0(0%)	.001
	No	15(75.0%)	62(100.0%)	

Table-3: Association between the disturbed serum electrolyte levels and the occurrence of arrhythmias among cardiac surgery patients.

	Pre-operative		Post-operative		P-value
	with arrhythmias	without arrhythmias	With arrhythmias	without arrhythmias	
Magnesium	2.110.646	2.060.485	2.110.646	2.060.485	0.759
Potassium	3.970.436	3.930.531	3.440.412	3.850.384	0.0234
Sodium	140.705.31	140.205.11	142.708.63	142.205.15	0.4567
Calcium	8.6451.040	8.940.7707	8.7451.040	8.840.7707	0.3876

flow rate, total bypass and cross-clamp time, total volume of priming solution, preoperative serum creatinine level and left ventricular ejection fraction(%) had no significant effect on cardiac arrhythmias.(Table-1)

5(6.10%) patients had cardiopulmonary resuscitation (CPR). The overall incidence of cardiac arrhythmias in this study was 20(24.39%). Serum electrolyte concentration after cardiac surgery were within normal ranges except potassium levels. Potassium level less than the normal range (3.4-5.0 mmol/L) was strongly associated with cardiac arrhythmias. CPR was done on 5(6.10%) patients in severe cardiac arrhythmias cases with 100%



mortality. (Table 2)

Regarding medicine in post operative period in patients with arrhythmias, anti-arrhythmic, ACE inhibitors and diuretics were common medicines used. Diuretics were the most frequent medicine followed by anti-arrhythmic and ACE inhibitors. (Table 2)

Regarding association between the disturbed serum electrolyte levels and the occurrence of arrhythmias among cardiac surgery patients, only hypokalemia (serum potassium level < 3.5mg/dl) was noted to be associated with cardiac arrhythmias. (Table-3)

DISCUSSION:

Many studies have clearly demonstrated that patients undergoing cardiac surgical procedures with extracorporeal circulation are at high risk for electrolyte depletion. This phenomenon occurred despite the facts that the cardioplegia solution contained high doses of potassium and magnesium, and that potassium supplementation was given throughout the surgical procedure. Preoperatively use of diuretics and hemodilution are considered the main causes of electrolyte depletion, which is significantly associated with the incidence of cardiac arrhythmias¹¹.

Our results support the conclusion that the no disturbed serum electrolytes level was observed except potassium level ≤ 3.5 mmol/L which was significantly associated with post-operative cardiac arrhythmias and patients who experienced cardiac arrhythmia observed high mortality as 25%.

Present study showed that incidence of cardiac arrhythmias was 20(24.39%). In contrast with the present study Svagzdiene M¹² et al reported high incidence of cardiac arrhythmias (26.83%). Valsangiacomo E¹³ et al demonstrated the high incidence of cardiac arrhythmia (27% and 48%). In the study by Yildirim SV¹⁴ et al demonstrated that incidence of cardiac arrhythmias was 8.8%. Delaney JW¹⁵ et al showed that the incidence of cardiac arrhythmias was 12.9%. This dissimilarity could be due to differences in the sample size of the present study.

Our results showed that the incidence of arrhythmias was high in male patients indicating that men are at increased risk of post-operative cardiac arrhythmias as compared to females (70% vs. 30%). Yildirim SV¹⁴ et al found that cardiac ar-

rhythmia was more in men than women (74.5% vs. 25.49%). Another study by Delaney JW¹⁵ et al has also established that cardiac arrhythmias were more prevalent in male patients compared to female patients (50.79% vs. 42.2%). Delaney JW¹⁵ study results showed the contradiction may be due to bias in selection of female patient.

The present study provides evidence that the mean age of the cardiac arrhythmias patient who underwent CABG was 46.0 ± 16.40 years. Polderman¹ et al reported that age of the cardiac arrhythmias patient who underwent CABG was 59.9 ± 23.2 years while Delaney JW¹⁵ et al reported that age of the cardiac arrhythmias patient who underwent CABG was 22.0 ± 39.7 years.

Present study showed that post-operative level of serum electrolyte concentration (magnesium, sodium, calcium) varied within normal ranges, while only potassium was significantly associated with post-operative cardiac arrhythmias (3.85 ± 0.384 vs. 3.44 ± 0.412). Delaney JW¹⁵ et al scrutinized that post-operative serum electrolyte level (magnesium, sodium, calcium, potassium) varied within normal ranges and insignificantly associated with postoperative cardiac arrhythmias (Magnesium (mmol/dL); 1.50 ± 0.37 vs. 1.51 ± 0.1 and Calcium (mmol/dL); 4.75 ± 0.26 vs. 4.92 ± 0.47). Yildirim SV et al¹⁴ evaluated that pre and post mean levels of electrolytes and were in normal ranges and significant relationship was found with post-operative cardiac arrhythmias as (sodium mEq/L; 144 ± 5 vs. 144.9 ± 5.3 : potassium mEq/L; 3.78 ± 0.91 vs. 3.8 ± 0.9 : ionized calcium mmol/L 1.15 ± 0.33 vs. 1.2 ± 0.3).

Present study reported that post-operative cardiac arrhythmias were independently associated with a higher in hospital mortality rate (25% vs. 0). Yildirim SV et al¹⁴ determined in-hospital mortality was found to be high in post-operative cardiac arrhythmias group (29.4% vs 2%).

CONCLUSION:

Therefore, it is concluded that there was no severe electrolyte disorder in post operative surgical patients. Serum electrolytes (sodium, magnesium, calcium, phosphorus) were within normal ranges except potassium level ≤ 3.5 mmol/L. This hypokalemia was considered to be associated with cardiac arrhythmias. CPR with 100% mortality was observed among challenging subset of these patients with cardiac arrhythmia.



Author's Contribution

SG: Developed idea for the research and agreed to be accountable for all aspects of the research and monitored the formulization of the research. IH: Drafted the work and helped in audit and reviewed the article. AF: Re-arranged data and corrected article. MI and SA: Data analysis, interpretation and assisted for presentation.

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