Original Article

Comparison of Cold Versus Warm Blood Cardioplegia in Diabetic Patients undergoing Coronary Artery Bypass Grafting on Cardiopulmonary Bypass

Muhammad Saeed Afridi, Komal Saeed Awan, Iram Alia, Syed Khalid Rasheed, Matti-u-rehman

ABSTRACT

Objective: Comparison of cold blood cardioplegia and warm blood cardioplegia in diabetic patients undergoing coronary artery bypass grafting (CABG).

Methodology: This prospective comparative study included 80 diabetic patients undergoing coronary artery bypass grafting (CABG) divided into two groups. Group I included patients with cold blood cardioplegia and group II included patients on warm blood cardioplegia. Diabetic patients of both genders with normal EF were included in this study. Data was analyzed by SPSS (Statistical Package for Social Sciences) version 20.0. A p-value <0.05 was considered significant.

Results: Use of inotropic support has shown the significant difference between two groups. Results have shown that in cold cardioplegia group, 18 patients needed no inotropic support whereas in warm cardioplegia group, only 1 patient went without support. Intra-aortic balloon pump (IABP) was used in 3 patients in each group. No mortality was found in both group.

Conclusion: Our study concluded that cold blood cardioplegia gives better myocardial protection than warm blood cardioplegia in diabetic patients undergoing CABG.

Keywords: *Cold blood cardioplegia. Warm blood cardioplegia. Cardiopulmonary bypass (CPB). Coronary artery bypass grafting (CABG).*

INTRODUCTION

Ischemic heart disease (IHD) is the main cause of morbidity and mortality around the world. Different strategies of treatment are adopted to treat IHD i.e medical treatment and surgical treatment.[1] Coronary Artery Bypass Grafting is the gold standard surgical procedure for ischemic heart disease. It is performed often on cardiopulmonary bypass by stopping the heart to provide bloodless and still field for the surgeon. Myocardial damage during surgery is one of the important complications of heart surgery. The improvement of technique of myocardial preservation has significantly contributed in cardiac surgery. However, still controversy persists regarding the use of warm versus cold cardioplegia.[2,10]

Cardioplegia stopped the heart as this solution is highly enriched with potassium which is given in coronary arteries by antegrade as well retrograde route. This solution decreases myocardial O_2 consumption.[2] Cardioplegic solution is the means by which the ischemic myocardium is protected from cell death. The fluid in which potassium is mixed can be either cold blood cardioplegia or warm blood cardioplegia. Since warm cardioplegia is more prone to an incidence of stroke and is more controversial, whereas cold blood cardioplegia gives better myocardial protection, less inotropic support and inflammatory response.[3-5]

The effect of intermittent cold blood cardioplegia (ICC) and intermittent warm blood cardioplegia (IWC) in high risk patients undergoing cardiac surgery was noted in various studies. Intermittent cold blood cardioplegia shows less myocardial damage, reduce mortality and morbidity in patients, defines superiority on IWC.[6,7] Warm blood cardioplegia can cause the high extent of endothelial injury in comparison to cold blood cardioplegia in patients undergoing coronary artery bypass grafting.[8]

Patients with LV dysfunction get more benefit after receiving cold blood and crystalloid cardioplegia. Cold cardioplegia solution gives immediate myocardial protection and quick postoperative myocardial recovery.[9-13] This study was planned to compare the effect of cold blood cardioplegia and warm blood cardioplegia in diabetic patients undergoing coronary artery bypasses grafting (CABG).

METHODOLOGY

This study was a prospective comparative study conducted in Cardiac Surgery Department, Punjab Institute of Cardiology, Lahore after approval from ethical committee. By balloting method, patients were randomly divided into two groups after inclusion criteria was fulfilled. Informed consent was obtained from the patients. Group I included diabetic patients undergoing CABG with the technique of cold blood cardioplegia and in group II diabetic patients

Sharif Medical & Dental College, Sharif Medical City. Sharif Medical City Road, Off Raiwind Road, Jati Umra, Lahore 54000, Pakistan.

Correspondence: Dr. Muhammad Saeed Afridi
Assistant Professor Department of Cardiac Surgery
Sharif Medical and Dental College, Lahore
E-mail: saeedafridi22@yahoo.com

Received: March 20, 2017; Accepted: June 5, 2017.

undergoing CABG with the technique of warm blood cardioplegia antegradely for myocardial preservation during CABG.

The pericardium was approached through a median sternotomy in both groups. Left internal mammary artery and great saphenous vein were taken and cardiopulmonary bypass was established using aortic and two stage venous cannula. After bypass procedure was completed, we have noted the need of inotropic support or inraaortic ballon pump (IABP) during weaning from CPB. After completion of surgery patients were shifted to intensive care unit, where primary and secondary endpoint was noted.

STATISTICAL ANALYSIS

The data was analyzed by SPSS (Statistical Package for Social Sciences) version 20.0. Continuous variables are presented as the mean ± standard deviation. Categorical variables were presented as frequencies, percentages and graphs. Qualitative characteristics of different groups were compared using Chi-square test and quantitative variables using t-test. A p-value <0.05 was considered significant.

RESULTS

Total 80 diabetic patients were included in this study, out of which 16.7% were females and 83.3% were males. The mean age of the patients undergoing coronary artery bypass grafting was 52.6 ± 9.46 years. In group I and group II mean age was 52.4±9.1 years and 52.6±9.4 years, respectively. Ages showed no significant difference in both cardioplegia techniques.

Regarding risk factors, hypertensive patients were 4 (10%) in group I and 7 (33%) in group II. Twenty one patients (52.5%) in group I and 14 (35%) in group II were hyperlipidemic. Nineteen (47.5%) patients in group I and 13 (32.5%) in group II were smokers. It showed no significant difference in both cardioplegia techniques. No mortality was observed in both groups. Intra-aortic balloon pump was used in 3 patients in each group. The difference noted was insignificant.

There was a significant difference in terms of ionotropic support used among both groups. In group I, 36% (18) patients weaned off from CPB without ionotropic support while in group II, only 2% (1) patient weaned off from CPB without support. In group I, no patient needed the high support whereas in group II one patient needed high support of adrenaline. Use of inotropes nor-adrenaline has shown significant differences between two groups (Table 1). No support was required in cold blood cardioplegia group, whereas, in warm blood cardioplegia group two patients required nor-adrenaline.

Results of blood parameters demonstrated that

Table 1: Inotropic support in study subjects

	Group I	Group II	p-value
Postoperative Adrenaline			
None	(18) 45%	(1) 2.5%	<0.0001
Mild	(18) 45%	(12) 30%	0.164
Moderate	(4)10%	(26) 65%	<0.001
High	(0) 0%	(1) 2.5%	<0.001
Postoperative Nor-Adrenaline			
None	(40) 100%	(38) 95%	<0.05
Mild	(0) 0%	(2) 5.0%	<0.05
Moderate	(0) 0%	(0) 0%	NA
High	(0) 0%	(0) 0%	NA

*mild= up to 10ml/hr, moderate=11-20ml/hr, high= more than 20ml/hr (of given dose)

Table 2: Postoperative blood parameters of cardioplegia groups

Variable		Day 1	Day 2	Day 3	Day 4	Day 5
Hemoglobin	Group I	10.5±0.17*	12.2±0.17	13.1±0.2*	13.9±0.1*	13.7±5.4
	Group II	10.0±0.14*	16.4±3.6	12.2±0.12*	12.9±0.13*	13.2±1.0
Blood urea	Group I	37.7±1.3	45.8±0.9	50.2±0.9	43.8±0.8	34.1±1.3
	Group II	40.4±1.14	45.1±1.3	48.9±1.2	44.9±1.4	37.3±1.4
Serum creatinine	Group I	0.7±0.04	0.7±0.03*	0.8±0.03	0.7±0.02	1.0±0.2
	Group II	0.88±0.4	1.0±0.36*	0.9±0.04	0.8±0.26	0.7±0.02
Blood Sugar Random	Group I	251±10.8*	191±10.3*	147±8.2*	126±5.6*	126±22.9
	Group II	327±12.5*	266±10.7*	196±9.01*	147±7.2*	118±5.7

*showed significant as p-value <0.05

hemoglobin was significantly lower in WBC on day 1st, 3rd and 4th post-operative. Whereas, creatinine was significantly high on day 2nd postoperative in WBC. Blood sugar levels were significantly higher in WBC throughout postoperative period (Table 2).

DISCUSSION

The present study was conducted to evaluate that which method is best for myocardial protection in diabetic patients undergoing CABG on cardiopulmonary bypass (CPB). During CABG, a stagnant and bloodless field is required for grafting that is done by infusing a fluid enriched in potassium. This fluid causes temporary cessation of the electrical activity of the heart which initiates myocardial ischemia. Over the decades, myocardial protection is an important matter for surgeons during cross clamp period. So, many interventions have been adopted to minimize the myocardial insult.[16-20]

For all types of open heart surgery including CABG cardioplegia techniques are established, so this technique is a matter of interest for surgeons. With cardioplegic technique heart is still and bloodless to manipulate for distal anastomosis especially grafts on the posterior side of the heart.[21,22]

In our results, use of inotropic support has shown significant differences between two groups. Our results have shown that in cold cardioplegia group 18 patients need no inotropic support whereas in warm cardioplegia group only 1 patient went without support. In another study, Liakopoulos and colleagues in 2010 described the effect of ICC versus IWC in high risk patients undergoing on pump cardiac surgery, in which they included 3527 patients went on pump CPB. Intermittent cold blood cardioplegia shows less myocardial damage, reduce mortality and morbidity in patients, defines superiority on IWC.[6]

Kuhn and colleagues in 2015 demonstrated the impact of cold and warm blood cardioplegia and proved that warm blood cardioplegia can cause the high extent of endothelial injury in comparison to cold blood cardioplegia but there is no major difference in clinical end points.[8]

The use of IABP in both warm and cold blood cardioplegia groups of diabetic patients still has no significant difference. Postoperative ejection fraction has shown the significant difference between two groups. In WBC group, 16 patients are with normal EF and in CBC 21 patients with normal EF. Mild and moderate EF had shown almost no significant percentages in WBC group (mild=21.2%, moderate=7.5%) and CBC group (mild=18.8%, moderate= 5.0%). In WBC group, 1 patient had shown poor EF whereas no patient had poor EF in CBC group. Similar results were shown by another study conducted by Cohen et al.[12]

No significant difference of death rate has been shown in our results which was also verified by Caputo and colleagues in 2002, who concluded that both methods were uniformly efficient and there is no difference between the mortality and morbidity in cold blood cardioplegia group in comparison with warm blood cardioplegia group.[9,11]

Another study conducted to compare cold and warm cardioplegia showed that both cold and warm cardioplegia were equally effective for myocardial

protection and are safe. Postoperative haemodynamic performance was better in patients with warm cardioplegia.[4]

CONCLUSION

Our study concluded that cold blood cardioplegia gives better myocardial protection than warm blood cardioplegia in diabetic patients undergoing CABG.

REFERENCES

1. Kaya K, Cavolli R, Telli A, Soyal MF, Aslan A, Gokaslan G, et al. Off-pump versus on-pump coronary artery bypass grafting in acute coronary syndrome: a clinical analysis. J Cardiothorac Surg. 2010 Apr 27;5:31. doi: 10.1186/1749-8090-5-31.

2. Buckberg GD, Brazier JR, Nelson RL, Goldstein SM, McConnell DH, Cooper N. Studies of the effects of hypothermia on regional myocardial blood flow and metabolism during cardiopulmonary bypass. I. The adequately perfused beating, fibrillating, and arrested heart. JThoracCardiovascSurg. 1977 Jan;73(1):87-94.

3. Zeriouh M, Heider A, Rahmanian PB, Choi Y-H, Sabashnikov A, Scherner M, et al. Six-years survival and predictors of mortality after CABG using cold vs. warm blood cardioplegia in elective and emergent settings. J Cardiothorac Surg. 2015 Dec 4;10:180. doi: 10.1186/s13019-015-0384-9.

4. Abah U, Garfjeld RP, Ishaq M, De Silva R. Is cold or warm blood cardioplegia superior for myocardial protection? Interact Cardiovasc Thorac Surg. 2012 Jun;14(6):848-55.

5. Baron O, Roussel JC, Delaroche O, Peron S, Duveau D. Prospective clinical and biological comparison of three blood cardioplegia techniques in low-risk CABG patients: better is worse than good enough. Cardiovasc Surg. 2003 Dec;11(6):489-95.

6. Liakopoulos OJ, Kuhn EW, Choi YH, Chang W, Wittwer T, Madershahian N, et al. Myocardial protection in cardiac surgery patients requiring prolonged aortic cross-clamp times: a single center evaluation of clinical outcomes comparing two blood cardioplegic strategies. JCardiovasc Surg(Torino). 2010 Dec;51(6):895-905.

7. Borowski A, Godehardt E, Paprotny G, Kurt M. Intermittent cold-blood vs. warm-blood cardioplegia–a comparative study on myocardial acidosis during coronary bypass surgery. J Cardiothorac Surg. 2013; 8(Suppl 2): P2. Published online 2013 Oct 23. doi: 10.1186/1749-8090-8-S2-P2.

8. Kuhn WE, Choi Y, Pyun J, Neef K, Liakopoulos O, Stamm C, et al. Endothelial injury associated with cold or warm blood cardioplegia during coronary artery bypass graft surgery. Biomed Res Int. 2015; 1-6. Published online 2015 May 19. doi: 10.1155/2015/256905.

9. Ibrahim MF, Refaat AA. Long-term outcome after coronary artery bypass grafting in patients with left ventricular dysfunction: does the type of cardioplegia matter? Interact Cardiovasc Thorac Surg.2008; 7 (3): 498.

10. Fan Y, Zhang AM, Xiao YB, Weng YG, Hetzer R. Warm versus cold cardioplegia for heart surgery: a meta-analysis. Eur J Cardiothorac Surg. 2010 Apr;37(4):912-9.

11. Caputo M, Modi P, Imura H, Pawade A, Parry AJ, Suleiman MS, et al. Cold blood versus cold crystalloid cardioplegia for repair of ventricular septal defects in pediatric heart surgery: a randomized controlled trial. Ann Thorac Surg. 2002 Aug;74(2):530-4.

12. Cohen Y, Raz I, Merin G, Mozes B. Comparison of factors associated with 30-day mortality after coronary artery bypass grafting in patients with versus without diabetes mellitus. Israeli Coronary Artery Bypass (ISCAB) study Consortium. Am J Cardiol. 1998 Jan 1;81(1):7-11.

13. Karaca P, Yurtseven N, Enç Y, Aksoy T, Sokullu O, Bilgen F, et al. Effects of different cardioplegic solutions on nitric oxide release from coronary vasculature in diabetic patients undergoing coronary artery bypass surgery. Anadolu Kardiyol Derg. 2006 Dec;6(4):347-51.

14. Sher-I-Murtaza M, Ali Rizvi HM, Raza Baig MA, Hamid W, Zaman H. Myocardial Protection with multiport antegrade cold blood cardioplegia and continuous controlled warm shot through vein grafts during proximal ends anastomosis in conventional coronary artery bypass graft. J Pak Med Assoc. 2016 Jan;66(1):53-8.

15. Prathanee S, Kuptanond C, Intanoo W, Wongbhudha C, Karunasumaeta C. Custodial-HTK Solution for myocardial protection in CABG patients. J Med Assoc Thai. 2015 Aug;98(7):S164-7.

16. Poncelet AJ, van Steenberghe M, Moniotte S, Detaille T, Beauloye C, Bertrand L, et al. Cardiac and neurological assessment of normothermia/warm blood cardioplegia vs hypothermia/cold crystalloid cardioplegia in pediatric cardiac surgery: insight from a prospective randomized trial. Eur J Cardiothorac Surg. 2011 Dec;40(6):1384-90. doi: 10.1016/j.ejcts.2011.03.047.

17. Epstein AJ, Polsky D, Yang F, Yang L, Groeneveld PW. Coronary revascularization trends in the United States, 2001-2008. JAMA. 2011 May 4;305(17):1769-76. doi: 10.1001/jama.2011.551.

18. Fallouh HB, Chambers DJ. Is blood versus crystalloid cardioplegia relevant? Significantly improved protection may require new cardioplegic concepts. Interact Cardiovasc Thorac Surg. 2008 Dec;7(6):1162-3. doi: 10.1510/icvts.2008.186494.

19. Venugopal V, Hausenloy DJ, Ludman A, Di Salvo C, Kolvekar S, Yap J, et al. Remote ischaemic preconditioning reduces myocardial injury in patients undergoing cardiac surgery with cold-blood cardioplegia: a randomised controlled trial. Heart. 2009 Oct;95(19):1567-71. doi: 10.1136/hrt.2008.155770.

20. Venugopal V, Ludman A, Yellon DM, Hausenloy DJ. 'Conditioning' the heart during surgery. Eur J Cardiothorac Surg. 2009; 35 (6): 977-87.

21. Savolainen H, Berdat P, Nand P, Ullal R, Long G, Carrel T. Warm versus cold heart surgery in diabetics. The Cardiology.2006; 2 (1): 1-6.

22. Harling L, Moscarelli M, Kidher E, Fattouch K, Ashrafian H, Athanasiou T. The effect of off-pump coronary artery bypass on mortality after acute coronary syndrome: a meta-analysis. Int J Cardiol. 2013 Nov 20;169(5):339-48.