

Effects of single antegrade hot shot in comparison with no hot shot administration during coronary artery bypass grafting

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Original Article

Abstract

BACKGROUND: Superior results will be achieved from cardiac surgery by minimizing the effect of ischemia/reperfusion injury during cross-clamping of the aorta. Different cardioplegia solutions have been introduced, but the optimum one is still ambiguous. The aim of this study is to determine the effect of single antegrade hot shot terminal warm blood cardioplegia (TWBC) on patients who had undergone coronary artery bypass grafting (CABG).

METHODS: In total, 2488 patients who had CABG surgery in Sina Hospital, Isfahan, Iran, from 2003 to 2011 were enrolled in this case-control study. They were divided into two groups, those who received cold cardioplegia only and those who received a hot shot following cold cardioplegia. Demographics, and clinical data, such as; premature atrial contraction (PAC) arrhythmia, diabetes treatment, and left ventricular ejection fraction (EF), were collected and logistic regression analysis was used to analyze the data.

RESULTS: There were significant differences found between subjects receiving antegrade hot shot based on direct current (DC) shocks, with regard to; female, EF levels, diabetes treatment ($P < 0.050$). Those who did not receive the hot shot and were not diabetic received more DC shock ($P = 0.019$). The prevalence of subjects who did not need DC shock was significantly higher among male subjects who had good EF and acceptable diabetic treatment. Multiple logistic regression showed that PAC arrhythmia did not have a significant effect on receiving DC shock during CABG [0.84 (0.25, 2.85), ($P = 0.780$)]. Having poor EF increased the risk of receiving DC shock among subjects by 2.81 [(1.69, 4.69), ($P \leq 0.001$)] ($P < 0.001$). Among the diabetic subjects, receiving insulin decreased the risk of receiving DC shock by 0.54 (0.29, 0.98) ($P = 0.042$).

CONCLUSION: It was concluded that single antegrade hot shot following cold cardioplegia was not particularly effective in the CABG group. TWBC will decrease the need for DC shock.

Keywords: Coronary Artery Bypass, Heart Arrest, Induced, Stroke, Mortality, Oxidative Stress, Reperfusion Injury

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Introduction

Since the coronary artery bypass grafting (CABG) procedure was introduced, ischemia/reperfusion (I/R) injury has become one of the most challenging problems in modern cardiac surgery. Hence, numerous solutions and techniques have been introduced to preserve the myocardium during this type of surgery.¹⁻⁴

Cold cardioplegia reduces the oxygen demands of myocardial cells by keeping the heart in an arrested state.⁵ As a consequence, the saved energy results in greater preservation of the heart and less reperfusion injury.⁶ Terminal warm blood

cardioplegia (TWBC) has proved to be effective in reducing I/R injury.⁵⁻⁷ The mechanisms which are responsible for myocardial protection using (TWBC) remain uncertain.⁸ In addition, TWBC has a significant impact in decreasing the incidence of I/R injuries, especially during coronary artery bypass surgery.⁹ There have been a number of studies conducted on patients undergoing coronary artery bypass graft using widely differing cardioplegia techniques, but there are fewer studies that have focused on hot shot administration during CABG and its clinical impact.^{8,10,11}

The aim of this study was to compare the effect

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of intermittent antegrade cold blood cardioplegia with or without TWBC (hot shot) on different clinical indicators in patients undergoing CABG.

Materials and Methods

A total of 2488 patients who underwent cardiac surgery in Sina Hospital, Isfahan, Iran, between 2003 and 2011, were enrolled in this study. Those patients who received warm blood cardioplegia or underwent reoperation were excluded. Patients were divided into two groups, those who only received intermittent cold blood cardioplegia (Group A, 925 patients) and those who were given intermittent cold blood cardioplegia, plus TWBC (hot shot) (Group B, 1563 patients). The research protocol was approved by the Ethics Committee of Isfahan University of Medical Sciences. All participants gave their written informed consent.

All of the surgeries were carried out by one surgeon, using the same surgical technique and devices. All of the patients were operated on with a median sternotomy. The left internal mammary artery (LIMA), saphenous vein, and radial artery were harvested simultaneously. Next, heparin 3 mg/kg was administered, and subsequently, cardiopulmonary bypass was established. The core body temperature was reduced to 34 °C (mild hypothermia). During the next stage, cardiac arrest was induced with antegrade cardioplegia through the ascending aorta via an inserted cannula. The radial artery was anastomosed to the arteries with more than 90% stenosis, in order to prevent competitive flow, which can compromise graft flow through the radial artery. Next, a saphenous vein graft was applied to the arteries based on angiographic findings. Then, the LIMA was anastomosed to the left anterior descending artery. After each distal anastomosis, 200-300 cc antegrade warm blood cardioplegia (hot shot) was administered randomly.

All of the patients received intermittent cold cardioplegia (1:8).

Data were gathered from Sina's Hospital electronic database, which is based on European Association of Cardiothoracic Surgeons' database. The technique of the surgeries and devices, which were used during cardiac surgery to all of the patients were the same. All statistics were carried out by SPSS software for Windows (version 16.0, SPSS Inc., Chicago, IL, USA). Data were shown as frequency (%) (or mean \pm standard deviation where appropriate). For comparing qualitative variables

between groups chi-square test (or Fisher exact test where appropriate) and for comparing quantitative variables independent sample t-test used. Multiple logistic regressions were used to determine multiple effects. $P < 0.050$ considered to be statistically significant. Variables included: sex, intra-aortic balloon pump post-operative, arrhythmia of premature atrial contraction (PAC), diabetes treatment, and hospital stay. Ejection fraction (EF) category defined as good ($> 50\%$), fair (30-50%) and poor ($< 30\%$).¹² The arrhythmias that recorded in this study are after weaning of cardiopulmonary bypass.

Results

In this study, a total of 2488 patients were selected (693 males and 1795 females). Mean length of the patients' hospital stay for those who received direct current (DC) shock was 7.81 ± 3.20 and for those who did not (7.92 ± 4.77). Overall, 1.1% had PAC arrhythmia. In total, 62.8% of the patients received antegrade hot shot). Table 1 shows the demographic characteristics of subjects who received an antegrade hot shot in compared with no DC shock.

There were significant differences between receiving DC shock based on hot shot with regard to: sex, EF category, diabetes treatment ($P < 0.050$). The non-diabetic patients who received hot shot got less DC shock ($P = 0.019$). In Group B, female subjects and diabetic patients with oral agents got less DC shock. Subjects with good EF level received less DC shock in Group B ($P = 0.003$) (Table 1). Table 2 shows the effect of antegrade hotshot on dc shock within group of peri and post-CABG complications. In Group B, those who experienced PAC and atrial fibrillation the need for DC shock cardioversion were less. Multiple logistic regression showed that receiving a hot shot in subjects who had PAC arrhythmia had no significant effect on DC shock during CABG [0.84 (0.25-2.85) $P = 0.780$]. Prevalence of other arrhythmias was few in cases. Multiple logistic regression showed that having poor EF level increased the risk of receiving DC shock among subjects by 2.81 (1.69, 4.69) ($P < 0.001$) (Table 3). In this regard, using antegrade hotshot decreased the chance of getting DC shock by 0.65 (0.51, 0.84) ($P = 0.001$). Among the diabetic subjects, receiving insulin decreased the risk of DC shock by 0.54 (0.29, 0.98) ($P = 0.042$). In Group B the mean length of hospital stay in those who received DC shock was not statistically significant (0.775).

Table 1. Effect of antegrade hot shot on direct current (DC) shock within group of different demographic characteristics

Characteristics	Ante grade hot shot	DC-shock	P
Sex			
Male	Yes	32 (9.1)	0.491
	No	27 (10.8)	
Female	Yes	128 (11)	0.001
	No	104 (16.4)	
EF category			
Poor	Yes	15 (22.4)	0.460
	No	8 (29.6)	
Fair	Yes	79 (11.6)	0.198
	No	58 (14.3)	
Good	Yes	69 (8.5)	0.003
	No	67 (13.6)	
Diabetes treat			
Oral alone	Yes	29 (7.5)	0.048
	No	28 (12.3)	
Diet	Yes	10 (16.7)	0.717
	No	5 (13.9)	
Insulin	Yes	9 (7.1)	0.975
	No	4 (7.3)	
None	Yes	116 (11.7)	0.019
	No	96 (15.9)	

EF: Ejection fraction; DC: Direct current

Table 2. Effect of antegrade hot shot on direct current (DC) shock within group of peri and post coronary artery bypass grafting (CABG) complications

Arrhythmia	Ante grade hot shot	DC-shock	P
PAC arrhythmia			
No	Have	55 (10.0)	0.002
	Not have	150 (15.6)	
Yes	Have	1 (25.0)	> 0.999
	Not have	3 (17.6)	
AF arrhythmia			
No	Have	52 (10.3)	0.009
	Not have	131 (15.2)	
Yes	Have	4 (8.7)	0.117
	Not have	22(18.6)	

DC: Direct current; PAC: Paroxysmal atrial contracture; AF: Atrial fibrillation

Table 3. Multiple logistic regressions for effect of characteristics on no need to direct current (DC) shock

Characteristics	OR (95.0% CI)	P
Sex (female)	1.21 (0.89, 1.66)	0.226
PAC arrhythmia (yes)	0.84 (0.25, 2.85)	0.780
EF category		
Poor	2.81 (1.69, 4.69)	< 0.001
Fair	1.22 (0.94, 1.58)	0.136
Good (ref)	1	-
Diabetes treat		
Oral alone	0.69 (0.51, 0.96)	0.026
Diet	1.24 (0.69, 2.21)	0.465
Insulin	0.54 (0.29, 0.98)	0.042
None (ref)	1	-
Hospital stay	1.21 (0.89, 1.66)	0.226
Ante grade hot shot	0.65 (0.51, 0.84)	0.001

Values are multiple adjusted by each other; PAC: Paroxysmal atrial contracture; OR: Odd ratio; CI: Confidence interval; EF: Ejection fraction

Discussion

Our results showed that a single antegrade hot shot following cold cardioplegia is not significantly effective in the CABG group. TWBC will decrease the chance of receiving Dc shock by 0.35 [0.65 (0.51, 0.84), $P = 0.001$]. Good EF ($> 50\%$) shows that the heart muscle is strong. Obviously those patients with good EF required less DC shock. Undoubtedly those with pre-operative sinus rhythm will need less DC shock. Diabetic subjects who controlled their diabetes mellitus (DM) with oral agents received 0.69 times more TWBC, however, in patients using other methods this was not the case. Diabetic patients who controlled their blood glucose with oral drugs alone, required less defibrillator during their surgery, this may be because of the lower levels of free radicals and better control of DM in these patients. Single hot shot does not seem to have an effect on the different types of arrhythmia. The length of hospital stay and spontaneous rhythm time from declamping were not statistically significant. As discussed above, the effect of single antegrade hot shot on defibrillator usage during cardiac surgery is still a matter of debate. In our literature review, the studies that examined the positive effects of hot shot in reducing DC shock defibrillator were rare. In contrast to our findings, Goncu et al. showed that antegrade hot shot does not affect DC shock usage. They concluded that combined antegrade cardioplegic infusion via the aortic root, with additional cardioplegia from a vein or free arterial grafts after each distal anastomosis, will result in decreased DC shock usage.¹³ Contrary to our findings, Ghazy et al. showed that single shot cardioplegia does not change the incidence of arrhythmia.³ Moreover, Akowuah et al. showed that retrograde cardioplegia does not have an effect on ventricular tachycardia/ventricular fibrillation arrhythmia during surgery.⁸ In addition, Falcoz et al. reported there was no difference in the number of electroshocks administered between two groups of cold crystalloid cardioplegia, followed by warm and cold crystalloid cardioplegia. Falcoz et al. compared electroshock usage only in heart valve surgery, and the sample size was 70 patients. The content of the cardioplegia solution was also different from ours.¹⁴ It is concluded that single antegrade hot shot can have an effect on DC shock usage during cardiac surgery. It can lower defibrillator usage 1.55-fold in contrast to not administering hot shot.

It is assumed that the constituents of the hot shot are also effective in preserving myocardial

function because of the lower damage, but more biochemical studies are required in order to evaluate the exact effect of this solution. The limitation of our study is that we did not evaluate the biomarkers in the two groups of patients, and the post-operative parameters are few in number. More studies favorably randomized clinical trials are needed in future in order to find the best contents for a hot shot and cold cardioplegia.

Assurances

- The research protocol was approved by the Ethics Committee of Isfahan University of Medical Sciences. All participants gave their written informed consent
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Conflict of Interests

Authors have no conflict of interests.

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