Brief Report

Investigating the relationship between intra-operative electrolyte abnormalities (sodium and potassium) with post-operative complications of coronary artery bypass surgery

Kaivan Bagheri, Mohammadreza Safavi, Azim Honarmand, Parviz Kashefi, Marziye Ghasemi, Leila Mohammadinia

Department of Anesthesia, Anesthesiology and Critical Care Research Center, Isfahan University of Medical Sciences, Isfahan, Iran

Abstract

Background: Generally, the electrolyte abnormalities are seen in many hospitalized patients, and this problem increases in ones with heart diseases. The purpose of this study is determination of the prevalence of electrolyte abnormalities during the coronary artery bypass surgery (CABG) and detecting the relationship between these abnormalities with the complications after the surgeries.

Materials and Methods: This is a cross-sectional study, which is done in Chamran hospital, the medical and educational center of Isfahan, Iran, in 2011. The target population included the patients who have undergone CABG in this hospital. In this study, 100 patients who had been candidates for CABG were selected, and we extracted their recorded intra-operative electrolyte information. The collected data was entered into the computer and analyzed by SPSS software. The Chi-square and t student tests were used for data analysis.

Results: The mean ± SD of sodium during CABG was 137.95 ± 4.6 (range 127-152) mg\dl. Also, the mean ± SD of potassium was 4.65 ± 0.9 (range: 2.9-7.4). According to these results, 48 patients (48% of all) had electrolyte imbalance and 52 patients (52% of all) were normal. Sodium level in 71% of patients was normal, and in 29% of them was abnormal. Potassium level in 73% of individuals was normal, and in 27% of them was abnormal.

Conclusion: Giving an attention to electrolyte abnormalities in patients who have undergone CABG surgery is a considerable necessity for them, and sufficient arrangements are needed to prevent such abnormalities.

Key Words: Coronary artery bypass surgery, electrolytes imbalance, potassium, sodium

Address for correspondence:
Prof. Mohammadreza Safavi, Department of Anesthesia, Anesthesiology and Critical Care Research Center, Isfahan University of Medical Sciences, Isfahan, Iran. E-mail: safavi@med.mui.ac.ir

Received: 07.05.2012, **Accepted:** 10.10.2012

Access this article online	
Quick Response Code:	Website: www.advbiores.net
	DOI: 10.4103/2277-9175.120871

INTRODUCTION

One of the greatest advances in the angina treatment is CABG surgery. The word bypass means by-way, since the bypass surgery removes the legs or chest artery and uses those as a bypass for blocked coronary artery, so the surgery has been named bypass.[1-3] Like any other surgery, there is

How to cite this article: Bagheri K, Safavi M, Honarmand A, Kashefi P, Ghasemi M, Mohammadinia L. Investigating the relationship between intra-operative electrolyte abnormalities (sodium and potassium) with post-operative complications of coronary artery bypass surgery. Adv Biomed Res 2013;2:82.

a series of complications during and after CABG surgery. The most important complications that may occur in patients are including, MI, pulmonary edema and pulmonary embolism, bleeding, pleural effusion, pneumothorax, hemothorax, infection, kidney failure, CVA, and electrolyte imbalances.[4-8] Electrolyte abnormalities are common disorders during coronary artery bypass surgery, so that the potassium disorders are seen in more than 20% of hospitalized patients.[8] Although potassium disorders are usually well tolerated in healthy people, it can be life-threatening in severity. Even mild and moderate hypokalemia also increases the risk of morbidity and mortality in cardiovascular patients.[9] In patients with various heart problems, mild to moderate disorders of potassium can also increase the probability of cardiac arrhythmias[10] and causes systolic and diastolic pressure increase.[11] As we know, hypokalemia increases the resting membrane potential and decreases the excitability of cells which increases the ability of cells to re-entry, a similar mechanism that there is in atrial fibrillation and flutter.[5] Arrhythmias after cardiac surgery are numerous and multi-factorial[6] It has been found in other studies that atrial fibrillation and other complications can result in unpleasant consequences such as thrombo-embolic events, hemodynamic disorders, increasing ICU hospitalization and costs, and the most importantly, they can lead to morbidity and mortality increase.[7] Sodium disorders as well as other complications are possible problems in coronary artery bypass surgery. Sodium is one of the important electrolytes to maintain blood pressure in normal level and proper functioning of nerve-muscle. Hypernatremia causes water penetration into the cells that cause cell swelling and other symptoms such as dizziness, loss of consciousness, convulsions, and, in severity, coma will happen. Brain herniation and death are the other possible complications. In one study, 7/9% of ICU inpatients ward have suffered hypernatremia.[16] Hyponatremia refers to reduction of blood sodium level under the normal value, so it can affect the brain cells and cause coma or death, especially in children and older people.[10] The purpose of this study is determination of relationship between intra-operative electrolyte imbalances (sodium and potassium) with outcomes and complications after coronary artery bypass surgery (CABG).

MATERIALS AND METHODS

This is a cross-sectional study, which is done in Chamran hospital, the medical and educational center of Isfahan, Iran, in 2011. The study population consisted of patients who were candidates for CABG (coronary artery bypass grafting) surgery during one year. Entry criteria included patients undergoing CABG, no pre-operative electrolyte disorder, no operation of aortic balloon pump before surgery, no risk of coagulation disorder, and no requirement of emergency surgery. Exclusion criteria included patients' death during surgery or before ICU admission. The sample size that is needed for this study was brought 96 patients, for more confidence, 100 patients who were candidates for CABG were selected and surveyed for electrolyte imbalances. This sampling method was simple, and patients who were appropriate, according to the entry criteria, elected consecutively until the sample volume reached its sufficient level.

For all patients who had undergone CABG surgery, there were recorded experiments of electrolyte values in their cases. The electrolyte (sodium and potassium) values were measured 10 minutes after pump removal. These values were extracted and recorded in specific checklist again.

Furthermore, patients had been evaluated for the incidence of hyponatremia or hypernatremia and hypokalemia or hyperkalemia, and the statistical results based on the amount of disorders and the numbers of patients were reported. By reading the cases of patients, it became clear which of the post-operative complications, including arrhythmias, bleeding, acid-base disturbances, cardiac arrest, and re-intubation requirement and the post-operative outcomes which including mortality, length of stay in ICU (The time of ICU admission until discharge), duration of mechanical ventilation (i.e., when the ventilator is connected to the patient on arrival, when the ventilator is removed. The patient is separated from the ventilator, if he is fully conscious, ABG is acceptable, hemodynamic is stable, has no active bleeding, saturation po2 is above 95%, TV should be at least 5 cc/kg, RR is between 12-18, urine output is acceptable), they have experienced. The data entered into computer and analyzed by SPSS18 soft ware. The Chi-square and student *t* tests were used for data analysis.

RESULTS

In this study, 100 patients undergoing coronary artery bypass surgery were selected. The average age of these patients was 9/4 ± 60/8 years, range 37-79 years. 52 patients were female and 48 were male. The average age of men and women, respectively, was 9/7 ± 60/4 and 9/2 ± 61/2 years. According to *t* test, there was no significant difference between sexes (P = 0.65). Patient's occupations were as follows: 11 workers, 22 crew, 1 employee, 52 housewives, and 14 retired people. The mean ± SD of natrium during

CABG was 137.95 ± 4.6 (range 127-152) mg\dl. Also, the mean ± SD of potassium was 4.65 ± 0.9 (range: 2.9-7.4). According to this results, 48 (48%) had electrolytes imbalances and 52 (52%) were normal. Natrium level in 71% was normal and in 29% was abnormal. Potassium level in 73% was normal and in 27% was abnormal [Figure 1]. According to the results, 18 women and 11 men had sodium's disrupted level (34/6% Vs. 22/9%). But, the Chi-square test had shown that there was no significant difference between the sexes (P = 0.2), and also 14 men and 13 women had imbalance of blood potassium level (26/9% Vs. 27/1%), According to the test, there was no significant difference between the sexes (P = 0.2) [Table 1].

The average length of ICU care stay in all patients was 1 ± 2/4 days. The minimum and maximum duration was respectively, 1 and 8 days. The mean length of ICU stay in patients with electrolyte disorders was 1/2 ± 2/67 and in patients without electrolyte abnormalities was 0/5 ± 2/17 days. T test had shown that differences between groups was significant (P = 0.008) [Table 2].

During the study period, 4 patients died; 1 of them was without electrolyte imbalances and 3 patients were with electrolyte imbalances (1/9% Vs. 6/3%), but according to Fisher's exact test, frequency distribution of mortality in both groups- infected and non-infected patients- had no significant electrolyte abnormalities (P = 0.35).

The duration of mechanical ventilation in total patients was 5/8 ± 8/82 hr with the range of 1-50 hr. The mean duration of mechanical ventilation in patients with and without non-electrolyte disorder, respectively, was 7/5 ± 9/5 and 3/6 ± 8/18 minutes; t-test observed no significant differences between groups (P = 0.26). In Figure 2, the distribution of duration of mechanical ventilation in these two groups is shown.

During surgery, 31 patients were with arrhythmia, 13 patients were bleeding, and 8 patients suffered cardiopulmonary arrest. Arrhythmia in patients without and with non-electrolyte disorder was 39/6% and 23/1%; the Chi-square test observed significant differences between groups (P = 0.09). The incidence of bleeding in these two groups, respectively, was 8/3% and 17/3%; the above test showed that there was no significant difference between the two groups. Also, 1 patient of no abnormality electrolyte group and 7 cases of electrolyte abnormalities group had arrested. (1/9% vs. 14/6%), and the Fisher exact test was the significant relation between the two difference groups (P = 0.023). The results are shown in Table 3.

DISCUSSION

The goal of this study was determination of the relationship between intra-operative electrolytes imbalance (sodium and potassium) with outcomes and complications after coronary artery bypass surgery (CABG) at one year. In our study, 100 patients undergoing coronary artery bypass surgery were studied with 60/8 ± 9/4 mean age of years, but 11% of them were less than 50 years, which indicates a considerable change in the epidemiology of cardiovascular diseases.

Table 1: The frequency distribution of sodium and potassium disturbances in terms of gender

Elements	Sex level	Female		Male		*P* value
		Percent	Number	Percent	Number	
Sodium	Normal	65/4	34	77/1	37	0.2
	Abnormal	34/6	18	22/9	11	
Potassium	Normal	73/1	38	72/9	35	0.2
	Abnormal	26/9	14	27/1	13	

Table 2: Standard deviation and mean stay in ICU based on the presence and absence of electrolyte disturbances

Electrolyte disturbances	Mean stay in ICU	Standard deviation (SD)	*P* value
Is	2/67	1/2	0.008
No	2/17	./5	
Overall	2/4	1	

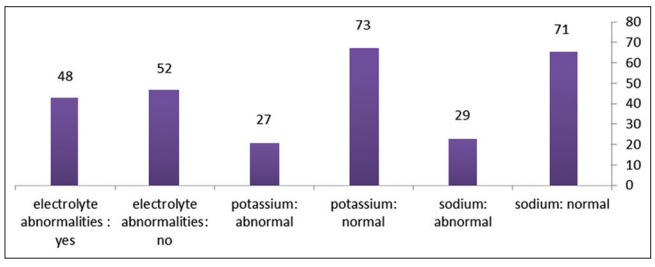

Figure 1: Percentage of normal and abnormal sodium and potassium in patients under study

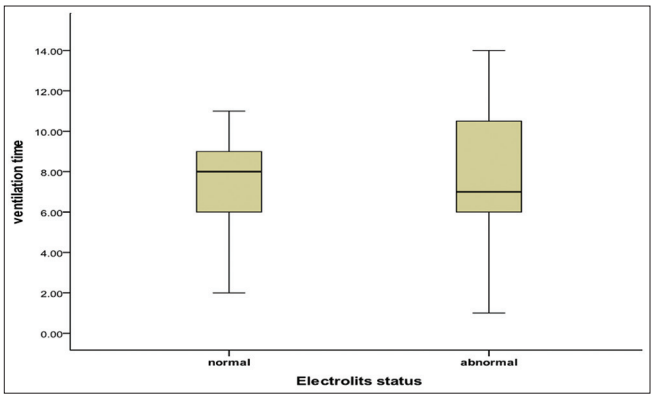

Figure 2: Median, 25% and 75% percentile of the amplitude and duration of mechanical ventilation

Table 3: Distribution of intra-operative complications, according to electrolyte imbalances

P value	There is		There is no		Electrolyte disturbance level	Complications
	Percent	Number	Percent	Number		
0.09	39/6	19	23/1	12	Is	Arrhythmia
	60/4	29	76/9	40	No	
0.24	8/3	4	17/3	9	Is	Bleeding
	91/7	44	82/7	43	No	
0.027	14/6	7	1/9	1	Yes	Arrest
	85/4	41	98/1	51	No	

According to the results, 48% of patients had electrolyte imbalances; 21% in sodium level, 19% in potassium level, and 8% had disorder in both sodium and potassium levels. The data shows that electrolyte abnormalities in patients undergoing CABG are serious and significant disorders, and according to some articles, which stated that a large percentage of electrolyte-disorder patients would be died, precise and more controlling of sodium and potassium levels during the surgery should be performed to prevent this unpleasant event. This issue is not allocated to our patients only, and generally electrolyte disorders are common during the CABG surgeries.

In our study, 4 patients died; 3 of them had electrolyte disorders. In our study, the incidence of mortality was 4%, considered high and significant.

Arrhythmia after heart surgery has got a high prevalence, and it is multifactorial.[6] Several studies have shown that electrolyte abnormalities can also lead to serious and significant post-operative complications such as arrhythmia in CABG patients.[12-15] In our study, 31% suffered from arrhythmia, 13% had bleeding, and 8% encountered cardiopulmonary arrest. Arrhythmia in patients with electrolyte disorder was 39/6% and in non-electrolyte-disorder patients was 23/1%. Despite the significant difference of disorder between the two groups, it did not reach the level of statistical difference. The bleeding incidence in these two groups, respectively, was 8/3% and 17/3%; the difference between two groups was not statistically significant. Also, among the 8 patients with cardiovascular arrest, 7 of them had electrolyte imbalances and, therefore, the difference between two groups was statistically significant.

Other studies have also shown that atrial fibrillation and other complications listed before can result unpleasant consequences such as thrombo-embolic events, hemodynamic disorders, increased duration of hospitalization in the ICU, increased costs, and most importantly, increased mortality and morbidity.[7] In our study, the mean length of ICU stay in patients with electrolyte disorders was 2/67 ± 1/2 days and in non-electrolyte-disorder patients was 2/17 ± 0/5 days, and the difference between these two groups was statistically significant. Therefore, in addition to the increase of morbidity and mortality, the electrolyte disorders can lengthen the duration of hospitalization and consequently, hospital expenses are increased and the patient and his family would be under pressure, economically and psychologically.

All the statistics represent the important role of intra-operative electrolyte imbalances in post-operative complications in CABG patients.

ACKNOWLEDGMENT

The authors wish to sincerely thank the support of all the colleagues in Chamran Hospital Medical Center affiliated to Isfahan University of Medical Sciences in Isfahan, Iran. Furthermore, our special thanks go to the patients, who wholeheartedly and actively assisted us to carry out this research. No conflict of interest existed. This cross-sectional study was approved by the Ethics Committee of our university, (Isfahan University of Medical Sciences), and all patients gave written, informed consent.

REFERENCES

1. Crop MJ, Hoorn EJ, Lindemans J, Zietse R. Hypokalaemia and subsequent hyperkalaemia in hospitalized patients. Nephrol Dial Transplant 2007;22:3471-7.
2. Clausen T. Role of Na+, K+-pumps and transmembrane Na+, K+-distribution in muscle function. The FEPS lecture - Bratislava 2007. Acta Physiol (Oxf) 2008;192:339-49.
3. Kjeldsen K. Hypokalemia and sudden cardiac death. Exp Clin Cardiol 2010;15:e96-9.
4. Hoes AW, Grobbee DE, Peet TM. Do non-potassium-sparing diuretics increase the risk of sudden cardiac death in hypertensive patients? Recent evidence. Drugs 1994;47:711-33.
5. Braden GL, von Oeyen PT, Germain MJ, Watson DJ, Haag BL. Ritodrine and terbutaline-induced hypokalemia in preterm labor: Mechanisms and consequences. Kidney Int 1997;51:1867-75.
6. Ho KM. Intravenous magnesium for cardiac arrhythmias: Jack of all trades. Magnes Res 2008;21:65-8.
7. Stühlinger HG, Kiss K, Smetana R. Significance of magnesium in cardiac arrhythmias. Wien Med Wochenschr 2000;150:330-4.
8. Beşoğul Y, Tünerir B, Ozdemir C, Aslan R. Magnesium-flush infusion into the aortic root just before reperfusion reduces the requirement for internal defibrillation and early post-perfusion arrhythmias. J Int Med Res 2003;31:202-9.
9. Abernathy MH, Walmsley TA, Fowler RT. Further evidence for the importance of inter-sample air compression as a source of error in a

continuous-flow (Technicon SMAC) system. Clin Chem 1982;28:1991-2.
10. Rasmussen HS, Thomsen PE. The electrophysiological effects of intravenous magnesium on human sinus node, atrioventricular node, atrium, and ventricle. Clin Cardiol 1989;12:85-90.
11. Humphreys M. Potassium disturbances and associated electrocardiogram changes. Emerg Nurse 2007;15:28-34.
12. Smith RC, Leung JM, Keith FM, Merrick S, Mangano DT. Ventricular dysrhythmias in patients undergoing coronary artery bypass graft surgery: Incidence, characteristics, and prognostic importance. Study of Perioperative Ischemia (SPI) Research Group. Am Heart J 1992;123:73-81.
13. Angelini P, Feldman MI, Lufschanowski R, Leachman RD. Cardiac arrhythmias during and after heart surgery: Diagnosis and management. Prog Cardiovasc Dis 1974;16:469-95.
14. Treggiari-Venzi MM, Waeber JL, Perneger TV, Suter PM, Adamec R, Romand JA. Intravenous amiodarone or magnesium sulfate is not cost-beneficial prophylaxis for atrial fibrillation after coronary artery bypass surgery. Br J Anaesth 2000;85:690-5.
15. Scoreki K, Ausiello D. Dimbalances of sodium and water homeostasis. In; Goldman L, Ausiello D, editors. Cecil medicine. 23rd ed. Philadelphia, Pa: Saunders Elsevier; 2007. Chap. 117.
16. Aiyagari V, Deibert E, Diringer MN. FCCM. Hypernatremia in the neurologic intensive care unit. J Crit Care 2006;21:163-72.

Source of Support: Anesthesiology and Critical Care Research Center, Isfahan University of Medical Sciences, Isfahan, Iran, **Conflict of Interest:** None declared.