http://www.cjmb.org

Open Access Original Article

Crescent Journal of Medical and Biological Sciences
Vol. 5, No. 3, July 2018, 228–232
eISSN 2148-9696

Comparison of Laboratory Findings and Incidence Rate of Renal Failure With and Without Cardiopulmonary Bypass Machine After Coronary Artery Bypass Graft

Zeinab Ghasemian Khojasteh[1], Naser Khezerlou Agdam[1], Sakineh Hadi[1], Mohammadreza Taban Sadeghi[1], Hossein Sate[1], Raziyeh Parizad[1,2*]

Abstract

Objectives: Acute kidney insufficiency is a prevalent and serious disease that follows coronary artery bypass graft (CABG). One of the important symptoms of acute renal failure (ARF) is the increased level of urea and serum creatinine. This study examined the rate of renal failure in patients undergoing on-pump and off-pump CABG.

Materials and Methods: In this descriptive–comparative survey, we selected the patients undergoing heart surgery. Levels of urea, creatinine, sodium, potassium and urinary output were controlled and recorded in the first days of admission and ICU discharge. Data collection tool was a checklist, the first part included demographic information and the second part was related to the information on kidney function. The data were analyzed using SPSS version 21.0.

Results: The findings of this study showed a statistically significant difference in terms of age and the incidence of renal failure based on the increased levels of urea and serum creatinine before and after CABG ($P<0.05$). Results of this study also showed that the incidence of renal failure significantly increased after CABG based on the levels of urea and serum creatinine ($P<0.00$). No considerable difference was observed between 2 surgery procedures (on-pump and off-pump) in terms of renal failure incidence ($P>0.05$).

Conclusions: Patients' age was an important factor for kidney insufficiency following CABG. Type of the surgery (on- and off-pump) and gender had no influence on the incidence rate of ARF. Stronger measures to protect the kidneys in older patients may reduce this high-risk complication.

Keywords: Open heart surgery, Acute renal failure, Lab findings, On- and off-pump surgery

Introduction

Treatment of coronary artery stenosis through coronary artery bypass graft (CABG) is a well-known method in patients with three-vessel involvement, left main coronary artery disease and left ventricular dysfunction in diabetic patients (1). More than 1 million patients undergo CABG annually in the world and around 77 000 of them develop acute renal failure (ARF) during the year after the operation and around 14 000 (1.4%) require dialysis for the first time (2,3). Acute kidney insufficiency is one the most dangerous complications of open heart surgery since it increases mortality, morbidity and ICU length of stay and the patients may need dialysis (4,5). Epidemiologic studies in other countries report different prevalence rates for ARF. A study in Lithuania was reported, the prevalence of ARF was 4% to 6% and 1.06% of the patients needed dialysis (6). In another study, patients were assessed in on-pump and off-pump groups and the prevalence rates of ARF were reported to be 46.7% and 20.0%, respectively (7). The results of another study showed that the mortality rate was 12% in patients with ARF (8). The ARF is defined as ≥0.3 mg/dL increase in serum creatinine from baseline in the first 24 hours or 50% increase in 48 hours. Studies showed that patients with doubled serum creatinine level are 2 to 5 times more likely to die and patients with recovered renal function are still at the risk of chronic renal failure and premature mortality (9-12).

Various studies report different influential factors in ARF progress after CABG including old age, high blood pressure, peripheral artery disease, left ventricular dysfunction, length of the surgery, aortic cross-clamp and type of the surgery (13,14). Moreover, one of the important ARF-related complications is electrolyte disorders especially increased serum potassium and decreased serum sodium levels. Potassium is one of the most important electrolytes whose role in inducing cardiac arrhythmias especially atrial fibrillation is well-known (15-17).

Received 4 March 2017, **Accepted** 11 August 2017, **Available online** 6 September 2017

[1]Cardiovascular Research Center, Tabriz University of Medical Sciences, Tabriz, Iran. [2]Faculty of Nursing and Midwifery, Tabriz University of Medical Sciences, Tabriz, Iran
***Corresponding Author:** Raziyeh Parizad, Tel: +98 9143134453, Email: r_parizad2003@yahoo .com

Identification of the prevalence and incidence related factors associated with the incidence of ARF after open heart surgery can help doctors and health service providers promote preventive measures and reduce the financial and mental burden on patients and their families. Therefore, considering the importance of the issue and shortage of the related research studies, this study aimed at comparing the lab results and changes in renal function in patients before and after on-pump and off-pump CABG.

Materials and Methods

This study is a descriptive-comparative research. Sixty patients undergoing CABG in Shahid Madani hospital from late 2015 to early 2016 were evaluated. Data collection tool was a researcher-made checklist with two parts. The first part collected demographic information and the second part consisted of test results of the changes in renal function gathered by the researcher in patients' bedside and also through observation and review of the patients' files. The sample size was determined to be 60 subjects based on the literature and the significance level was 0.05. The patients were randomly divided into 2 groups of 30, that is the on-pump and off-pump groups and their results were compared. The criterion for inclusion in this study was being 18 to 85 years of age and the patients with a history of renal disorders were excluded. After the surgery and transfer of patients to the ICU until their discharge from there, 24-hour urine volume and serum urea, creatinine, sodium and potassium of all the patients were measured and recorded. Lab results of all of the patients in the first day of admission and hospitalization in the surgery ward were also recorded. A descriptive statistical index (mean, standard deviation, variance) was used for analyzing the quantitative data and inferential statistics for qualitative data (paired *t* test, independent *t* test).

Results

Demographic information of the patients was as follows: 43 males (71.7%), 17 females (28.3%), 17 from Tabriz (28.3%), 43 from other cities (71.7%); 50 with middle school education (83.37%), 8 with high school degree (13.3%), 1 with bachelor's degree (1.7%) and 1 with master's degree; 30 patients (50%) underwent CABG with cardiopulmonary bypass and 30 patients (50%) underwent CABG without cardiopulmonary bypass; there were 26 patients with blood group A (43.3%), 13 with blood group O (21.7%), 11 with blood group B (18.3%), and 10 with blood group AB (16.7%) .

There was a significant relationship between serum levels of urea, creatinine, sodium and potassium before and after CABG ($P>0.001$) (Table 1).

There was no statistically significant difference between on-pump and off-pump CABG in terms of serum levels of urea, creatinine, sodium and potassium ($P>0.05$) (Table 2).

The comparison of 24 hours urine volumes before and after CABG showed a statistically significant difference ($P<0.05$). Moreover, comparison of 24 hours urine volume showed a statistically significant difference in terms of the serum levels of urea and creatinine ($P<0.05$) (Tables 3 and 4).

Results of this study showed that there was a statistically significant difference between glomerular filtration before CABG in terms of pre-operative age, weight and creatinine ($P<0.05$) and glomerular filtration after CABG in terms of post-operative age, weight and creatinine ($P<0.05$) (Table 5).

Discussion

Lab results including serum urea, creatinine, sodium and potassium before and after CABG showed a statistically significant difference. The highest levels of serum urea and creatinine were observed in the first 48 hours after the operation which is inconsistent with findings of Provenchere et al (18) because they found the highest serum creatinine increase 72 hours after the operation. The difference may be attributed to the sample size and assessment criteria which was consistent with the findings of the study by Akbari et al who recorded the highest increase in serum creatinine 24 hours after the operation (19). Serum potassium and sodium concentrations were at normal levels 48 hours after the operation, which is compatible with the finding a study by Ebadi et al (20).

In our study, no statically significant discrepancy in ARF

Table 1. Comparison of Lab Results before and After CABG

Variable	*P* Value	Sig. (2-tailed)	MD (CI 95%)	Mean
Bun before CABG	0.00	0.5	7.00 (-1.27-02.34)	20.28
Bun 1 day after CABG				19.75
Cr before CABG	0.00	0.00	0.31 (0.05-0.21)	1.22
Cr 1 day after CABG				1.08
Na before CABG	0.00	0.5	3.07 (-1.04-o0.54)	141.85
Na 1 day after CABG				142.1
K before CABG	0.1	0.1	0.51 (-0.24-0.024)	4.47
K 1 day after CABG				4.5

Abbreviation: Na, Sodium; K, Potassium; CABG, coronary artery bypass graft; MD, mean differences.

Table 2. Comparison of On-pump and Off-pump CABG in Terms of Lab

Pump	Mean	Sig (2-tailed)	MD (CI 95%)	*P* Value
BUN before CABG				
Yes	20.13	0.8	-0.3 (-4.3 to 3.7)	0.8
No	20.43			
BUN 1 day after CABG				
Yes	19.2	0.6	-1.1 (-5.4 to 3.28)	0.6
No	20.3			
Cr before CABG				
Yes	1.25	0.00	0.06 (-0.13 to 0.27)	0.3
No	1.18			
Cr 1 day after CABG				
Yes	1.1	0.4	0.05 (-0.10 to 0.21)	0.1
No	1.05			
Na before CABG				
Yes	141.56	0.4	-0.5 (-2.17 to 1.04)	0.6
No	142.13			
Na 1 day after CABG				
Yes	142.56	0.1	0.93 (-0.42 to 2.29)	0.0
No	141.63			
K before CABG				
Yes	4.46	0.7	-0.03 (0.23 to 0.17)	0.8
No	4.50			
K 1 day after CABG				
Yes	4.67	0.1	0.17 (-0.3 to 0.38)	0.3
No	4.5			
Output				
Yes	2513.3	1.08	57.99 (251.6 to 716.9)	0.6
No	2266.6			

Abbreviation: Na, Sodium; K, Potassium; CABG, coronary artery bypass graft; BUN, blood urea nitrogen; MD, mean differences.

Table 3. Comparison of 24-hour Urine Volumes in CABG

Variable	Sig (2-tailed)	Mean	MD (95% CI)	*P* Value
Output 1	0.00	-2391.5	-901.5 (-2624.3 to-2158.6)	0.2
Output 2	0.00	449.1	1066.77 (173.58 to724.74)	0.2

Abbreviation: CABG, coronary artery bypass graft; BUN, blood urea nitrogen; MD, mean differences.

Table 4. Comparison of 24-hour Urine Volume in Terms of Renal Function (Urea, Cr)

Variable	Sig (2-tailed)	Mean	MD (95% CI)	*P* Value
BUN 1 day after CABG	0.00	2372.75-	902.3(-2605.8 to -2139.6)	0.2
Cr 1 day after CABG	0.00	-2391.41	901.54(-2624.31 to -2158.52)	0.2

Abbreviation: CABG, coronary artery bypass graft; BUN, blood urea nitrogen; Cr, creatinine; MD, mean differences.

Table 5. Comparison of Glomerular Filtration After and Before CABG in Terms of Pre-operative Age, Weight and Creatinine

Variable	Mean	Sig (2- tailed)	MD (95% CI)	*P* Value
Age	61.73			
GFR before CABG	17.19	0.00	-44.54(-69. 4 to -19.68)	0.3
GFR 1 day after CABG	5.98	0.00	-55.75(-62. 13 to -49.36)	0.4
Weight	76.21			
Cr before CABG	1.2	0.00	74.99(71.69to 78.29)	0.5
Cr 1 day after CABG	1.08	0.00	-0.27(-0.37 to - 0.17)	0.00

Abbreviation: CABG, coronary artery bypass graft; BUN, blood urea nitrogen; GFR: glomerular filtration renal; Cr, creatinine; MD, mean differences.

incidence rates after on-pump and off-pump CABG was reported, which is consistent with the results of a study by Ebadi et al (20). According to the study conducted by Pramodh et al, ARF increases length of the hospitalization in the hospital and the ICU section, which is in accord with the results of the present study (7).

Although creatinine level was higher 24 hours after operation in the cardiopulmonary bypass group, no significant difference was found between the two groups in terms of creatinine levels immediately after ICU admission and discharge. Temporary increase in serum creatinine level in the cardiopulmonary bypass group goes back to its normal level during pre- and post-discharge days and as a result, the incidence rate of renal failure remains the same in both groups based on pre-discharge creatinine level. However, the incidence rate of hemodynamic disorders seems to be lower in patients undergoing off-pump surgery and as a result, the probability of renal failure incidence may also be lower; this, however, was not found in the present study and the incidence rates of stable renal failure were the same in both groups. The comparison of glomerular filtration before and after CABG showed no statistically significant difference ($P>0.3$) which is consistent with the study by Noori Majelan and Ardekani. The comparison of glomerular filtration before and after CABG in terms of pre- and post-operative age, weight and creatinine showed a statistically significant difference. However, Noori Majelan and Ardekani found no statistically significant difference between glomerular filtration and creatinine (4).

Conclusions

This study showed that age and increase in urea and creatinine or decrease in GFR after CABG are important factors for the patients. Therefore, nurses should be adequately skilled in handling older patients with increased urea and creatinine and accurately and regularly recording the patients' intake and output during their stay in the ICU. They also need to observe the factors that may increase serum urea and creatinine such as drugs, decreased intake and remaining not per oral (NPO) prevent renal failure because it is one of the complications associated with CABG and even a slight increase in serum creatinine raises the likelihood of mortality. According to the results of this study, the type of CABG surgery that is on-pump or off-pump has no impact on the incidence rate of stable renal failure. However, age is an important factor in the increased incidence of renal failure in all of these patients. Paying attention to the patients' glomerular filtration renal (GFR) before surgery, more accurate hemodynamic monitoring during and after the surgery in older patients undergoing CABG may help reduce the rate of renal failure.

Conflict of Interests

None.

Ethical Issues

Ethics Committee of Tabriz University of Medical Sciences approved the study protocol.

Financial Support

None.

Acknowledgments

The authors would like to thank all the patients who attended this survey and all those who had collaborated in the project.

References

1. Filsoufi F, Rahmanian PB, Castillo JG, Chikwe J, Kini AS, Adams DH. Results and predictors of early and late outcome of coronary artery bypass grafting in patients with severely depressed left ventricular function. Ann Thorac Surg. 2007;84(3):808-816. doi:10.1016/j.athoracsur.2007.04.117
2. Jalali Farahani AR, Mohammadi M, Naseri S, Ghiasi S. Urine oxygen pressur measurement as an early function assessment in pationts undergoing open heart surgery. Kowsar Medical Journal. 2010;15(3):167-169.
3. MirMohammad-Sadeghi M, Fotouhi E, Beigi-Habibabadi H, Mortazavi M, Hosseini SM, Nematbakhsh M . The prevalance of Acute Kidney injury in pationts undergoing coronary artery bypass graft surgery. Jurnal of Isfahan Medical School. 2013;31(251):1405-1412.
4. Noori Majelan N, Fotouhi Ardekani E. Comparing effect of vitamin E and allopurinol in diabetic patients with renal dysfunction undergoing coronary bypass surgery. Ofogh-e-Danesh. 2008;14(3):34-44.
5. Gao FJ, Yao KP, Tsai CS, Wang KY. Predictors of health care needs in discharged patients who have undergone coronary artery bypass graft surgery. Heart Lung. 2009;38(3):182-191. doi:10.1016/j.hrtlng.2008.07.006
6. Sirvinskas E, Andrejaitiene J, Raliene L, et al. Cardiopulmonary bypass management and acute renal failure: risk factors and prognosis. Perfusion. 2008;23(6):323-327. doi:10.1177/0267659109105251
7. Pramodh K, Vani, Muralidhar K. Renal function following CABG: On-pump vs off-pump. Indian J Thorac Cardiovasc Surg. 2003;19(4):169-173. doi:10.1007/s12055-003-0012-5
8. Ryckwaert F, Boccara G, Frappier JM, Colson PH. Incidence, risk factors, and prognosis of a moderate increase in plasma creatinine early after cardiac surgery. Crit Care Med. 2002;30(7):1495-1498.
9. Massoudy P, Wagner S, Thielmann M, et al. Coronary artery bypass surgery and acute kidney injury--impact of the off-pump technique. Nephrol Dial Transplant. 2008;23(9):2853-2860. doi:10.1093/ndt/gfn153
10. Conlon PJ, Stafford-Smith M, White WD, et al. Acute renal failure following cardiac surgery. Nephrol Dial Transplant. 1999;14(5):1158-1162.
11. Hobson CE, Yavas S, Segal MS, et al. Acute kidney injury is associated with increased long-term mortality after cardiothoracic surgery. Circulation. 2009;119(18):2444-2453. doi:10.1161/circulationaha.108.800011
12. Sirvinskas E, Andrejaitiene J, Raliene L, et al. Cardiopulmonary bypass management and acute renal failure: risk factors and prognosis. Perfusion. 2008;23(6):323-327. doi:10.1177/0267659109105251
13. Suen WS, Mok CK, Chiu SW, et al. Risk factors for

development of acute renal failure (ARF) requiring dialysis in patients undergoing cardiac surgery. Angiology. 1998;49(10):789-800. doi:10.1177/000331979804900902
14. Thakar CV, Worley S, Arrigain S, Yared JP, Paganini EP. Influence of renal dysfunction on mortality after cardiac surgery: modifying effect of preoperative renal function. Kidney Int. 2005;67(3):1112-1119. doi:10.1111/j.1523-1755.2005.00177.x
15. Inoue S, Akazawa S, Nakaigawa Y, Shimizu R, Seo N. Changes in plasma total and ionized magnesium concentrations and factors affecting magnesium concentrations during cardiac surgery. J Anesth. 2004;18(3):216-219. doi:10.1007/s00540-004-0235-7
16. Wilkes NJ, Mallett SV, Peachey T, Di Salvo C, Walesby R. Correction of ionized plasma magnesium during cardiopulmonary bypass reduces the risk of postoperative cardiac arrhythmia. Anesth Analg. 2002;95(4):828-834, table of contents.
17. Silva RG, Lima GG, Laranjeira A, Costa AR, Pereira E, Rodrigues R. Risk factors, morbidity, and mortality associated with atrial fibrillation in the postoperative period of cardiac surgery. Arq Bras Cardiol. 2004;83(2):105-110; 199-104. doi:/S0066-782x2004001400002
18. Provenchere S, Plantefeve G, Hufnagel G, et al. Renal dysfunction after cardiac surgery with normothermic cardiopulmonary bypass: incidence, risk factors, and effect on clinical outcome. Anesth Analg. 2003;96(5):1258-1264, table of contents.
19. Akbari H, Nikkhah A, Alizadeh A. Evaluation of acute renal failure and its associated factors in heart surgery patients in Fatima Zahra Hospital, Sari, 2012. J Mazandaran Univ Med Sci. 2014;24(112):97-102.
20. Ebadi A, Motamedi Kalantar MH, Moradian T. Laboratory findings in patients undergoing coronary artery bypass surgery with and without cardiopulmonary bypass - lung. Yafteh. 2012;4(4):122-127. [Persian].