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Original Article

Comparison of Blood and del Nido Cardioplegia Solutions in Coronary Artery Bypass Surgery for Post-Operative Morbidity and Mortality

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Abstract

Objective: Del Nido cardioplegia (DNC) has been used routinely in pediatric cardiac surgery, but its use in adult cardiac surgery is still to be debated. This study was conducted to investigate and compare the effects of isotermic blood cardioplegia (BC) and DNC on early morbidity and mortality in adult patients undergoing isolated elective coronary artery bypass surgery.

Methods: A total of 187 patients who underwent isolated elective coronary artery bypass grafting surgery at our hospital in 2023 were included in the study. Patients with normal pre-operative left ventricular function who received DNC (85 patients) or isothermic BC (102 patients) for intraoperative myocardial protection were examined.

Results: There was no significant difference between the groups in terms of demographic data and pre-operative risk factors. The comparison of intraoperative parameters, including aortic cross-clamp time, perfusion time, and total operation time, revealed similar results between groups. There was no statistically significant difference between the groups regarding major morbidity and length of hospital stay, with the exception of greater atrial fibrillation rate in DNC group (5.9% in del Nido group vs. 0 in BC group, p=0.018). Mortality rate did not differ between groups.

Conclusion: This study revealed that DNC can be safely used in adult coronary artery bypass surgery for patients with preserved left ventricular function. To establish routine use of DNC solution in adult coronary bypass surgery, large randomized studies including patients with low ejection fraction and concomitant cardiac pathologies are required.

Keywords: Blood cardioplegia; coronary artery bypass graft; del Nido cardioplegia; myocardial protection.

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Koroner Arter Bypass Cerrahisinde Kan ve Del Nido Kardiyopleji Solüsyonlarının Postoperatif Morbidite ve Mortalite Üzerine Etkilerinin Karşılaştırılması

Özet

Amaç: Del Nido kardiyoplejisi pediatrik kardiyak cerrahide rutin olarak kullanılmasına rağmen, erişkin kalp cerrahisindeki yeri hâlâ tartışmalıdır. Bu çalışma, elektif izole koroner arter bypass cerrahisi geçiren erişkin hastalarda izotermik kan kardiyoplejisi ile Del Nido kardiyoplejisinin, erken dönem morbidite ve mortalite üzerindeki etkilerini araştırmak ve karşılaştırmak amacıyla gerçekleştirilmiştir.

Yöntem: 2023 yılında hastanemizde izole elektif koroner arter baypas greftleme (CABG) ameliyatı geçiren toplam 187 hasta çalışmaya dahil edildi. İntraoperatif miyokard koruması amacıyla del Nido kardiyoplejisi (85 hasta) veya izotermik kan kardiyoplejisi (102 hasta) uygulanan, preoperatif sol ventrikül fonksiyonu normal olan hastalar incelendi.

Bulgular: Gruplar arasında demografik veriler ve preoperatif risk faktörleri açısından anlamlı bir fark bulunmamıştır. Aortik kross-klemp süresi, perfüzyon süresi ve toplam operasyon süresi gibi intraoperatif parametreler açısından gruplarda benzer sonuçlar gözlemlenmiştir. Major morbidite oranları ve hastanede kalış süresi açısından

gruplar arasında istatistiksel olarak anlamlı bir fark saptanmamış, yalnızca Del Nido kardiyopleji grubunda atriyal fibrilasyon insidansı daha yüksek bulunmjuştur (%5,9'a karşılık 0%, p=0,018). Mortalite oranlarında da gruplar arasında anlamlı bir fark gözlenmemiştir.

Sonuç: Bu çalışma, sol ventrikül fonksiyonları korunmuş hastalarda del Nido kardiyoplejisinin erişkin koroner arter bypass cerrahisinde güvenle kullanılabileceğini ortaya koymuştur. del Nido kardiyopleji solüsyonunun erişkin koroner bypass cerrahisinde rutin kullanımı için düşük ejeksiyon fraksiyonuna sahip ve eşlik eden kardiyak patolojileri bulunan hastaları da içeren geniş kapsamlı randomize çalışmalara ihtiyaç vardır.

Anahtar sözcükler: Kan kardiyoplejisi; koroner arter bypass greftleme; del Nido kardiyoplejisi; miyokardiyal koruma.

Introduction

Myocardial protection is one of the most important factors affecting postoperative morbidity and mortality in cardiac surgery.[1,2] For many years, new strategies have been continuously developed to enhance myocardial protection. Hypothermic hyperkalemic solutions have made it possible to perform many procedures in cardiac surgery. Crystalloid and blood cardioplegia (BC) have been used for myocardial protection for many years. Del Nido cardioplegia (DNC) solution, originally developed in the 1990s for pediatric cardiac surgery, gained popularity due to its ability to provide myocardial protection for up to 90 min with a single-dose application[3–5] DNC has the advantage of increasing operative efficiency through shortening cardiopulmonary bypass and aortic clamp times with single dose strategy. DNC is classified as a modified depolarizing agent that promotes membrane polarization during ischemic arrest and reduces myocardial metabolic energy consumption. However, there are also concerns about DNC utilization in adult cardiac surgery since there is limited long-term adult data, a lack of standardization in redosing practices, and hemodilution in repeated doses.

Since there are still controversies about DNC versus blood cardioplegia (BC) in adult cardiac surgery, we aimed to compare surgical and clinical outcomes when DNC solution was used instead of our standard BC solution in patients undergoing isolated elective coronary artery bypass graft (CABG) surgery with normal left ventricular ejection fraction (EF).

Materials and Methods

Study Population

This retrospective study included a total of 187 patients with ischemic coronary artery disease and preserved left ventricular EF, who underwent isolated elective coronary artery bypass grafting (CABG) surgery at Kartal Koşuyolu Training and Research Hospital between January 2023 and January 2024. The study was approved by the Kartal Koşuyolu Training and Research Hospital Clinical Research Ethics Committee (approval date: September 3, 2024; approval number: 2024/15/895). The article is conducted according to the Declaration of Helsinki.

Clinical data were extracted from hospital archive records and electronic database; only in-hospital outcomes were assessed. Inclusion criteria were elective, isolated, on-pump, with cardioplegia-induced cardiac arrest CABG surgery in adult patients with preserved left ventricular function. Exclusion criteria were as follows: patients undergoing emergency CABG, patients under 18 years of age, patients with a left ventricular EF below 45%, those with a history of previous cardiac surgery, patients undergoing concomitant surgical procedures, those with concomitant cardiac pathologies, patients with pre-operative renal failure, patients with a history of pre-operative cerebrovascular events, patients undergoing minimally invasive surgery, cases using minimally invasive extracorporeal circulation, cases using a centrifugal pump, off-pump CABG, and cases where perioperative retrograde cardioplegia was administered. Patients were divided into two groups based on the type of cardioplegia used during surgery as BC and DNC groups.

Variable Definitions

Post-operative atrial fibrillation was defined as new-onset atrial fibrillation in the immediate period after surgery and required treatment.[6]

Perioperative acute kidney injury (AKI) was defined as:

1. ≥0.3 mg/dL increase in serum creatinine within 48 h or
2. ≥1.5- times increased serum creatinine from baseline, known or presumed to have occurred within 7 days or
3. Urine output <0.5 mg/kg/h for ≥6 h depending on KDIGO classification system.[7,8]

Packed red blood cells and fresh frozen plasma transfused during intensive care unit (ICU) were recorded.

Surgical Technique

Patients in the study group underwent surgery using the same surgical technique performed by four different teams at our hospital. Median sternotomy was performed to access the mediastinum. Grafts were prepared, and systemic heparinization was administered, ensuring an activated clotting time of over 480 s throughout the procedure. Arterial cannulation was performed through the ascending aorta, and systemic perfusion was initiated using a two-stage venous cannula in the right atrium. An aortic root cannula was placed. Following cross-clamping of the ascending aorta, antegrade cardioplegia was administered through the root cannula to induce cardiac arrest. The choice of cardioplegia was left to the surgeon's discretion. BC and DNC were prepared and administered according to our hospital's pre-established cardioplegia protocol. DNC contains 1000 mL Isolyte-S solution, 250 mL blood, 16.4 mL 20% mannitol solution, 13.2 mL 15% Mg SO_4, 12.4 ml $NaHCO_3$, 6.4 mL 2% lidokain, and 8.6 mL 22.5% KCL. BC contains 1000 mL blood, 10 mL 15% $MgSO_4$, 10 mL $NaHCO_3$, 10 mL 22.5% KCL. In all patients, a roller pump and membrane oxygenators were used. The pump flow rate was set between 2.2 and 2.4 L/min/m2 in a non-pulsatile manner, and the mean arterial pressure was maintained between 60 and 80 mmHg during the cross-

clamp period. Hematocrit levels were kept between 21% and 25% throughout the cardiopulmonary bypass period. After decannulation, heparin was neutralized with protamine sulfate. A mediastinal and thoracic drain was placed, and the sternum was closed with sternal wires. Following proper closure of the subcutaneous and skin layers, patients were transferred to the surgical ICU for postoperative monitoring.

Statistical Analysis

In our study, statistical analysis of the data was performed using version 21.0 of the Statistical Package for the Social Sciences software (IBM, Armonk, NY, USA). Descriptive statistics were expressed as mean ± standard deviation or median (minimum–maximum) for discrete and continuous numerical variables, while categorical variables were presented as case numbers and percentages (%). Cross-tabulation statistics (Chi-square, Fisher's exact test) were used for the comparison of categorical variables. Parametric data with a normal distribution were compared using the Student's t-test and Analysis of Variance, whereas non-parametric data that did not follow a normal distribution were analyzed using the Mann–Whitney U and Kruskal–Wallis tests. A $p<0.05$ was considered statistically significant.

Results

A total of 187 patients who underwent isolated elective CABG were included, consisting of 37 women (19.8%) and 150 men (80.2%), with a mean age of 60.06±8.94 years (range: 36–79 years). The mean age was 59.62±9.11 years for men and 61.86±8.07 years for women. BC group included 102 patients (54.5%), and 85 patients (45.5%) received DNC. The mean age of patients in the BC group was 60.37±9.27 years, while in the DNC group, it was 59.69±8.56 years. No statistically significant difference was found between the groups in terms of demographic and pre-operative risk factors that could have influenced the early surgical outcomes. Similarly, as the echocardiographic parameters between the groups were evaluated, no statistically significant difference was found in left atrial (LA) size, tricuspid annular plane systolic excursion, and pre-operative left ventricular EF (Table 1).

Comparison of intraoperative parameters between groups revealed no statistically significant differences between groups for aortic cross-clamp time, cardiopulmonary bypass time (CPB), and total operation time ($p>0.05$). The most common graft used was the left internal mammary artery (LIMA), used in 89.8% of cases (n=168), followed by the right internal mammary artery in 8.6% of cases (n=16) and radial artery grafts in 0.5% of cases (n=1). Utilization of LIMA did not show a statistically significant difference between the groups (88.2% vs. 91.8%) ($p=0.475$). The average number of total coronary anastomoses performed for revascularization was 3.00±0.82 (Range: 1–5). In the DNC group, the average number of total coronary anastomoses was 3.18 versus 2.85 in the BC group, which was found to be significantly higher ($p=0.011$). Complete revascularization was achieved in 175 patients (93.6%). In 12 patients, revascularization was incomplete due to an unsuitable vascular bed, but no statistically significant difference was observed between the groups in terms of incomplete revascularization. Comparing the hypothermia between the groups, 65.7% of cases in the BC group were revascularized at 30°C, whereas 52.9% of cases in the DNC group were revascularized at 32°C, which was found to be statistically significant ($p=0.005$). Intraoperative data are shown in Table 2.

Table 1. Pre-operative characteristics and data

	BC group (n=102)	DNC group (n=85)	p
Age (years)	60.37±9.27	59.69±8.56	0.172
Male (%)	86 (84.3)	64 (75.3)	0.142
Hypertension (%)	59 (57.8)	59 (69.4)	0.103
Diabetes mellitus (%)	56 (54.9)	45 (52.9)	0.789
COPD (%)	7 (6.9)	8 (9.4)	0.523
MI (%)	39 (38.2)	31 (36.5)	0.804
Hyperlipidemia	26 (25.5)	18 (21.2)	0.489
Smoke addiction	47 (46.1)	34 (40.0)	0.404
BMI (kg/m2)	27.81±3.79	35.98±47.73	0.131
Pre-operative LVEF (%)	61.42±6.79	59.63±7.90	0.059
Pre-operative TAPSE	2.24±0.39	2.33±0.38	0.160
LA size	3.57±0.37	3.70±0.45	0.105

Data are reported as mean±standard deviation or as absolute frequencies (percentages). BC: Blood cardioplegia; DNC: Del Nido cardioplegia; COPD: Chronic obstructive pulmonary disease; MI: Myocardial infarction; BMI: Body mass index; LVEF: Left ventricular ejection fraction; TAPSE: Tricuspid annular plane systolic excursion; LA: Left atrium.

Comparing the clinical data early after surgery, no statistically significant difference was found between the groups in terms of urine output, drainage, extubation time, replaced PE and FFP amounts ($p>0.05$). No differences were found between BC and DNC groups in terms of postoperative complications, including AKI and respiratory complications, except for new onset atrial fibrillation. Patients in the DNC group showed a higher rate of postoperative atrial fibrillation (5 patients in DNC group vs no patients in the BC group, $p=0.018$) and required antiarrhythmic medication. Patients identified with postoperative AF were verified by 12-lead electrocardiogram, monitorized and treated with medical cardioversion therapy. None of them required mechanical cardioversion, and all were discharged from the hospital in normal sinus rhythm. One patient from each group had acute renal insufficiency after surgery; the patient in the BC group developed renal insufficiency due to low cardiac output syndrome (LCOS) and was lost early after surgery, the patient in the DNC group was followed up medically and recovered without the requirement for renal replacement therapy. Median length of stay in (ICU) was shorter in patients of the DNC group; however, the difference between groups did not reach statistical significance.

For functional assessment of myocardium, postoperative echocardiographic evaluation revealed similar mean EF values for BC and DNC groups (59.34±8.64 vs 58.86±7.92, $p=0.612$). The variation between pre-operative and postoperative Troponin T

Table 2. Intraoperative parameters

	BC group	DNC group	p
Total CPB time (min) (Mean±SD)	96.49±28.69	99.02±27.14	0.665
ACC time (min) (Mean±SD)	56.60±20.60	58.04±17.73	0.401
Total surgery time (min) (Mean±SD)	275.54±53.65	273.76±49.90	0.900
Distal anastomosis with saphenous graft (Mean±SD)	1.87±0.86	2.14±0.95	0.073
Total coronary anastomosis (Mean±SD)	2.85±0.76	3.18±0.86	0.011*
Esophageal temperature (%)			
28°	3 (2.9)	0 (0.0)	**0.005***
30°	67 (65.7)	39 (45.9)	
32°	31 (30.4)	45 (52.9)	
34°	1(1.0)	1 (1.2)	

*: p≤0.05 was considered statistically significant. BC: Blood cardioplegia; DNC: Del Nido cardioplegia; CPB: Cardiopulmonary bypass; ACC: Aortic cross clamp; SD: Standard deviation.

levels was analyzed in each group separately and the rate of this change did not differ between groups as illustrated in Figure 1.

In-hospital mortality was not different between groups; 3 patients (2.9%) in the BC group and 1 patient (1.1%) in DNC group died. The only mortality in DNC group was a patient who had perioperative myocardial infarction due to graft failure on post-operative first hour, taken into emergency surgery, revascularized, and finally supported by extracorporeal membrane oxygenation (ECMO) but lost due to LCOS. One of the three mortalities in BC group was due to perioperative LCOS, who left the operating room with inotropic and intra-aortic balloon pump (IABP) support, and further required ECMO support, but unfortunately died on post-operative 3rd day. The other two patients in BC group died due to infection, one on postoperative day 28 due to sepsis, and one due to prolonged ventilation and pulmonary infection.

Postoperative findings of the patients are summarized in Table 3.

Discussion

In adult cardiac surgery, BC and DNC are the most commonly used cardioplegia solutions for effective myocardial protection; their superiority in terms of morbidity and mortality in coronary artery bypass surgery has not been clearly established yet.[9] The aim of this study was to evaluate advantages and disadvantages of Del Nido and BC solutions on early morbidity and mortality in patients undergoing isolated coronary artery bypass surgery.

Despite its retrospective design, propensity score matching demonstrated a homogeneous distribution between BC and DNC groups in terms of demographic and pre-operative clinical variables. In our study, no statistically significant differences were observed between the groups in terms of postoperative morbidities; acute renal failure, extubation time, inotropic support requirement, need for IABP or ECMO, postoperative myocardial infarction, or surgical site infection in the first 24 postoperative h. In addition, there were no significant differences regarding ICU stay duration, ward stay duration, total length of hospitalization, and early mortality.

Table 3. Post-operative outcomes

	BC group (n=102)	DNC group (n=85)	p
Total drainage (mL)	599.02±328.73	659.76±348.65	0.254
ICU PE transfusion	0.31±0.59	0.48±0.98	0.472
ICU FFP transfusion	0.42±0.63	0.38±0.59	0.667
Extubation time (hour)	6.96±4.75	6.67±4.47	0.445
Inotropic support (%)	29 (28.4)	25 (29.4)	0.883
IABP (%)	1 (0.98)	0 (0.0)	1.000
ECMO support (%)	1 (0.98)	1 (1.17)	1.000
Postoperative troponin T(ng/L)	0.58±0.69	0.53±1.04	0.709
Post-operative EF (%)	59.34±8.64	58.86±7.92	0.612
Myocardial infarction (%)	2 (1.96)	1 (1.17)	1.000
Atrial fibrillation (%)	0 (0.0)	5 (5.8)	0.018*
Antiarrhythmic medication (%)	0 (0.0)	4 (4.7)	0.041*
Acute renal insufficiency (%)	1 (0.98)	1 (1.17)	1.000
Surgical site infection (%)	2 (1.96)	0 (0.0)	0.501
ICU stay (day)	2.42±3.55	1.54±1.12	0.075
Hospital stay (day)	6.81±5.40	6.08±3.62	0.962
Mortality (30 day) (%)	3 (2.9)	1 (1.1)	0.627

Data are reported as mean±standard deviation or as absolute frequencies (percentages). *: p≤0.05 was considered statistically significant. BC: Blood cardioplegia; DNC: Del Nido cardioplegia; PE: Packed erythrocyte; FFP: Fresh frozen plasma; IABP: Intra-aortic balloon pump; ECMO: Extracorporeal membrane oxygenation; EF: Ejection fraction; ICU: Intensive care unit.

Several reports suggest that BC and DNC offer comparable efficacy for myocardial protection. In a study by Garcia-Suarez et al.,[10] the incidence of acute myocardial infarction and severe ventricular arrhythmias was found to be similar between the groups. Although postoperative troponin levels were observed to be elevated, the difference was not statistically significant. The incidence of ventricular fibrillation during reperfusion was higher in the BC group, which led to a greater need for defibrillation in that group. In another study sharing 6 years of clinical experience, Timek et al.[11] reported that patients receiving DNC had lower postoperative tropo-

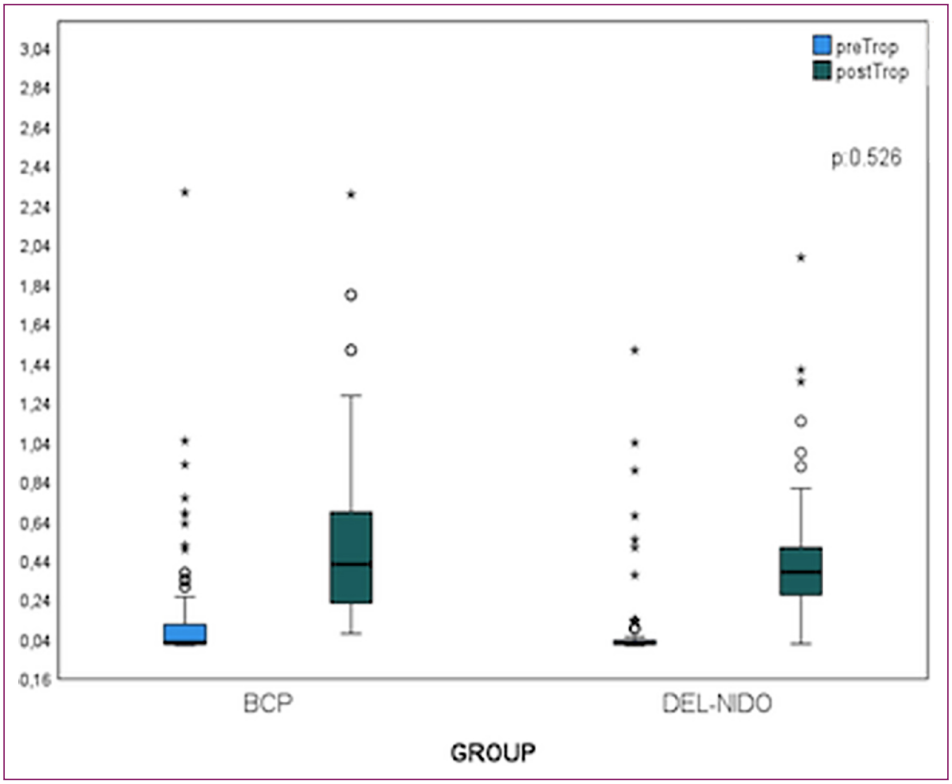

Figure 1. Preoperative and Postoperative troponin T variation in blood cardioplegia and Del Nido cardioplegia groups.

nin levels compared to those receiving BC, despite having a higher pre-operative STS risk profile. However, this difference was not statistically significant. In our study, post-operative echocardiographic parameters were similar, and post-operative troponin T levels did not differ between groups, showing comparable myocardial protection between BC and DNC preservation strategies. Supporting this outcome, there were no differences between groups in terms of post-operative requirement for inotropic medication and IABP or ECMO support during post-operative follow-up. However, the number of patients in the study groups was relatively small, so experience with larger groups is required to confirm our results.

We did not observe any difference between myocardial ischemia times between groups in contrast to previous studies,[11,12] and no statistically significant differences were observed between the groups in terms of total operative time, aortic cross-clamp time, or perfusion time, but the average number of distal coronary anastomosis was significantly higher in DNC group (3.18 vs. 2.85, p=0.011). This might be the advantage of single dose administration of DNC; prolonged myocardial protection may allow a greater number of distal anastomosis by enabling the surgical procedure to proceed without interruption. This may be explained by the surgical team's preference for DNC, especially in cases where a higher number of target vessels are planned to be revascularized.

In our clinic, the degree of hypothermia during CPB is determined according to clinical guidelines and within optimal safety limits. In our study, esophageal temperatures during CPB were most commonly recorded as 30°C in the BC group, and 30°C–32°C in the Del Nido group. Patients in the DNC group were operated under slightly less hypothermic conditions, but we were unable to comment on the clinical significance of this finding since we observed no difference between groups when total drainage, revision for bleeding, and transfusion of blood products were assessed.

Atrial fibrillation (AF) after cardiac surgery has been attributed to many pre-operative, operative, and post-operative risk factors including advanced age, hypertension, obesity, chronic lung disease, left ventricular dysfunction, aortic cross-clamp and cardiopulmonary bypass times, hypothermia, temperature of the cardioplegia, administration of inotropic agents electrolyte imbalance, and inflammatory response.[13] In most of the previous studies comparing blood and DNC, no difference was reported for post-operative AF development.[14] In our study, new onset AF was detected in five patients, and all patients were in the DNC group. Pre-operative risk factors that might be related with post-operative AF development were similar between groups, and mean aortic-clamp and total perfusion times were not different.

In contrast to our results, in their retrospective cohort analysis, Schutz et al.[15] concluded that patients receiving DNC experienced significantly lower rates of post-operative AF and ventricular tachycardia in their 299 pairs of propensity-matched only CABG patients compared to the BC group (21.7 vs. 30.1, p: 0.02). Similarly, Comentale and colleagues, in their study about role of Del Nido CP on onset of AF after CABG surgery, suggested that cardioplegia solutions might have an important

role through several mechanisms. They observed three times higher risk of AF in BC group compared to DNC group, and claimed that del Nido CP reduced AF rate acting on electrolyte balance and decreasing requirement for inotropic support.[16] Since we did not have full records of electrolyte levels during ICU follow-up, it was not possible to make such an assessment, but there were no group differences for inotropic support. Sanrı and colleagues, reported higher rates of post-operative atrial fibrillation in BC versus DNC groups of CABG patients, which was found to be related with higher cardioplegia volumes by BC.[17] In 2020, Timek et al.[11] reported retrospective analysis of their 851 isolated CABG cases, comparing del Nido and BC, confirming non-inferior myocardial protection and clinical outcomes even in high-risk patients, but similar to our results, they also reported a greater rate of postoperative AF in DNC group after propensity-matched analysis. However, a recent study by Toz et al.[18] comparing DNC with BC in CABG surgery found significantly lower rates of postoperative AF on post-operative days 1, 5, and 30 in the DNC group, and it was claimed that lidocaine in this solution plays the critical role in reducing rhythm disturbances. There is still inconsistent evidence about the benefits or similar effects of DNC versus BC on postoperative AF. Whether DNC is truly antiarrhythmic or the observed benefits in several studies are due to confounding factors is still the debate that should further be analyzed by large randomized trials.

Study Limitations

Main limitation of the study is its retrospective nature and the limited number of patients included. Furthermore, due to the low number of patients experiencing complications in both groups, statistical analysis could not be performed for some outcome variables.

Patients included were the initial group of adult patients in our center, operated with DNC, and they were isolated coronary artery patients with preserved left and right ventricular functions, and without concomitant cardiac pathologies requiring complex surgical procedures; therefore, the results of this study should be interpreted carefully before being translated to general routine.

Conclusion

This study confirms that single-dose DNC is a feasible alternative to repeated doses of BC in isolated coronary bypass surgery in patients with preserved EF. DNC provided non-inferior myocardial protection and early clinical results for coronary revascularization in patients with preserved left ventricular function. Since both techniques demonstrate similar effects on postoperative mortality and morbidity, the choice of the appropriate method should be guided by patient characteristics and the planned surgical procedure. Although the DNC solution can be used safely in patients with normal left ventricular function for isolated CABG, further studies with a higher number of patients, including high-risk patients and complex surgical procedures requiring longer cross-clamp times, should be planned before DNC is accepted as a routine protocol in all-comers.

Disclosures

Ethics Committee Approval: The study was approved by the Kartal Koşuyolu Training and Research Hospital Clinical Research Ethics Committee (no: 2024/15/895, date: 03/09/2024).

Informed Consent: Written informed consent was obtained.

Conflict of Interest Statement: None declared.

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References

1. Timek T, Willekes C, Hulme O, Himelhoch B, Nadeau D, Borgman A, et al. Propensity matched analysis of del nido cardioplegia in adult coronary artery bypass grafting: initial experience with 100 consecutive patients. Ann Thorac Surg 2016;101:2237–41.
2. Kachoueian N, Janghorban S, Gorjipour F, Torkashvand M, Mahjoob MP, Aslani H, et al. Traditional vs. modified Ringer lactate-based del Nido cardioplegia impacts on clinical outcomes in patients undergoing coronary artery bypass grafting: Results from a prospective, randomized, blinded trial. J Extra Corpor Technol 2024;56:159–66.
3. Demir D, Balci AB, Kahraman N, Sunbul SA, Gucu A, Seker IB, et al. The comparison of del nido cardioplegia and crystalloid-based blood cardioplegia in adult isolated coronary bypass surgery: A randomized controlled trial. Niger J Clin Pract 2022;25:1998–2004.
4. Jung JC, Kim SI, Hwang HY, Sohn SH, Choi JW, Chung JH, et al. Serial ultrastructural evaluation of myocardial ischemic injury after infusion of del Nido cardioplegia in the human heart. J Thorac Cardiovasc Surg 2022;164:528-35.e2.
5. Reidy MR, Jimenez E, Omer S, Cornwell LD, Runbeck SX, Preventza O, et al. Single-dose del nido cardioplegia compared with standard cardioplegia during coronary artery bypass grafting at a veterans affairs hospital. Tex Heart Inst J 2021;48:e196981.
6. January CT, Wann LS, Alpert JS, Calkins H, Cigarroa JE, Cleveland JC Jr, et al. 2014 AHA/ACC/HRS guideline for the management of patients with atrial fibrillation: executive summary: a report of the American College of Cardiology/American Heart Association Task Force on practice guidelines and the Heart Rhythm Society. Circulation 2014;130:2071–104.
7. Gumbert SD, Kork F, Jackson ML, Vanga N, Ghebremichael SJ, Wang CY, et al. Perioperative acute kidney injury. Anesthesiology 2020;132:180–204.
8. James M, Bouchard J, Ho J, Klarenbach S, LaFrance JP, Rigatto C, et al. Canadian society of nephrology commentary on the 2012 KDIGO clinical practice guideline for acute kidney injury. Am J Kidney Dis 2013;61:673–85.
9. Lin X, Jiang Y, Zhu P, Peng Q, Meng W, Zheng S. The application of del Nido cardioplegia for myocardial protection in adult coronary artery bypass grafting: a cohort study. J Thorac Dis 2022;14:177–84.
10. Garcia-Suarez J, Garcia-Fernandez J, Martinez Lopez D, Reques L, Sanz S, Carballo D, et al. Clinical impact of del Nido cardioplegia in adult cardiac surgery: A prospective randomized trial. J Thorac Cardiovasc Surg 2023;166:1458–67.
11. Timek TA, Beute T, Robinson JA, Zalizadeh D, Mater R, Parker JL, et al. Del Nido cardioplegia in isolated adult coronary artery bypass surgery. J Thorac Cardiovasc Surg 2020;160:1479–85.e5.
12. Hawkins RB, Stewart JW, Wu X, Goldberg J, Fitzgerald D, DeLucia A, et

al. del Nido versus blood cardioplegia in cardiac surgery: A multicenter analysis of over 40,000 patients. J Thorac Cardiovasc Surg 2024;168:1687-97.e5.
13. Mauro MD, Calafiore AM, Di Franco A, Nicolini F, Formica F, Scrofani R, et al. Association between cardioplegia and postoperative atrial fibrillation in coronary surgery. Int J Cardiol 2021;324:38–43.
14. Guajardo Salinas GE, Nutt R, Rodriguez-Araujo G. Del Nido cardioplegia in low risk adults undergoing first time coronary artery bypass surgery. Perfusion 2017;32:68–73.
15. Schutz A, Zhang Q, Bertapelle K, Beecher N, Long W, Lee VV, et al. Del Nido cardioplegia in coronary surgery: a propensity-matched analysis. Interact Cardiovasc Thorac Surg 2020;30:699–705.
16. Comentale G, Parisi V, Fontana V, Manzo R, Conte M, Nunziata A, et al. The role of Del Nido Cardioplegia in reducing postoperative atrial fibrillation after cardiac surgery in patients with impaired cardiac function. Heart Lung 2023;60:108–15.
17. Sanrı US, Özsin KK, Toktaş F, Yavuz Ş. Comparison of del nido cardioplegia and blood cardioplegia in terms of development of postoperative atrial fibrillation in patients undergoing isolated coronary artery bypass grafting. Braz J Cardiovasc Surg 2021;36:158–64.
18. Toz H, Kavala AA, Türkyılmaz S, Kuserli Y, Türkyılmaz G, Yesiltas MA, et al. Del nido vs. blood cardioplegia: a comparative analysis of postoperative atrial fibrillation in coronary artery bypass grafting patients. Braz J Cardiovasc Surg 2025;40:e20240071.