Original Article

Does Combined Antegrade and Retrograde Cardioplegia Offer Better Myocardial Protection in Patients Undergoing Valve Surgery?

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Abstract

Objective: Myocardial ischemia is metabolic phenomenon that occurs in patients undergoing open heart surgery like Coronary Artery Bypass Grafting and Valve surgery due to interruption of coronary blood flow during aortic cross-clamp and reperfusion after aortic cross-clamp release. This myocardial damage leads to hemodynamic instability, arrhythmias, high dose of inotropes, difficulty in weaning of CPB and chance of intra aortic balloon pump use. This study examined the efficacy and safety of Retrograde with Antegrade Cardioplegia comparison with Antegrade approach in valve surgery.

Methods: The effects of Retrograde with Antegrade (ACP+RCP) and Antegrade (ACP) delivery of Cardioplegia were evaluated and compared in 30 patients. The patients were randomly separated into 2 groups, Group -1-ACP+RCP (n=15), Group -2-ACP (n=15). Cardiac energy metabolism was monitored by evaluation of coronary sinus lactate levels. Blood samples were taken from Coronary Sinus during soon after cannulation, before institution of CPB and on removal of aortic cross-clamp.

Results: There was an increase of the coronary sinus lactate levels during aortic cross-clamp period in both groups. The rise in lactate levels was lower in the group-1 than group-2.

Conclusion: Based on this study we conclude that combined antegrade and retrograde cardioplegia provides good myocardial preservation and may provide superior preservation in case of long clamp times and extensive surgeries.

Key Words: Cardiopulmonary bypass, Antegrade cardioplegia, Retrograde cardioplegia, Lactate, Myocardium.

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Introduction

Myocardial ischemia is a metabolic phenomenon that occurs in patients undergoing open heart surgery like coronary artery bypass grafting and valve surgeries[1]. This happens due to stress response to Cardiopulmonary bypass (CPB) and interruption of coronary blood flow during aortic cross clamp and reperfusion after aortic cross clamp release[1].

During cardiac surgery, myocardial damage is cumulative. Cardiac surgery at some point will induce ischemia to myocardium. Each patient's myocardium will respond differently and lead to immediate or delayed poor outcome. This myocardial damage leads to hemodynamic instability, arrhythmias, high dose of inotropes, difficulty in weaning of CPB and chance of intra- aortic balloon pump use.

Hyperlactatemia occurs in anaerobic conditions where induced glycolysis occurs with the stimulation of exo and endogenous catecholamines. Once anaerobic conditions prevail, pyruate a substrate for oxidative phosporylation cannot be utilized. Therefore the level increases and it is diverted to the formation of lactate. Normal lactate to pyruvate ratio i.e. LP ratio is 10:1 which also occurs in the cases of increased metabolism, but increases in LP ratio >10:1 occurs in tissue hypoxia alone[1].

Cardiac metabolism is monitored by evaluation of coronary sinus (CS) lactate concentration and we hypothesized that myocardial lactate levels can be used as markers of myocardial dysfunction during and after cardiopulmonary bypass. We sought to evaluate efficacy and safety of Antegrade with Retrograde (RCP) in comparison with only Antegrade (ACP) approach in valve surgery.

Materials and Methods

This clinical observational study was conducted in Department of Cardio-thoracic surgery, Chettinad Health City, Chennai. Thirty patients who underwent elective valve surgery with CPB were included in this study (Table-1).

RCP and ACP delivery of cardioplegia were evaluated and compared in 30 patients, and randomly separated in 2 groups, Group -1-ACP+RCP (n=15), Group -2- ACP (n=15).

Patients with neurological dysfunction, hemodynamic instability, coagulopathy, aneurysm, congestive heart failure, redo surgery and emergency surgeries were excluded from this study.

Operation Technique

All patients underwent valve surgery with a standard CPB protocol under moderate hypothermia at 30-32 degree Celsius. Pump flow rate and perfusion pressure were maintained at 2.2-2.6 l/min/m^2 and 50-80 mmHg, respectively. Alpha stat-strategy was used for blood gas management and blood sugar was maintained between 100 and 200 mg/dl during CPB. A hematocrit of 18-27% and mixed venous oxygen saturation of 70-75% was maintained.

Myocardial protection was achieved with intermittent blood cardioplegia St Thomas solution, 4:1, (4 parts of oxygenated blood and one part of crystalloid solution). Cardioplegia (CP) was delivered through Spictra myocardial protection system, repeated at 20-25 min intervals. CP solution was cooled and maintained at 20°C - 25°C. In both groups cardiac arrest was achieved with an Antegrade infusion into aortic root at pressure of 80-100 mmHg with HK (high concentrated potassium 20mEq/l). After initial dose of Antegrade cardioplegia infusion, the aortic root was vented and retrograde cardioplegia delivery with LK (low concentrated potassium 10mEq/l) was infused into the coronary sinus cannula (DLP manual inflating cuff 15 Fr, Medtronic, Inc. Minneapolis, MIN, USA). Retrograde cardioplegia delivery pressure was monitored by a separate monitoring line and was maintained between 35-45 mmHg.

Blood samples were collected from coronary sinus (CS) through Retrograde CP cannula[2] (Fig. 1) and myocardial lactate levels were measured by commercial gas analyzer (ABL 800 basic).

Sampling Methods

1. Soon after cannulation, before institution of cardio pulmonary bypass.
2. On removal of aortic cross clamp

The intraoperative variable records included CPB time and aortic cross clamp time. The postoperative variables observed included post-CPB need for inotropes, duration of mechanical ventilation, inotrope usage and ICU stay.

Statistical Methods

Statistical analysis was performed with Social Science Statistics (SSS). Descriptive analysis and paired t-test were used for comparison between the groups. A p-value less than 0.05 was considered statistically significant. Data is presented as mean ± standard deviation where appropriate.

Results

Patients were randomly divided into 2 groups Group-1 ACP+ RCP and Group-2 ACP. Patient characteristics were comparable in both groups (Table-2). CPB time , aortic cross clamp time was significantly higher in RCP group but there was no difference in myocardial lactate levels in both groups (Table 3) .Duration of mechanical ventilation and length of ICU stay were similar in both groups (Table 3) .

Coronary sinus lactate levels during cross clamp period were high in both groups, comparatively. Group-1 lactate levels were lesser than Group-2. Differences in coronary sinus lactate levels were not significant (Table 4).

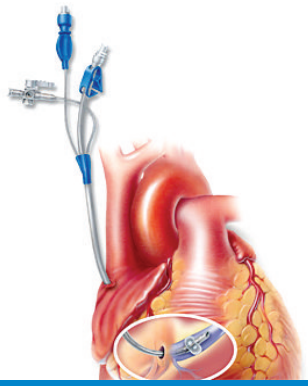

Fig 1 - Retrograde cardioplegia cannula

Table 1 - Operating Procedures

Valve Procedures	Group-1	Group-2
MV repair	1	2
MVR	5	8
AVR	3	0
DVR	5	4
MVR+ASD	0	1
OMV	1	0

Table 2 - Patient Demographics

Patient Demographics	Group-1(n=15)	Group-2(n=15)	p-value
Age	46.8±13.42	41.4±12.98	0.23
Age>60	2	0	0.16
Sex(M/F)	11/4	5/10	-
NYHA(II/III/IV)	2/9/4	1/10/4	0.77
Single valve	10	11	0.33
Double valve	5	4	0.5
LV Function <60%	3	5	0.33
PA Pressure>60%	2	1	0.33

p value <0.05 significant

Table 3 - Operative and Post Operative Variables

Operative and Post Operative variables	Group-1(n=15)	Group-2(n=15)	p-value
CPB time	74.33±26.52	58.4±18.98	0.068
X-clamp time	53.93±12.89	41.86±15.25	0.02
Mechanical ventilation(minutes)	172±48.43	183.4±34.64	0.30
ICU stay(Hours)	40.6±4.41	40.4±4.29	0.91
Ventilation > 24 Hrs	0	0	-
Inotropes > 24Hrs	2	1	0.33

Table 4 - Coronary Sinus Lactate Levels

Coronary Sinus Lactate	Group-1	Group-2	p-value
Pre-bypass	0.853	1.2	0.16
Post clamp	2.78	3.48	0.49

p value <0.05 significant

Discussion

Improvements in myocardial protection have contributed to improved results after cardiac surgeries. Better myocardial protection will decrease the morbidity and mortality[2]. Optimal myocardial protection requires uniform delivery of cardioplegic solution throughout the heart[3]. The infusion of cardioplegia solution through the aortic root is a common delivery method used by the majority of cardiac surgeons. This method produces rapid diastolic arrest and good preservation of myocardial function, but in patients with aortic insufficiency and during LA retraction this approach can result in uneven and inadequate distribution of cardioplegia solution to the myocardium. This limitation of antegrade cardioplegia can be overcome by using of coronary sinus retrograde cardioplegia[3]. Retrograde cardioplegia has several advantages including. 1. Exclusion of need for aortotomy and coronary ostial cannulation in patients with minimal aortic insufficiency. 2.Homogenous distribution of cardioplegia. 3. Avoidance of direct coronary cannulation and possible late ostial stenosis and uneven cooling of myocardium[4]. Disadvantages of retrograde cardioplegia include possible barotrauma, chances of coronary sinus rupture, myocardial oedema and inadequate right ventricular preservation[3]. Generally retrograde cardioplegia administration requires more time to deliver same amount of Antegrade CP solution, because of lower flow rates(100-200 ml/min) and pressures (35-45 mmHg) to prevent myocardial oedema and coronary sinus injury[3]. Group-1 received first dose of cardioplegia solution through Antegrade route, after achieving cardiac arrest with initial Antegrade infusion, the aortic root was vented and Retrograde cardioplegia was delivered through coronary sinus cannula.

Loop and associates, compared Antegrade and combined Antegrade +Retrograde blood cardioplegia[5]. They found that combined group showed decrease in the levels of morbidity, mortality and cost, comparatively more in antegrade cardioplegia alone[5]. Bhayana et al.. reported the results of combined delivery and antegrade alone[6]. The results suggested the antegrade cardiac arrest followed by retrograde infusion may be responsible for more rapid recovery of left ventricular stroke work index and may provide superior myocardial protection. Diehl's group evaluated and found that the group that received combined delivery had improvements in radionuclide derived left ventricular ejection fraction, and overall myocardial performance, mortality were unchanged in both groups[7]. The sampling of coronary sinus blood via cannula in coronary sinus is a simple, cheap, easy technique and can be performed routinely. Myocardial lactate levels may be effective in predicting post operative needs for inotropes, post operative myocardial dysfunction, duration of post operative ventilation and ICU stay. Retrograde cardioplegia in combination with Antegrade cardioplegia has been demonstrated to be an effective and safe technique for myocardial preservation; clinical outcomes does not appear to be affected by the route of cardioplegia administration[8,9].

Conclusion

We conclude that combined antegrade and retrograde cardioplegia provides good myocardial preservation and may provide superior preservation in case of long clamp times and extensive surgeries. Clinical benefit may become more apparent with larger number of patients.

Authors declare no conflict of interest.

References

1) PM Kapoor. Changes in myocardial lactate, pyruvate and lactate-pyruvate ratio during cardiopulmonary bypass for elective adult cardiac surgery: early indicator of morbidity. J Anaesthesiol Clin Pharmacol. 2011 Apr; 27(2):225-32. doi: 10.4103/0970-9185.81819.

2) Toshizumi Shirai. Antegrade and Retrograde cardioplegia: alternate or simultaneous? J Thorac Cardiovasc Surg. 1996 Sep; 112(3):787-96.

3) Aurel Cernaianu. Comparison of Antegrade with Antegrade + Retrograde cold blood cardioplegia for myocardial revascularization. Tex Heart Inst J 1996; 23(1):9-14.

4) Gerald D Buckberg. Antegrade cardioplegia, Retrograde cardioplegia, or both ? Ann Thorac Surg June 1989; 45:589-90.

5) Loop FD Higgins. Myocardial protection during cardiac operations. Decreased morbidity and lower cost with blood cardioplegia and coronary sinus perfusion. J Thorac Cardiovasc Surg. 1992;104: 608-18.

6) Bhayana JN. Combined Antegrade/Retrograde cardioplegia for myocardial protection: a clinical trial. J Thoracic Cardiovasc Surg 1989; 98:956-60.

7) Diehl J, Eichhorn EJ, Konstam, MA et al. Efficacy of retrograde coronary sinus cardioplegia in patients undergoing myocardial revascularization. Ann Thorac Surg 1988;45:595-602.

8) Kit V Arom. Evaluation of 7000+ patients with two different routes of cardioplegia. Ann Thorac Surg 1997;63:1619-24.

9) Claudio G Sobrosa. Myocardial metabolism after hypothermic Retrograde continuos blood cardioplegia with Antegrade warm cardioplegia, Braz J Cardiovasc Surg 2005;20(4):416-422.