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Does combined antegrade and selective coronary graft cardioplegia reduce conduction defects in right coronary artery occluded patients?

Sağ koroner arteri oklude hastalarda kombine antegrad ve selektif koroner greft kardiyopleji iletim defektlerini azaltır mı?

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Abstract

Aim: Post coronary artery bypass grafting (CABG) procedure conduction disturbances may appear due to many reasons. In this particular study we compared postoperative cardiac rhythm disturbances in right coronary artery (RCA) occluded patients, which cardioplegia disturbed with antegrade aortic and continuous retrograde way versus antegrade plus continue right coronary graft.
Methods: A total of 104 patients with right coronary artery occlusion who underwent isolated CABG procedure between 2011 and 2017 were included. The number of female patients was 43 (41.4%). Left bundle branch, left branch hemi block, and left branch hemi block and 3rd degree atrioventricular blocks were evaluated in the early postoperative period.
Results: The mean age of patients was 55.54±4.42 years (range 46-65 years). There was no statistical difference among groups according to preoperative and intraoperative demographics. Postoperative rhythm disturbances were higher in Group 1 but there was no statistical difference. (Group 1: 9 patients and Group 2: 4 patients. p=0.378). Hospital stay and intensive care unit (ICU) stay had statistically significant difference among groups (Group 1 mean hospital stay was 7.40±1.31 days and Group 2 had mean 6.53±1.19 days, p=0.026 and Group 1 mean ICU stay was days 2.20±0.67 and Group 2 had mean 1.87±0.72 days, p=0.021).
Conclusion: We believe that continuous RCA-selective cardioplegia administration in addition to antegrade cardioplegia may be more successful in terms of prevention of postoperative rhythm disturbances in postoperative CABG applied patients.
Keywords: Cardioplegia, Myocardial protection, Conduction disturbance

Öz

Amaç: Koroner arter bypass grefti (CABG) sonrası iletim bozukluklarının birçok farklı sebebi olabilir. Biz çalışmamızda proksimal sağ koroner arter (RCA) oklude olan hastalarda antegrad ve devamlı RCA selektif kardiyopleji uygulanmasının, aralıklı antegrad ve devamlı retrograd kardiyopleji uygulamasına kıyasla koroner bypass cerrahisi sonrası görülen postoperatif ritm bozukluklarına etkisini değerlendirdik.
Yöntemler: Bu çalışmada 2011 ile 2017 yılları arasında proksimal RCA oklude olan ve izole CABG yapılmış 104 hasta retrospektif olarak değerlendirilmiştir. Bu hastalardan 43 (%41,4)'ü kadın idi. Postoperatif erken dönemde gelişen sağ dal bloğu, sol dal bloğu, sol ön dal hemiblok, sol arka dal hemiblok ve 3. derece atriyoventriküler bloklar değerlendirildi.
Bulgular: Çalışmaya dahil edilen hastaların ortalama yaşı 55,54±4,42 idi (dağılım 46-65 yıl). Preoperatif ve intraoperatif özellikler açısından gruplar arasında anlamlı farklılık yoktu. Ancak postoperatif ritm bozukluğu görülen hastalar sayıca Grup 1 de fazla olsa da istatistiksel anlamlılık kazanmadı (Grup 1: 9 hasta ve Grup 2: 4 hasta p=0,378). Hastane yatış süresi ve yoğun bakımda kalış süresi açısından gruplar arasında Grup 2 lehine anlamlı istatistiksel fark vardı (Grup 1 ortalama hastane yatış süresi 7,40±1,31 gün ve Grup 2 ortalama hastane yatış süresi 6,53±1,19 gün p=0,026. Grup 1 yoğun bakım kalış süresi 2,20±0,67 gün ve Grup 2 yoğun bakım kalış süresi 1,87±0,72 gün p=0,021).
Sonuç: Antegrad kardiyoplejiye ek devamlı RCA selektif kardiyopleji uygulamasının CABG sonrası ritm bozukluğunu önlemede daha başarılı olabileceğini düşünmekteyiz.
Anahtar kelimeler: Kardiyopleji, Myokardiyal koruma, İletim bozuklukları

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Introduction

The incidence of rhythm disturbance after coronary artery bypass grafting (CABG) was reported as 43%. [1-3]. Particularly, it is known that third degree atrioventricular (AV) block and left bundle branch block are associated with poor postoperative prognosis and high mortality-morbidity rates [4]. The effect of cardioplegia techniques on postoperative rhythm disorders is known. It was shown that total occlusion of right coronary artery (RCA) prevents antegrade cardioplegia from reaching the right ventricle and retrograde cardioplegia is not reliable in right ventricular protection [5, 6]. Right ventricular cardioplegia distribution was demonstrated in one third of the patients with antegrade cardioplegia given in the presence of RCA occlusion. This rate was found as 20% in retrograde cardioplegia [5].

Protection of the right ventricle is a clinical question in terms of the development of postoperative rhythm disturbance. We think that RCA occlusion increases the risk of early postoperative rhythm disturbance due to inadequate protection of the right ventricle with existing cardioplegia applications in RCA proximal occlusion patients. In this study we have examined effect of intermittent antegrade and continue selective RCA graft cardioplegia on postoperative rhythm disturbances in RCA occluded patients.

Materials and Methods

Patients

Study was carried out in accordance with the principles of the Helsinki Declaration. In this single centered study, 104 proximal RCA occluded patients who underwent CABG operation between 2011 and 2017 were evaluated retrospectively. Of these patients, 61 (58.6%) were male and 43 (41.4%) were female. All patients underwent CABG due to coronary artery disease. Preoperative characteristics of the groups are shown in Table 1.

Patients who underwent cardiac procedures in addition to off-pump CABG, emergency operation, presence of high cardiac enzymes, recurrent MI, redo CABG, patients with long term antiarrhythmic drug use with known preoperative chronic rhythm disturbance, patients with severe anemia and thyrotoxicosis were excluded.

Table 1: Preoperative properties

	Group 1 (n=58)	Group 2 (n=46)	p
Age (Mean±SD)	54.74±4.41	55.59±4.94	0.360
Gender (M/F) (%)	32(55.2)/26(44.8)	29(63)/17(37)	0.432
HT (%)	13(22.4)	4(30.4)	0.377
DM (%)	13(22.4)	15(32.6)	0.272
PAD (%)	12(20.7)	7(15.2)	0.640
COPD (%)	7(12.1)	10(21.7)	0.285
Smoking (%)	34(58.6)	31(67.4)	0.418

SD: Standard deviation, M: Male, F: Female, HT: Hypertension, DM: Diabetes mellitus, PAD: Peripheral arterial disease, COPD: Chronic obstructive pulmonary disease

All patients who underwent CABG with coronary artery disease between March 2011 and December 2014 were given intermittent antegrade and continuous retrograde cardioplegia, of these patients, 58 RCA occluded patients were accepted as the first group. After December 2014, selective continuous cardioplegia began to be introduced as passive infusion to RCA-fed region from RCA anastomosis with intermittent antegrade cardioplegia after RCA anastomosis to prevent postoperative rhythm disturbances, 46 patients who were selected between these dates were accepted as the second group.

Surgical Technique

Anesthesia technique was standard for all patients and surgeries were performed by the same surgical team using the same anastomosis techniques. General anesthesia and intratracheal intubation were performed. Chest was opened with median sternotomy. Left internal mammary artery was prepared before pericardiotomy. Left internal mammary artery was used as a routine graft for all patients. Moderate systemic hypothermia was used during cardiopulmonary bypass (CPB). Alpha static acid-base management was accepted and systemic anticoagulation was performed with an activated coagulation time of more than 450 seconds. At the end of the operation heparin was neutralized with protamine sulfate. Chest was closed in a standard technique.

Myocardial Protection Methods

Myocardial protection was decided according to the preference of the surgeon. Isothermic hyperkalemic blood cardioplegia was used in both groups for myocardial protection. Intermittent antegrade and continuous retrograde cardioplegia were performed in all patients, including RCA occluded patients between March 2011 and December 2014. First, cardioplegia was prepared in the presence of 20-30 mEq potassium chloride, 10 mEq sodium bicarbonate, and 1 amp $MgSO_4$ in 1000 mL of pump blood. After cross-clamping, initial cardioplegia was given antegrade with 3-5 minutes at a flow rate of 200mL per minute, a dose of 10-15 mL/kg at 70-90 mmHg pressure. Potassium was then repeatedly applied with an antegrade cardioplegia every 20 minutes by reducing the dose. During distal anastomoses, it was planned to continuously apply retrograde cardioplegia with 20-30 mmHg pressure to avoid excessive pressure on the myocardium, and passive infusion was performed with the effect of gravity (140-150 mL/min). After December 2014; cardioplegia was given antegrade using the same method, and selective RCA was started as a passive infusion to RCA-fed region from RCA graft after RCA anastomosis.

The blood temperature (25-28°C) and hematocrit level (20-25%) collected for cardioplegia were the same as perfusate level.

Electrocardiography

All patients underwent electrocardiography immediately prior to surgery, immediately after surgery, and post-operative daily electrocardiography. Standard was evaluated by a 12- lead electrocardiographic recorder. New right bundle branch block, left anterior hemiblock, left posterior hemiblock, left bundle branch block, or third degree AV blocks after CABG were evaluated.

Statistical Analysis

SPSS 15 (Statistical Package for Social Sciences, SPSS Inc., Chicago, IL, USA) software was used for statistical analysis. Kolmogorov-Smirnov test was used to test normal or abnormal distributions of continuous variables. An independent sample T-test was used for comparisons between groups with normal distributions of continuous variables. Data are expressed as mean ± standard deviation (SD). The Mann-Whitney U test was applied for variables with non-uniform distribution. The data are expressed in median and quartile intervals. Categorical data were analyzed by Pearson's chi-square test and Fisher's exact test was performed if the expected frequency was below 5 in 20% of all cells. Values of $p<0.05$ were considered statistically significant.

Results

Total mortality was calculated as 2.8% (3 patients) in all groups. In these patients mortality was observed in 1 patient due to low cardiac output syndrome, 1 patient due to respiratory distress and 1 patient due to ventricular fibrillation. No significant difference was found between the mortality rates of the groups (p=0.696). CPB durations, cross clamp times, number of distal anastomoses, intraaortic balloon pump support, and inotropic support rates were similar. There were statistically significant differences between the groups in intensive care unit follow-up periods (p=0.021) and hospitalization durations (p=0.026). The number of coronary bypass vessels applied to the patients in addition to RCA was similar in both groups (Group 1 = 3.1, Group 2 = 3.9).

When the groups were analyzed according to the incidence of postoperative rhythm disturbance, the incidence of postoperative rhythm disturbance was significantly higher in group 1 (p=0.006). Preoperative risk factors had no significant effect on postoperative rhythm disturbance. Age, number of distal anastomoses, CPB time and cross-clamp time did not affect postoperative rhythm disturbances. Multivariate analysis showed that there was no statistically significant difference (p=0.378) in preventing postoperative rhythm disturbance of selective continuous cardioplegia from RCA due to low patient numbers in our study (Table 2). Distribution of postoperative rhythm disturbances according to groups is given in Table 3.

Table 2: Operation and post-operative data

	Group 1 (n=58)	Group 2 (n=46)	p
CPB durations (minute)	55.34±6.78	56.91±7.13	0.255
Cross clamp durations (minute)	31.83±5.26	32.65±5.89	0.454
Anastomosis numbers	3(3-5)	4(3-5)	0.126
Intensive care stay durations (days)	2.20±0.67	1.87±0.72	0.021*
Hospitalization durations (days)	7.40±1.31	6.53±1.19	0.026*
IABP (%)	3 (5.2)	2 (4.3)	0.845
Inotropic support (%)	16 (27.6)	15 (32.6)	0.667
Postoperative rhythm disorder (%)	9 (15.5)	4 (8.7)	0.378
Mortality (%)	2 (3.4)	1 (2.2)	0.696

CPB: Cardiopulmonary bypass, IABP: Intraaortic balloon pump, * p<0.05

Table 3: Postoperative rhythm disorders

	Group 1 (n=58)	Group 2 (n=46)
RBBB (%)	5	2
RBBB+LAHB (%)	1	1
LPHB (%)	1	1
LBBB (%)	1	none
TDAVB (%)	none	none
RBBB+TDAVB (%)	1	none

RBBB: Right bundle branch block, LAHB: Left anterior branch hemiblock, LPHB: Left posterior bundle hemiblock, LBBB: Left bundle branch block, TDAVB: Third degree atrioventricular block

Discussion

Today, surgical experience in open heart surgery increased and advances were made especially in the bypass technique in beating heart. Despite these advances, the use of cardiopulmonary bypass (CPB) and preservation of myocardium in open heart surgery maintains its importance.

Proper protection of the myocardium during CABG reduces operative mortality and morbidity. In order for cardioplegia to be effective, the solution must be sufficiently distributed to all regions of the heart [5-7]. Theoretically, it is known that homogeneous cardioplegia distribution cannot be obtained in the presence of fully occluded coronary arteries [8]. Natural coronary artery anatomy and collateral flow are critical factors for the prevention of cardioplegia distribution and myocardial dysfunction [5].

In Partington et al.'s study [9] of the retrograde perfusion distribution by applying radioactive microspheres through cardioplegic solution in dogs via coronary sinus; they observed an inadequate distribution in the right ventricle. The clinical significance of poor right ventricular perfusion in this study is controversial due to differences in the coronary venous anatomy between animals and humans. A number of different studies showed that retrograde cardioplegic practice provides inadequate and poor right ventricular perfusion in the clinical setting [10-13] Inadequate RV perfusion can be explained by the direct discharge of the right atrium, usually anterior cardiac venous drainage, which releases the free wall of RV [12,14]. Despite the use of antegrade or retrograde cardioplegia, CABG has been reported in the right ventricular dysfunction after surgery [5].

Since antegrade and retrograde cardioplegia caused suboptimal perfusion in RV, it was thought that cardioplegia administration in the antegrade way after early implantation of RCA graft could provide the best protection for RV [12,15]. However, it is present only in publications that suggest that antegrade cardioplegia is adequate to maintain adequate coronary occlusion [16].

There are many studies showing that myocardial ischemia is effective in the development of postoperative rhythm disturbances [17,18]. Lipid peroxidation of free oxygen radicals in the heart cell membrane, especially during ischemia-reperfusion, is thought to be responsible for the severe arrhythmia of the resulting damage [19,20].

Left bundle branch block is widely accepted as a marker of perioperative myocardial ischemia [21], but the prospect of a new right bundle branch after CABG in terms of myocardial ischemia is still controversial [17,18]. In some studies, a clear association was found between new transient and / or permanent right bundle branch block and perioperative CK-MB levels [22]. In the study of Mustonen et al. [17], it is thought that the number of postoperative rhythm disturbances depends on the injuries associated with cold on the myocardium. For this reason, the low rate of postoperative rhythm disturbance in this study may be avoided by hypothermia.

Blood cardioplegia is known to provide more effective intraoperative myocardial protection than crystalloid cardioplegic solutions. Pehkonen et al. [23] found no correlation between cardioplegia technique and postoperative rhythm disturbances and found that left postoperative rhythm disturbance decreased with improved myocardial protection. It has been found that right coronary artery bypasses and stenosis are associated with the formation of numerous new right bundle branches. [24].

In this study, we compared the occurrence of postoperative rhythm disturbance of selective continuous cardioplegia from RCA grafts in addition to antegrade cardioplegia, especially in patients with RCA proximal occlusion, instead of intermittent antegrade + continuous retrograde cardioplegia. No statistically significant difference was observed between the technique used and postoperative rhythm disturbance (p=0.378). Although there was a numerical difference between the two groups in terms of postoperative rhythm disturbance development, there was no statistically significant difference due to the small number of patients. However, we believe that this difference may be statistically significant with a larger study and sufficient number of patients. More extensive work is needed for this.

In our study, we could not find a correlation between the numbers of vessels bypassed and postoperative rhythm disturbances. There was no correlation between preoperative factors and time of aortic cross clamp, CPB time, intra-operative data such as inotropic support requirement and IABP use, cardioplegia applied.

Mosseri et al. [25] found a clear association between postoperative rhythm disturbances and the first septal perforator branch of the left anterior descending artery and found that the lesions in the left anterior descending coronary artery, which was impaired in the first perforator, produced local damage and transmission disorders after CABG.

Our study has some limitations; the number of patients is low, study design is retrospective, and the amount of cardioplegia given may vary between groups due to differences in applied techniques. Furthermore postoperative complications other than low cardiac output were not mentioned. Lastly we have some missing data on comparing of pre and postoperative echocardiographic parameters.

In conclusion, this study of patients with CABG, especially RCA proximal occlusion in patients with antegrade cardioplegia plus selective continuous cardioplegia from RCA graft; there was statistically significant difference among groups considering hospital stay and ICU stay in the favor of Group 1. Although it was not statistically significant we found a decrease in number of postoperative rhythm disorders observed cases with continuous selective RCA graft perfusion. New studies with large number of patients is needed, RCA should be assessed for the effect of selective continuous cardioplegia on postoperative rhythm disturbances from RCA grafts in addition to antegrade cardioplegia in patients with proximal occlusion.

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