The Heart Surgery Forum 2021-3955
24 (5), 2021 [Epub September 2021]
doi: 10.1532/hsf.3955

Online address: http://journal.hsforum.com

Comparison of Microplegia Solution and Del Nido Cardioplegia Solution in Coronary Artery Bypass Grafting Surgery: Which One is More Effective?

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ABSTRACT

Background: The aim of this study is to compare the efficacy of the microplegia solution and Del Nido cardioplegia solution in coronary artery bypass surgery with clinical, biochemical, and echocardiographic data.

Methods: Three hundred patients, who underwent coronary artery bypass surgery between January 2017 and January 2020, by the same surgical team were included in the study. Preoperative, operative and postoperative data (cardiac biomarker levels, cross-clamp and CPB times, echocardiographic measurements, etc.) of the patients were compared.

Results: In the study, cross-clamp time was significantly shorter in the DN cardioplegia group (55.60 ± 13.49 min/75.58 ± 12.43 min, $P = 0.024$). No significant difference was observed between the two groups in terms of intensive care stay, extubation time, hospital stay, and cardiopulmonary bypass time. In our study, it was shown that both the left and right ventricular ejection fraction was better protected in the Del Nido cardioplegia group (5.34±3.03 vs. 3.40±2.84, $P = 0.017$ and 3.82±1.19 vs. 2.28±1.87, $P = 0.047$, respectively), and the need for inotrope support was lower in this group (28% vs. 44%, $P < 0.021$). There was no significant difference between the groups, in terms of blood transfusion rates, IABP requirement.

Conclusion: In light of short-term results, we can say that Del Nido cardioplegia provides better myocardial protection than microplegia. In addition, Del Nido cardioplegia can be given as a single dose for 90 minutes of cross-clamp time and therefore can be preferred to increase surgical comfort and reduce cross-clamp times.

INTRODUCTION

In patients undergoing open-heart surgery, it is crucial to provide a bloodless and quiet operating field allowing the planned surgical repair. Strategies and methods used to prevent or alleviate postischemic myocardial dysfunction, during and after cardiac surgery, are defined as "myocardial protection." Cardioplegia solution in many different contents delivered via the coronary system to induce cardiac arrest at the diastolic phase and permitting surgery to be performed on a non-beating flaccid heart is the cornerstone of myocardial protection. It is the most commonly used myocardial protection method throughout the world [Ali 2018]. Many researchers accept that the use of diluted or whole blood cardioplegia has opened a new era in myocardial protection [Trescher 2017]. Blood cardioplegia has found itself in extensive use by providing a better oxygenated environment, high endogenous buffering capacity, and ideal osmotic properties without the potential disadvantages of hemodilution. However, the optimal mixing ratio of blood to chemical solutions in blood cardioplegia remains uncertain. Microplegia is being used in our clinic, considering its similar clinical results with standard blood cardioplegia [Gong 2015].

Furthermore, the use of single-dose Del Nido cardioplegia (DN), which provides long-term electromechanical silence, for adult cardiac surgery has been expanding due to studies revealing its effectiveness [Guajardo 2017]. The use of single-dose cardioplegia in cardiac surgery cases requiring long cross-clamp times increases the comfort of the surgeon as it does not disrupt the surgical flow of the case and does not require additional time adjustment for the maintenance dose. Meanwhile, our use of the DN cardioplegia solution in adult patients has been increasing over the past several years. This study aims to evaluate the efficacy and safety of two different cardioplegia solutions (microplegia and DN cardioplegia), which frequently are used in our clinic, at the level of clinical outcomes, biochemical markers, and echocardiographic imaging.

MATERIAL AND METHODS

Study design: This study was conducted at the Department of Cardiovascular Surgery of Adiyaman Training and Research Hospital and included 300 patients, who underwent coronary artery bypass graft (CABG) surgery and were operated by the same surgical team between January 2017 to January 2020. In order to conduct the study, approval was obtained from the local ethics committee with the number 2020/7-13, dated 07.21.2020. Patients were randomized to one of two groups. The DN group ($N = 150$) received single dose DN cardioplegia, and the Microplegia group ($N = 150$)

Received May 7, 2021; received in revised form June 11, 2021; accepted June 11, 2021.

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received intermittent blood cardioplegia. Patients were randomized to one of the two groups, using computer-generated random-number assignment. Exclusion criteria included unstability of hemodynamics, cardiogenic shock, preoperative inotropic support and the need for an intraaortic balloon pump, cases requiring emergency surgery and additional surgical procedures, and cases that previously had undergone cardiac surgery. The first 30-day period after surgery was accepted as early mortality and later as late mortality. The primary outcomes included mortality and ejection fraction (EF) exchange. The secondary outcomes were duration of cardiopulmonary bypass (CPB), cross-clamp (XC) time, and inotropic support.

Surgery: Patients were premedicated by Diazepam 5 mg orally the night before the surgery and Morphine Sulfate 10 mg intramuscularly 30 minutes before the start of the operation. The patient taken to the operating room was monitored, and electrodes, venous and radial artery cannulas were placed. Anesthesia induction was then performed with Fentanyl 30-50 µg/kg. Succinyl Choline 1 mg/kg was used as the muscle relaxant, and then, Pancuronium 0.1 mg/kg was administered. Fentanyl 3 µg/kg/min infusion was used for anesthesia maintenance and Isoflurane inhalation, if needed. Intubated patients were ventilated with 100% O2. A Foley urinary catheter was inserted to monitor urine output during the operation.

Following median sternotomy, Heparin 400 IU/kg IV was administered before arterial cannulation with a target activated clotting time (ACT) (measured after 3 min) (Hemochron 801 International Technidyne Corporation, Edison, NJ) of over 400 seconds. When ACT was observed over 400 seconds, standard ascending aorta cannulation and unicaval venous cannulation were performed. CPB arterial flow rate was set to 2.2 lt/min/m2, then the XC was placed. The optimum cooling degree was determined as 32°C. Hematocrit level was aimed to be maintained between 23-25% and blood pressure between 50-80 mmHg. Cardioplegia was delivered, and the heart was stopped in the diastolic phase. Distal and proximal coronary anastomoses were performed under XC. Then, the aortic XC was removed, and CPB was terminated when appropriate conditions were met. Protamine sulfate at a ratio of 1: 1 was administered to reverse the anticoagulant effects of Heparin. The surgical field was inspected for bleeding, and 36 French drains and one external pace wire were placed. The median sternotomy was closed with four figure-8 wires. After the skin and subcutaneous tissues were closed in accordance with the anatomy, the operation was terminated. Patients were then taken to the intensive care for follow up.

Cardioplegia: Microplegia solution is created by adding 10 ml 22.5% potassium chloride (KCl) and 10 ml 15% magnesium sulfate (MgSO4) into the autologous blood amount of patient weight x 10 ml. Electromechanical quiescence of heart was provided by administering cardioplegia 2/3 antegrade and 1/3 retrograde route. In case of need to maintain electromechanical silence during the XC, microplegia prepared by adding 2.5 ml 7.5% KCL and 2.5 ml 15% MgSO4 in 300 ml blood was given as a maintenance dose every 20 to 25 minutes. The last dose of cardioplegia was given as a "hot shot" at 37°C before reperfusion by adding 2.5 ml of 15% MgSO4 to 300 ml of blood before the removal of the aortic XC.

On the other hand, DN cardioplegia was prepared using Isolyte A as the base solution and was mixed with autologous blood for crystalloid: blood ratio of 4:1 and adding additional components (16.3 ml 20% Mannitol, 4 ml 50% MgSO4, 13ml 1mEq/ml NaHCO3, 13 ml %1 Lidocaine, 13 ml 2 mEq/ml KCl). Cardiac arrest was achieved with an induction dose of 1200 ml DN cardioplegia at about 4°C. Unless the electromechanical silence deteriorated, doses were not repeated up to 60 minutes; and 600-800 ml cardioplegia was administered as the second dose in the 60th minute in patients who were thought to have a XC time exceeding 90 minutes. (Table 1)

Data collection: The mean follow-up period was 5.9 ± 1.4 months. Data on the preoperative demographic details, medical and cardiovascular histories, vital signs, hemodynamic measurements, laboratory and echocardiographic findings, and the drugs that patients regularly had been using were obtained from patient files in the hospital archive. XC and CPB times were recorded in the operative process. Data from the intensive care unit, inotropic support need, cardiac assist device requirements, arrhythmias, intensive care stay, and extubation times also were recorded. Postoperative follow-up data were collected from patient files and computerized patient records. Blood product needs of the patients in the perioperative and postoperative processes and biochemical markers at the 24th postoperative hour were recorded. Transthoracic echocardiography (Vivid 7 Dimension, GE Medical Systems, Horten, Norway) routinely was performed in the second month of follow up. Echocardiography results

Table 1. Contents of Microplegia and Del Nido cardioplegia

Microplegia			Del Nido Cardioplegia	
KCL 7.5%	Induction	30 ml	Plazma Lyte A	1000 ml
	Maintenance	2.5 ml	Mannitol 20%	16.3 ml (3.3 g)
Mg sulfate 15%	Induction	10 ml	Mg sulfate 50%	4.0 ml (2 g)
	Maintenance	2.5 ml	Sodium Bicarbonate 1 mEq/ml	13 ml
Ph	Induction	7.48	Lidocaine 1%	13 ml (130 mg)
	Maintenance	7.48	KCL 2 mEq/ml	13 ml

at the postoperative second-month follow up was recorded by same physician.

Statistical analysis: Data were analyzed in SPSS version 11.5. The mean ± standard deviation (SD) and median (min-max) for quantitative variables and the number (percentage) for qualitative variables were used as descriptive variables. For the qualitative variable, whether there is a difference between the categories of the qualitative variable with two categories, Student t-test, if not, the Mann-Whitney U test was used. Chi-squared and Fisher Exact tests were used to examine the relationship between two qualitative variables. Statistical significance level was taken as 0.05.

RESULTS

Demographic features, additional diseases, and preoperative blood results of the patients are presented in tables

Table 2. Preoperative demographic data

Variables	Del Nido Cardioplegia (*N* = 150)		Microplegia (*N* = 150)		*P*-value
	Mean ± SD/n (%)	Median (Min-Max)	Mean ± SD/n (%)	Median (Min-Max)	
Age (year)	57.64±12.66	58.00 (24.00-79.00)	61.78±11.33	63.50 (32.00-85.00)	0.088
Male gender	114 (76.0%)	-	126 (84.0%)	-	0.715
BMI (kg/m^2)	27.43±4.01	27.50 (18.60-37.80)	26.18±4.28	25.80 (19.10-40.00)	0.134
HT	72 (48.0%)	-	60 (40.0%)	-	0.420
DM	45 (30.0%)	-	27 (18.0%)	-	0.060
COPD	18 (12.0%)	-	33 (22.0%)	-	0.183
CVD	12 (8.0%)	-	6 (4.0%)	-	0.678
Thyroid dysfunction	24 (16.0%)	-	15 (10.0%)	-	0.372
Recent AMI	24 (16.0%)	-	36 (24.0%)	0.317	
ASA use	81 (54.0%)	-	57 (38.0%)	-	0.108
NYHA	2.08±0.75	2.00 (1.00-3.00)	1.96±0.73	2.00 (0.00-3.00)	0.450
EuroSCORE	1.89±2.07	1.23 (0.55-13.00)	2.19±2.60	1.29 (0.45-13.98)	0.764
Left ventricle EF (%)	50.66±8.71	50.00 (30.00-65.00)	52.44±8.03	55.00 (30.00-65.00)	0.364
Right ventricle EF (%)	59.83±3.72	60.00 (50.00-65.00)	60.22±3.78	60.00 (48.00-65.00)	0.366

SD, standard deviation; Min, minimum; Max, maximum; BMI, body mass index; HT, hypertension; DM, diabetes mellitus; COPD, chronic obstructive pulmonary disease; CVD, cerebrovascular disease; AMI, acute myocardial infarction; ASA, acetylsalicylic acid; NYHA, New York Heart Association; EF, ejection fraction

Table 3. Preoperative blood values

Variables	Del Nido Cardioplegia (*N* = 150)		Microplegia (*N* = 150)		*P*-value
	Mean ± SD/n (%)	Median (Min-Max)	Mean ± SD/n (%)	Median (Min-Max)	
Troponin-T (ng/mL)	0.54±1.6	0.09 (0.01-6.12)	0.43±1.18	0.04 (0.01-8.24)	0.891
LDH (IU/L)	213±49.9	151 (101-317)	228±161	164 (127-841)	0.130
CK-MB (IU/L)	21.7±12.5	16.3 (12-91)	24.2±13.7	17.4 (18-235)	0.270
AST (IU/L)	22.98±8.20	20.00 (12.00-51.00)	30.14±23.26	25.00 (10.00-163.00)	0.124
ALT (IU/L)	26.16±24.89	21.00 (10.00-186.00)	32.72±41.49	22.00 (7.00-288.00)	0.486
Cr (mg/dL)	0.97±0.25	0.92 (0.70-2.21)	1.03±0.36	0.97 (0.54-2.82)	0.414
Hb (g/dL)	13.12±1.79	13.05 (9.20-17.50)	13.46±1.78	13.70 (9.80-16.90)	0.336
Plt (10^3/μL)	248.42±69.39	237.50 (153.00-502.00)	231.12±58.28	227.50 (88.00-362.00)	0.312

SD, standard deviation; Min, minimum; Max, maximum; LDH, lactate dehydrogenase; CK-MB, creatine kinase mb; AST, aspartate aminotransferase; ALT, Alanin aminotransferase; Cr, Creatinin; Hb, hemoglobin; Plt, platelet

2 and 3. (Table 2) (Table 3) When the demographic data are compared between the two groups, there is no significant difference, in terms of gender, age, BMI, NYHA score, euroSCORE, and average bypass numbers. When evaluated in terms of additional diseases, there was no difference between the two groups, in terms of the preoperative cerebrovascular event, COPD, DM, thyroid dysfunction, hypertension, and recent myocardial infarction. As preoperative cardiac enzyme values, there was no difference between the groups, in terms of troponin-t, LDH, CK-MB and preoperatively routinely examined blood values. Right and left ventricular ejection fractions (EF) of the patients were evaluated separately, and no statistically significant difference was observed.

No significant difference was observed between the two groups, in terms of intensive care stay, extubation time, hospital stay, and CPB time. (Table 4) XC times were recorded as 55.60 ± 13.49 minutes and 75.58 ± 12.43 minutes in DN cardioplegia and cold blood cardioplegia groups, respectively. XC time was significantly shorter in the DN cardioplegia group (P = 0.024).

Comparing the need for inotropic support in patients receiving DN cardioplegia and microplegia, inotropic support was needed in 42 (28%) and 66 (44%) patients. This difference was statistically significant (P = 0.021). (Table 4) IABP was required in 6 (4%) and 9 (6%) patients, respectively; this did not create a statistically significant difference between the groups (P = 1.000). In the postoperative period, AF development was observed in 6 (4%) patients in the DN cardioplegia group and 15 (10%) patients in the Microplegia group; there was no significant difference between the two groups (P = 0.055). No difference was observed between the two groups, in terms of red blood cell transfusion rates (P = 0.882) (Table 4).

Considering the left ventricular and right ventricular EF increases in the postoperative second month, it was found that a statistically significant increase in EF was obtained in the DN cardioplegia group (5.34±3.03 vs. 3.40±2.84, P = 0.017 and 3.82±1.19 vs. 2.28±1.87, P = 0.047, respectively) (Table 5). There was no significant difference between the groups in the postoperative increase rates of troponin-t and CK-MB, which are considered cardiac biomarkers. Although hemoglobin (Hb) values observed in blood gases taken at the CPB output were observationally higher in the Microplegia group, the difference was not statistically significant (P = 0.165). (Table 5)

DISCUSSION

Insufficient myocardial protection results in myocardial stunning, cell apoptosis, and myocardial infarction. Elective CABG operations are considered among the low-risk cardiac operations today. However, the lack of good myocardial protection during the operation shadows the technical successes and leads to poor clinical results. Cardioplegic solutions used for myocardial protection should provide a rapid cardiac arrest, provide protection in the heart by reducing the high energy demand, provide the oxygen and required substrates for the myocardium, reduce toxic metabolites and oxygen radicals, and prevent unwanted reperfusion actions caused by calcium paradoxes. Also, their effects should be quickly reversible [Masuda 2015]. After Buckberg et al. described blood cardioplegia, it has been used with different dilution rates in many centers. The most commonly used blood/crystalloid ratios are 8:1, 4:1, 2:1 and microplegia [Buckberg 1982]. Blood cardioplegia has been shown to have many benefits.

Table 4. Evaluation of peroperative and postoperative variables by groups

Variables	Del Nido Cardioplegia (N = 150)		Microplegia (N = 150)		P-value
	Mean ± SD/n (%)	Median (Min-Max)	Mean ± SD/n (%)	Median (Min-Max)	
Number of distal anastomoses	4.02±0.32	4.00 (3.00-5.00)	4.18±0.52	4.00 (3.00-5.00)	0.057
Cross-clamp duration (minutes)	55.60±13.49	55 (35.00-101.00)	75.58±12.43	70.00 (45.00-96.00)	0.024
CPB duration (minutes)	88.14±23.02	85.00 (50.00-198.00)	89.50±35.12	87.00 (57.00-308.00)	0.915
Extubation time (hour)	9.13±2.82	8.00 (6.00-21.00)	9.88±4.40	8.00 (5.00-24.00)	0.926
ICU stay (day)	1.40±0.90	1.00 (0.00-5.00)	1.39±0.61	1.00 (1.00-3.00)	0.482
Hospital stay (day)	6.38±1.88	6.00 (5.00-15.00)	5.96±1.49	6.00 (4.00-12.00)	0.237
Postoperative atrial fibrillation	6 (4.0%)	-	15 (10.0%)	-	0.055
Postoperative inotropic support requirement	42 (28.0%)	-	66 (42.0%)	-	0.021
Postoperative IABP	6 (4.0%)	-	9 (6.0%)	-	1.000
Postoperative bleeding (ml)	673.00±552.93	475.00 (150-2450.00)	615.00±327.83	575.00 (100.00-1550.00)	0.626
PRBC requirement	0.5±1.4	0 (0-7)	0.2±0.4	0 (0-1)	0.882

SD, standard deviation; Min, minimum; Max, maximum; CPB, cardiopulmonary bypass; ICU, intensive care unit; IABP, intra-aortic balloon pump; PRBC, packed red blood cells

These can be classified as providing an oxygenated environment, hemodilution limiting, containing ideal osmotic properties and many endogenous antioxidants, and high buffering capacity. In the following years, Menasche et al. developed a cardioplegia solution, which they named Micro Cardioplegia, in which they added only the arresting agents (potassium, magnesium) into the pureblood they obtained from the arterial part of the oxygenator as an alternative to diluting the blood in order to eliminate the disadvantages of diluted cardioplegia [Menasché 1993]. Again, Menasche et al. in their later proposals listed the advantages of Microplegia as better oxygen delivery, better control of blood volume, ease of preparation, and cost-effectiveness [Menasché 1996]. DN cardioplegia, which has been used in pediatric cardiac surgery as of the early 1990s, has been proven to be effective in adult cardiac surgery today, and its use is gradually increasing [Sanrı 2020]. DN cardioplegia with blood to the crystalloid ratio of 1:4 provides long-term electromechanical quiescence with a single dose [O'Blenes 2011]. The elective cardiac arrest created with cardioplegic solutions remains the most current and frequently used method for myocardial protection. Lack of consensus on optimal cardioplegia still causes research about cardioplegia to continue.

DN cardioplegia has been associated with shorter XC and CPB times in many studies since it allows undisrupted operation flow and does not require time adjustment for additional cardioplegia doses because it provides long-term cardiac arrest with a single dose [Mishra 2016; Yerebakan 2014; Cayir 2020]. In our study, while XC times were statistically lower in the DN cardioplegia group, and there was no difference between the patients' CPB time mechanical ventilation time, intensive care stay, and hospital stay. In the study comparing the standard blood cardioplegia and DN cardioplegia conducted by Li et al., the duration of mechanic ventilation and intensive care stay were stated significantly lower in the DN cardioplegia group [Li 2018]. In the study of Algarni et al., Microplegia was compared with blood cardioplegia diluted at a rate of 8:1, and the durations of ventilation and hospital stays were significantly shorter in the Microplegia group [Algarni 2013]. In the same study, XC times were similar in the Microplegia group, while no difference was observed between the CPB times. However, Microplegia was reported to have better clinical outcomes. In the DN cardioplegia group in our study, short XC times did not affect the intensive care unit stay, ventilation time, and hospital stay. However, as we mentioned earlier, in complex cases that may require longer XC times, this may increase ischemia-reperfusion injury and affect clinical outcomes. However, there are studies in the literature reporting that long XC times alone are independent predictors of mortality [Nissinen 2009].

It still is unclear whether the biomarkers emerging as a result of myocardial damage are independent determinants of clinical outcomes. In the study of Beller et al., no relationship between peak troponin levels and myocardial infarction after CABG was stated [Beller 2018]. In addition, there are studies in the literature reporting that ischemia-reperfusion injury after revascularization following CABG causes an increase in cardiac enzymes [Beyersdorf 2001]. In myocardial infarction due to coronary occlusion following CABG, there are publications indicating that cardiac enzymes increase up to ten-fold with necrosis findings occurring in electrocardiography [Thygesen 2012]. In a study that examined 18,908 CABG patients, the increase in cardiac enzyme in the first 24 hours was found to be associated with increased mortality [Domanski 2011]. In our study, troponin-t and CK-MB levels were evaluated as cardiac biomarkers. There was no

Table 5. Evaluation of ejection fraction, cardiac biomarkers and postoperative blood values by groups

Variables	Del Nido Cardioplegia (*N* = 150)		Microplegia (*N* = 150)		*P*-value
	Mean ± SD/n (%)	Median (Min-Max)	Mean ± SD/n (%)	Median (Min-Max)	
Left ventricle EF (%)	56.00±7.98	57 (36-65)	55.84±7.65	57 (32-65)	0.069
Right ventricle EF (%)	63.65±3.73	62 (53-67)	62.50±3.34	62 (51-66)	0.078
Left ventricle EF difference	5.34±3.03	5.00 (0.00-10.00)	3.40±2.84	3.00 (0.00-8.00)	0.017
Right ventricle EF difference	3.82±1.19	3 (0.00-5.00)	2.28±1.87	2 (0.00-4.00)	0.047
Troponin-T difference	0.8±2.1	0.63 (-6.1-5.1)	2.6±3.4	1.5 (-0.3-27.2)	0.172
CK-MB difference	13.2±20	19 (-37-111)	28.7±66.6	29 (-83-267)	0.640
AST (IU/L)	64.44±47.72	53.00 (25.00-312.00)	63.90±42.83	51.00 (28.00-231.00)	0.966
ALT (IU/L)	34.72±43.83	25.00 (9.00-289.00)	30.71±18.82	25.00 (11.00-111.00)	0.677
Cr (mg/dL)	1.16±0.46	1.04 (0.65-2.59)	1.13±0.40	1.07 (0.44-2.83)	0.504
Hb (g/dL)	9.10±1.23	8.80 (7.40-13.00)	9.88±3.05	9.40 (7.50-29.80)	0.165
Plt (10^3/μL)	163.02±42.82	154.00 (76.00-272.00)	166.75±53.02	167.00 (7.80-310.00)	0.701

SD, standard deviation; Min, minimum; Max, maximum; EF, ejection fraction; CK-MB, Creatine kinase mb; AST, Aspartate aminotransferase; ALT, Alanin aminotransferase; Cr, Creatinin; Hb, hemoglobin; Plt, platelet

significant difference between the cardiac biomarker levels between the groups. In their study comparing blood cardioplegia with DN cardioplegia by Loberman et al., the group that received with DN cardioplegia had higher CK-MB levels compared with the group receiving blood cardioplegia, yet it did not affect the clinical outcomes [Loberman 2014]. In the study by Albacker et al., Microplegia and standard blood cardioplegia were compared in the elderly patient population; no difference was stated in terms of postoperative peak troponin levels [Albacker 2009]. If slight increases in postoperative troponin-t and CK-MB values after cardiac surgery are not supported by electrocardiographic and echocardiographic findings, it does not show significance [Wang 2013]. In our study, although it was not statistically significant, postoperative troponin-t and CK-MB values increased less in the DN group. This result suggests that DN cardioplegia is superior in cardiac protection, considering that the need for inotrope support is less in the DN cardioplegia group, and it provides better EF protection.

Poor myocardial protection leads to an increased need for high-dose inotropic and mechanical support in the period after XC removal. In the following period, it may lead to a decrease in the systolic function of the myocardium and heart failure. In our study, right and left ventricular ejection fractions were evaluated separately, and it was shown that DN cardioplegia was superior in preserving both left and right ventricular EF. Although there was no statistically significant difference, the need for IABP and development of AF were less common in the DN cardioplegia group. The need for inotropes was significantly lower in the DN cardioplegia group. Different studies comparing DN cardioplegia and Microplegia with standard blood cardioplegia have shown similar clinical results to standard blood cardioplegia [Yerebakan 2014; Li 2018; Albacker 2009]. In the study conducted by Algarni et al., comparing 8:1 diluted blood cardioplegia with Microplegia, it was stated that inotropic support requirement, IABP use, and low cardiac output syndrome occurrence were found to be lower in the Microplegia group [Algarni 2013]. Many studies comparing DN cardioplegia and Microplegia with different cardioplegia types stated equal or superior results, in terms of protection of ejection fraction. This suggests that both cardioplegias can be safely used in myocardial protection [Mishra 2016; Algarni 2013]. To the best of our knowledge, this is the first study in the literature to compare Microplegia and DN cardioplegia. In this comparison, DN cardioplegia shows superior results, in terms of myocardial protection.

Although it is known that blood cardioplegia contributes to myocardial protection by reducing myocardial edema, it should be kept in mind that a cardioplegia prepared with high-density blood may not provide a good distribution and may become more concentrated in case of hypothermia and cause microvascular obstructions. Among the most important features of Microplegia in studies, decreasing hemodilution, providing higher hematocrit levels, and higher buffering capacity can be given as examples [Hayashida 1998]. Gong et al. showed in their study that the use of Microplegia reduced hemodilution, increased buffering capacity and osmotic potential [Gong 2015]. In the study of Guajardo et al. comparing DN and standard blood cardioplegia in CABG patients, they found similar results in terms of blood transfusion requirements [Guajardo 2017]. In our study, although the hemoglobin (Hb) values observed in the blood gases taken at the CPB output of the two groups were higher in the Microplegia group, the difference between them was not statistically significant. Again, no difference was observed between the two groups, in terms of peroperative PRBC use rates. These results can be explained by the fact that the patient group in our study were not complex cases requiring longer XC times. Although DN cardioplegia is a more diluted cardioplegia, it provides a safe arrest time up to 90 minutes from the initial dose, and in most cases, a single dose was used, thus preventing the delivery of crystalloid fluid in high volume.

The limitations of our study include the fact that it only included CABG patients who required a short XC and that EF measurements were not performed in the early postoperative period.

CONCLUSION

In conclusion, Microplegia and DN cardioplegia are both proven to be effective in myocardial protection in the literature. In light of short-term results, due to its better protection of the ejection fraction, we can say that DN cardioplegia provides better myocardial protection than microplegia. In addition, DN cardioplegia can be given as a single dose for 90 minutes of XC times, and therefore can be preferred to increase surgical comfort and reduce XC times. However, studies to be carried out in more complicated case series and larger case groups will guide us.

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