Antegrade-Retrograde Cold Blood Cardioplegia versus Antegrade Cardioplegia on Myocardial Function after Coronary Artery Bypass Surgery

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Abstract

Objective- Antegrade and retrograde infusions of cardioplegia may provide more homogenous distribution of cardioplegia especially in cases of coronary arteries occlusion. The purpose of this study was to compare intermittent antegrade-retrograde and antegrade cardioplegia on myocardial function following CABG.

Methods- One hundred ninety six patients in two groups were studied on a non randomized basis in order to compare their operational results after using the two methods. In the antegrade-retrograde method (group A), 15 ml/kg of cold blood infusion of antegrade cardioplegia was followed by 8 ml/kg of retrograde infusion. The antegrade-retrograde route of infusion was repeated every 20 minutes (10 ml/kg and 8 ml/kg respectively). In the antegrade group (group B), 15 ml/kg of cold blood cardioplegia was followed by 10 ml/kg in repeated doses every 20 minutes. Important variables of myocardial performance were compared in the two groups.

Results- The two groups had similar preoperative characteristics (age, sex, body mass index, severity of coronary artery disease and ejection fraction). Postoperative ejection fraction either did not change or increased 5 to 15% in 51.1% of group A. Inotropic agent was needed in 8.2% of this group, while post operative ejection fraction reduced 5 to 20% in 76.9% of group B and inotropic agent was needed in 24.5% of this group ($P<0.001$ and $P<0.002$ respectively). The mortality rate was more in the control group, but was not statistically significant. The ventilatory support time was longer in the control group ($P<0.01$).

Conclusion- In view of our findings, we conclude that there is a significantly better postoperative myocardial performance following antegrade-retrograde cardioplegia and we recommend it as a routine method for myocardial protection in coronary artery bypass graft. **(*Iranian Heart Journal.* 2002, 2003; 3(2&3): 19-23)**

Keyword: heart arrest induced method < coronary artery bypass < heart surgery

Optimal myocardial protection relies on adequate delivery of the cardioplegic solution to all parts of the heart, and critical stenosis, especially total occlusion in coronary arteries limit this delivery by antegrade route. This is particularly important when the left internal mammary artery is anastomosed to the occluded left anterior descending coronary artery with no vein grafts through which cardioplegia could be delivered to the septum and the anterior wall of the myocardium. Retrograde cardioplegic solution delivery provides a sufficient flow to the myocardium beyond the occlusion of the coronary artery to maintain a near normal cellular energy state. This is especially correct in the area of the left anterior

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descending artery (LAD) distribution.[1,2] On the other hand, as a large percentage of retroperfusate is shunted to the arteriosinosoidal system and the bessian veins into the ventricular cavities as a nutritive flow, the distribution of retrograde cardioplegia is inadequate for the protection of the right ventricle and posterior left ventricles.[3,4] It is suggested that a combination of antegrade and retrograde infusions of cardioplegia improves its distribution to all parts of the myocardium. Several experimental studies have demonstrated that antegrade-retrograde infusions of cardioplegia improve the myocardial protection in coronary artery bypass graft (CABG),[5,6] but controversy over its routine use still exists.[7,8,9] The purpose of this study was to compare the effect of antegrade-retrograde infusions of cold blood cardioplegia versus antegrade cold blood cardioplegia on myocardial function after coronary artery bypass surgery.

Material & Methods

We conducted a prospective non-randomized trial to study the effect of antegrade-retrograde cardioplegia on myocardial function during coronary artery bypass surgery. A pilot study on 20 patients utilized this method and compared the important results following operations with antegrade cardioplegic protection, which was the routine method before, and consequently determined the sample volume as 98 cases. The patients operated on consequently for 2 or more coronary artery grafts from October 2000 to August 2001(group A) were the cases, and the data of the same number of patients who were consequently operated on prior to that time with the routine method of antegrade cardioplegic infusion were regarded as the control group (group B). Changes in left ventricular ejection fraction before and after surgery, need for inotropes (Adrenaline, Dobutamin and Dopamin), need for intra aortic balloon pump support, length of intensive care (ICU) stays, early (30 day) mortality, ventilatory support time, enzymatic changes before and after surgery (CK, Alkalin phosphatase, LDH, SGOT, SGPT), cardiopulmonary bypass and crossclamping time of the aorta were variables compared in the two groups.

The same cardiac surgeon did all the operations. Single vessel disease was the only exclusion criterion. The research committee of Kermanshah University of Medical Sciences approved this study and informed consent was obtained from all the patients.

Operative technique:

Median sternotomy was done in all the patients. Total cardiopulmonary bypass (CPB) was established using a single two – stage venous cannula and ascending aortic cannulation, moderate systemic hypothermia (rectal temperature, 28°C) and hemodilution during CPB. The pump flow was between 2.0 and 2.5 L/min per square meter and the mean arterial pressure was kept between 50 to 80 mmHg during CPB.

After the establishment of CPB, a coronary sinus catheter with a manually inflated balloon (DLP catheter) was inserted by closed transatrial cannulation method. Purse- string sutures and the catheter insertion point were at the mid portion of the anterior right atrial wall near the atrioventricular groove. The catheter was placed by the aid of the point and middle fingers of the right hand and was introduced to the mid portion of the coronary sinus. The balloon of the catheter was inflated with 2-3 ml of isotonic solution. After cardiac arrest was achieved with the initial antegrade infusion of cold blood cardioplegia (15 ml/kg, at 200-230 ml/min), the aortic root was vented and the retrograde infusion of cold blood cardioplegic solution (8 ml/kg, at 140-160 ml/min) was done through a retrograde catheter. Cold blood cardioplegia was a

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mixture of 3 parts of 5℃ St.-Thomas cardioplegic solution with one part of 28°C pump blood. Deairing of the retrograde catheter was possible during the antegrade cardioplegic infusion. Free drainage of cardioplegic solution through the retrograde catheter during the antegrade infusion of cardioplegia was a test for the correct position of the catheter as well.

We did not use a manometer for pressure control of the retrograde infusion. Antegrade and retrograde infusions of cardioplegia were repeated every 20-minutes during the aortic cross clamp. Catheter insertion by this method was not possible in two patients. In these cases, the retrograde infusion of cardioplegic was done by conversion to two venous cannula and direct infusion in the coronary sinus. It was possible to switch the direction of the infusion and venting the aortic root during retro perfusion by using two 3- way stopcocks and the connection of the proximal 3- way stopcock to the retrograde catheter and the distal one to the antegrade catheter. Distal anastomoses of vein grafts were done during the cross clamp period and the left internal mammary artery was anastomosed to the left anterior descending coronary artery as the last distal graft in all patients. The vein graft to the right coronary artery was always anastomosed first for the purpose of cardioplegia infusion via the graft. All proximal anastomoses were performed after removal of the aortic cross clamp.

All of the technical methods of surgery in the two groups were the same except the retrograde infusion of cardioplegia in group A. Echocardiography was performed in all the patients the day before surgery and on the 6th postoperative day by the same cardiologist. Measurements of LDH, CK, SGOT, SGPT and alkaline phosphatase were done before surgery and three times after it (on the first, second and third postoperative days). The mean value of these measurements was compared to the preoperative range of these substances.

Early mortality of the patients was regarded as any mortality during the first month after surgery. A need for inotropic agents was regarded as the use of more than 5 μg /kg /min of dobutamin or dopamin or more than 1μg/min of adrenaline infusion for more than one hour to establish the normal hemodynamic of the patients. Statistical analyses were performed using the statistical package program. The paired student T-test and X^2 test were used to compare the clinical variables between the two groups. And the multiple analysis of variance was used to test time dependent changes in the measured variables. Significant was assumed when the P value was less than 0.05.

Results

Ninety eight patients were studied in each group. The two groups had similar preoperative characteristics with no differences in age, sex, body mass index, severity of coronary artery disease and preoperative ejection fraction of the left ventricular and the time of the aortic cross clamp, but the perfusion time was longer in group A (P< 0.01) (Table I).

Table I: Clinical characteristics of the patients.

Variable	Antegrade-retrograde group A (n=98)	Antegrade group B (n=98)
Age	55.7 ± 9.1	54.5 ± 8.8
Sex: Male	75.5%	69.4%
Female	24.5%	30.6%
Weight (kg)	73.59 ± 11.41	73.61 ± 10.74
Height (cm)	166.51 ± 9.21	163.11 ± 8.35
2 bypass grafts	26.5%	32.6%
3 bypass grafts	59.2%	57.1%
4 or more bypass grafts	14.3%	10.2%
Perfusion time (minute)	100.08 ± 23.86	91.90 ± 22.73
Clamp time of the aorta (minute)	55.59 ± 11.99	52.91 ± 12.93
Volume of cardioplegic solution	3102.57 ± 677.74	2306.82 ± 671.1

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The mortality rate in the two groups was different (2 in group B versus 1 in group A), but was not statistically significant. Important and significant differences were variations of the left ventricular ejection fraction (EF) before and after surgery in the two groups. In 33.7% of group A, EF was the same before and after surgery and in 17.4%, EF increased 5-15%. In contrast, EF reduced 5- 20% in 76.9% of group B (P<0.001) (Figure 1).

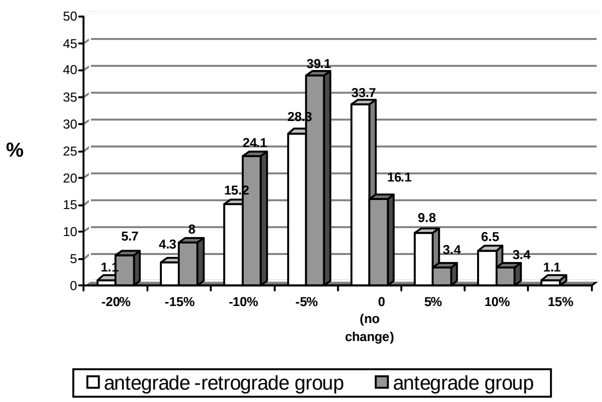

Fig. 1. Variations of EF before and after operation in two groups.

Although the perfusion time was longer in group A, the need for inotropic agent was more in group B (P<0.002). The length of intensive care and enzymatic changes before and after surgery were not different before and after surgery in the two groups, except in alkaline phosphatase, which decreased significantly in group A after surgery (P<0.001). The time of ventilatory support time was longer in group B (P< 0.01) (Table II). The need for IABP was the same in both groups.

Table II: Postoperative characteristic of patients.

Variable	Group A(n=107)	Group B (n=107)
Preop EF	50.00 % ± 7.94%	49.73% ± 8.53%
Postop EF	47.50% ± 5.95%	42.95% ± 8.42%
ICU stay (day)	3.38 ± 4.6	3.59 ± 3.8
Ventilatory support (h)	15.68 ± 15.27	22.03 ± 20.69
Inotropic Support	8.2%	24.5%
IABP support	4.1%	4.2%
Mortality	1%	2%
Mean rise in LDH	171.53 ± 171	214.01 ± 202
Mean rise in CPK	488.29 ± 456	523.79 ± 493
Mean decrease in alkaline phosphatase	53.19 ± 43.09	18.58 ± 59.58
SGPT	2.97 ± 36.29	1.37 ± 21.50
SGOT	19.09 ± 36.06	22.79 ± 27.02

Discussion

This study indicates that the use of antegrade-retrograde cardioplegia is more effective for myocardial protection than antegrade cardioplegia in CABG. As the results of the study indicated, EF of the left ventricle after CABG with antegrade-retrograde either did not change or was increased significantly. On the other hand, the need for inotropic agent in control group was three times that of the antegrade-retrograde groups. The time of ventilatory support was different in both groups. All of the above- mentioned are clinical indices for the postoperative ventricular performance. The results of this study support the investigations of Tian and his colleagues. They carried out an experimental study on isolated pig's hearts and compared the results of antegrade-retrograde versus antegrade cardioplegia on their hearts after the occlusion of the anterior descending artery. They concluded that simultaneous antegrade-retrograde cardioplegia significantly improved myocardial perfusion in jeopardized areas of the myocardium. Lee and his colleagues in another study on explanted heart compared the effect of antegrade-retrograde cardioplegic delivery and concluded that a sequential infusion of antegrade-retrograde cardioplegia has a better effect in comparison with all other routes of cardioplegic infusion. On the other hand, Ericsson et al. indicated that the use of simultaneous antegrade-retrograde cardioplegia does not change the global left ventricular function in comparison with the antegrade route. Cernainau et al. indicated that the route of cardioplegia administration is not a determinant of the clinical outcome. In another study, Jegarden et al. showed that there is no difference in the outcome of antegrade or antegrade-retrograde cardioplegic infusions.

Closed transatrial catheter insertion is a simple and safe method without significant complications. It is possible to insert the catheter from any part of the right atrial wall, but mid portion and anterior to the passage of the venous catheter is more suitable. The important technical issue for catheter insertion is to keep it at posterior surface of the right atrial wall while pushing it forward with the aid of the point finger and middle finger of the right hand. In unsuccessful insertion of the catheter and severe ventricular hypertrophy, it is possible to postpone retrograde catheter insertion after cardiac arrest. The correct position of the catheter may be evaluated by the distension of the cardiac veins (especially the veins of the left ventricle), palpation of the catheter tip and venting of the cardioplegic solution via the aortic root. As the pilot study showed a significant increase in ventricular performance after antegrade-retrograde cardioplegia, we selected our control group from the patients who had been operated on before. This was the only limitation of the study, which limited the variables. To summarize, this study demonstrated the effect of antegrade-retrograde cardioplegia on myocardial function after CABG. We believe that this is a convenient method for myocardial protection especially in cases of severe stenosis in the left main coronary artery, three vessel disease and the occlusion of the left anterior descending artery. We recommend it as a method of choice in coronary artery bypass surgery.

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