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Impact of Modified Del Nido Versus Traditional Cold Cardioplegia on Myocardial Protection in Cardiac Patients with a Low Ejection Fraction

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Abstract

Background: The optimal cardioplegia solution in patients undergoing complex cardiac surgery is debatable. This study aimed to compare the efficacy of modified Del Nido cardioplegia to that of conventional cold cardioplegia in patients undergoing cardiac surgery with low ejection fraction.

Methods: Participants were randomly divided into two groups: Group I had modified Del Nido cardioplegia (n=23), while Group II had standard blood cardioplegia (n=23).

Results: There was no difference in baseline data between the study groups. Group I had 20% lower additional doses of Del Nido (p= 0.032) and had shorter periods of cardiopulmonary bypass (2.78 ± 0.69 vs 3.35 ± 0.72 h, p= 0.039) and aortic cross-clamp (2.1 ± 0.56 vs. 2.5 ± 0.8 h, p= 0.040) times. Group I's need for inotropes decreased by 20% (p= 0.044). Postoperative data revealed that Group I had less time in the hospital (5.9 ± 2.9 vs. 7.7 ± 3.4 days, p= 0.037) and intensive care unit (26.3% less duration) and required less time to wean off the mechanical ventilator (18.2 ± 15.7 vs. 45.4 ± 22.7, p<0.001). There was no difference in mortality between the two groups.

Conclusion: In complex cardiac surgery patients with low ejection fraction, modified Del Nido cardioplegia may be as effective as traditional cardioplegia, with the added benefit of shorter cross-clamp and cardiopulmonary bypass times. Additionally, modified Del Nido cardioplegia may result in less inotropic support.

KEYWORDS
Cardiac surgery; Cardioplegia; Modified Del Nido; Myocardial preservation

Introduction

Valvular heart disease (CVD) exerts a substantial global health burden [1], a circumstance further aggravated by degenerative features, aging, demographic factors, a reduced ejection fraction (EF), and general health. These factors are anticipated to increase the prevalence of combined coronary artery bypass grafting (CABG) and valve operations. Cardioplegia, used to induce cardiac arrest during surgical procedures, emerges as a critical element in this context. The choice of cardioplegic solution in patients undergoing combined cardiac surgery could affect the short and long-term outcomes [2].

Cardioplegia ensures favorable surgical outcomes by protecting the heart, diminishing metabolic activity, and enhancing the

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myocardium's resilience to prolonged ischemia. The development of prolonged-action cardioplegia medications aimed at optimizing treatment has yielded primary benefits. These benefits include administering cardioplegia at a single dose, preventing procedural disruptions, and reducing aortic cross-clamp duration, which is particularly advantageous in advanced or minimally invasive cardiac procedures [3]. Despite the theoretical expectation that single-dose cardioplegia would more effectively protect the heart, patients undergoing heart surgery continue to experience postoperative cardiac issues [3].

Enhancing myocardial protection is crucial for patients undergoing cardiopulmonary bypass (CPB) to recover from ischemia and maintain functional sustainability [4]. Del Nido and his team pioneered the use of the Del Nido cardioplegia in the 1990s for pediatric cardiac procedures [5, 6]. Although initially designed for young age groups, recent studies have explored its application in adult cases [7]. The classic Del Nido cardioplegia formulation relies on calcium-free Plasma-Lyte A, which mirrors the electrolyte composition of the extracellular fluid. However, the limited availability of Plasma-Lyte A in many countries has led to recommendations for lactated Ringers as a suitable alternative for preparing modified Del Nido cardioplegia (MDNC). This modified version could offer effective myocardial protection while minimizing surgical interruptions by administering it in a single dose [7].

Marzouk and associates compared Del Nido and cold blood cardioplegia. Approximately 10% of patients reported in the Marzouk et al. study had left ventricular ejection fractions (LVEFs) of 35% or lower, and the cold blood (CB) group exhibited a 1% mortality rate, while the del Nido (DN) group had no recorded mortality. Postoperatively, 20% of the CB group and 40% of the DN group experienced a 10% increase in LVEF, with no observed decrease in LVEF in either Group [8]. However, only a few studies have examined the safety of MDNC in people undergoing cardiac surgery [8, 9]. This study aimed to compare the efficacy of modified Del Nido cardioplegia to that of conventional cardioplegia in patients with low ejection fraction undergoing cardiac surgery.

Patients and Methods

Design and patients

The study was carried out between July 2022 and June 2023. This study was conducted after receiving approval from the local ethics committee and written informed consent from each patient. A total of 46 cardiac patients who underwent complex open heart surgery participated in this prospective comparative randomized controlled trial. The cohort comprised 23 patients in Group I, utilizing modified Del Nido, and 23 in Group II, employing traditional cold cardioplegia. We included combined cardiac operations (double-valve procedures and CABG associated with valve surgery) in patients with a low EF (<40%) [9]. Short procedures involving single valves, isolated CABG, and patients with normal EF were excluded.

Preoperative evaluation

Preoperative assessments were conducted for all patients, encompassing thorough history-taking, including personal and occupational aspects. Additionally, a meticulous analysis of their complaints and associated symptoms was performed. Following the full history-taking process, a thorough clinical examination was conducted, supplemented by preoperative investigations, including electrocardiography, chest X-ray, transthoracic echocardiography, and coronary angiography. Warfarin, if administered, was discontinued four days before surgery until the International Normalized Ratio (INR) reached a level less than or equal to 1.5. Additionally, aspirin and clopidogrel were discontinued five days and one week before the surgical procedure, respectively.

Anesthetic management

In the operating room, proper monitoring lines were applied, which included a pulse oximeter, radial arterial line for invasive blood pressure monitoring, and urinary catheter insertion. Then, anesthesia was induced, followed by endotracheal intubation; subsequently, a central venous line was inserted, and a thermal probe.

The operative procedure

In the supine position, median sternotomy and pericardiotomy were performed for all patients.

CPB was established with aorto-bicaval cannulation after full heparinization was completed with intravenous unfractionated heparin (400 units/kg) with a target-activated clotting time >400 seconds. The vena cava snares and left ventricle vents were all inserted when indicated. At mild degrees of systemic hypothermia, an aortic cross-clamp was applied, followed by antegrade cardioplegia, which was different for each group in our study:

In Group I, modified Del Nido cardioplegia was employed, while classic hyperkalaemic blood cardioplegia was given for patients in Group II. The modified DN cardioplegia solution consisted of the base solution of 0.9% normal saline (800 mL), potassium chloride 26 mEq, 10% magnesium sulfate (25 ml), lidocaine 2% (6.5 ml), sodium bicarbonate (8.4%;13 mL), mannitol (20%, 16 ml) and crystalloid: blood ratio of 4:1.

For each patient, 100 mL was given as the induction dose. Subsequent doses of 500 mL were administered at 90-minute intervals. Del Nido cardioplegia was given at 20 mL/kg, with a maximum total volume of 1,000 mL. Extra doses of cardioplegia were not given unless the duration of myocardial ischemia was longer than 90 minutes or cardiac electrical activity was detected during the aortic cross-clamp.

The traditional cold blood cardioplegia solution was administered at 2 to 60 C. An induction dosage (1 L) was used to arrest the heart. Furthermore, additional dosages (500 mL) were administered at 30-minute intervals. The solution was infused at a rate of 20 mL/kg, with the total amount not exceeding 1,000 mL. At 30-minute intervals, another half-volume of potassium-rich cardioplegia (300–500 mL) was added.

After administering cardioplegia and achieving cardiac arrest, surgical procedures were allowed, and further doses of cardioplegia were administered as indicated above. Finally, the weaning-off bypass was followed by the heparin reversal with protamine. Thorough hemostasis, drains, and temporary epicardial pacemaker wires were all inserted. Finally, sternotomy closure and wound closure in layers was performed.

The following intraoperative parameters were reported: the total aortic cross-clamp time, CPB time, and vasoactive-inotropic support [9].

Postoperative care

After surgery, the patients were transferred to the ICU on a mechanical ventilator (MV) and proper inotropes when needed. The degree of consciousness was plotted based on the Glasgow Coma Scale (GCS) score. Hemodynamics were also recorded, including heart rate, blood pressure, fluid balance, and arterial blood gases. The need for inotropic support and the total duration of inotropes were documented. Ventilation times and ICU stays were also monitored. Laboratory investigations of kidney function and liver function were performed. Furthermore, serial troponin T (T) measurements were obtained immediately after ICU admission and 24 hours after the operation. Any stroke, bleeding, prolonged MV, renal or hepatic derangements, or ICU mortalities were considered.

Patients were discharged from the ICU after stabilization and removal of the drains. Additional parameters, including in-hospital stay and in-hospital mortality, were recorded. Postoperative echocardiography was performed on day five following surgery to assess the ejection fraction.

Statistical analysis

The data were analyzed using MedCalc 18.9.1. Parametric data are presented as the means and standard deviations (SDs), and categorical data are presented as percentages and frequencies when appropriate. Continuous data were compared using the t-test or Mann-Whitney test. The chi-squared test and Fisher exact test were used to analyze categorical variables. The significance level was set at the 5% level for all the statistical tests.

Results

Demographic Data

There were 16 females, 8 in each Group, and 30 males, 15 in each Group. The mean age was 40 ± 14.7 years for Group I and 43.4 ± 15.3 years for

Group II, with no statistically significant difference between the two groups. The preoperative NYHA class did not significantly differ between the two groups (2.74±0.45 for Group I versus 2.83±0.38 for Group II). Similarly, the preoperative ejection fraction did not differ significantly, with means of 34.7±3.6 for Group I versus 34.4±3.7 for Group II.

Valvular heart disease was the prevalent cardiac illness in the present study. Double valvular heart disease was prevalent in 60.9% of Group I patients and 34.8% of Group II patients (p= 0.077). Triple-valve disease, on the other hand, was observed in 26.1% of the patients. Aortic aneurysms were observed in one patient in each Group, whereas 8.7% of patients in Group I and 26.1% of patients in Group II had both valvular heart disease and coronary artery disease.

Concerning the type of operation, there was no significant difference between the two groups. Valve replacement was performed in 9 patients (39.1%) in each Group, whereas combined repair and replacement were performed in 11 (47.8%) patients in Group I and 8 (34.8%) in Group II. Only two patients (8.7%) in Group I and six (26.1%) in Group II underwent both valve replacement and CABG. One patient in each Group underwent Bentall surgery (Table 1).

Table 1: Comparison of the baseline data between patients who received modified Del Nido cardioplegia (Group I) and those who received traditional cardioplegia (Group II). Data are presented as numbers and percentages or mean and SD.

	Group I (n= 23)	Group II (n= 23)	*p*-value
Age (Years)	40 ± 14.7	43.4 ± 15.3	0.446
Sex:			
Female	8 (34.8%)	8 (34.8%)	>0.99
Male	15 (65.2%)	15 (65.2%)	
Risk Factors:			
Hypertension	12 (52.2%)	11 (47.8%)	0.768
Diabetes Mellitus	9 (39.1%)	8 (34.8%)	0.760
Cardiac Disease:			
MR	22 (95.7%)	19 (82.6%)	0.346
AR	16 (69.6%)	15 (65.2%)	0.753
TR	10 (43.5%)	8 (34.8%)	0.546
Double valve	14 (60.9%)	8 (34.8%)	0.077
Triple Valve	6 (26.1%)	6 (26.1%)	>0.99
CAD	2 (8.7%)	6 (26.1%)	0.243
Valve+ CAD	2 (8.7%)	6 (26.1%)	0.243
Aortic aneurysm	1 (4.4%)	1 (4.4%)	>0.99
NYHA class	2.74 ± 0.45	2.83 ± 0.38	0.468
Ejection fraction (%)	34.7 ±3.6	34.4 ± 3.7	0.782
Type of operation			
Valve replacement	9 (39.1%)	9 (39.1%)	>0.99
Valve repair and replacement	11 (47.8%)	8 (34.8%)	0.369
Valve replacement and CABG	2 (8.7%)	6 (26.1%)	0.243
Bentall operation	1 (4.3%)	1 (4.3%)	0.99

MR: mitral regurgitation, AR: aortic regurgitation, TR: tricuspid valve regurgitation, CAD: coronary artery disease, NYHA: New York Heart Association class, CABG: coronary artery bypass grafting.

Table 2: Comparison of the operative data between patients who received modified Del Nido cardioplegia (Group I) and those who received traditional cardioplegia (Group II)

Variable	Group I	Group II	p-value
CP duration (h)	2.78 ± 0.69	3.35 ± 0.72	0.039
Aortic Cross clamp (h)	2.1 ± 0.56	2.5 ± 0.8	0.040
Number of CP doses	1.96 ± 0.75	2.46 ± 0.8	0.032
Need defibrillator	3 (13.64%)	9 (39.13%)	0.091
Inotropic score	2 ± 0.8	2.5 ± 0.87	0.044

CP: cardioplegia, hrs: hours

Operative results

A statistically significant difference in the mean cardiopulmonary bypass (CPB) duration existed between the groups; Group I had 2.78 ± 0.69 hours, and Group II had 3.35 ± 0.72 hours ($p = 0.039$). Similar results were obtained for the aortic cross-clamp time, which indicated a 16% reduction in time from Group II (2.5 ± 0.8 hours) to Group I (2.1 ± 0.56 hours), with a statistically significant difference (Table 2). Moreover, it was discovered that the demand for additional modified del Nido doses decreased by 20% to 1.96 ± 0.79, compared to 2.46 ± 0.8 in Group II. The defibrillator was required in 3 patients in Group I (13%) 9 patients (39.1%) in Group II.

A lower VIS in the modified Del Nido group indicated a reduced need for inotropic agents. The study revealed a statistically significant 20% reduction in the demand for inotropes in Group I (2 ± 0.8) compared to Group II (2.5 ± 0.87) (Table 2).

Postoperative results

The present study revealed a statistically significant decrease in the duration of ICU stay for patients in Group I (2.8 ± 1.7 days) in comparison to Group II, where the duration was 3.8 ± 1.4 days, reflecting a 26.3% reduction in days ($p = 0.035$). Parallel findings regarding hospital stay following ICU discharge revealed a 29% decrease in the modified Del Nido group. As a result, the total hospital stay in days, encompassing both the ICU and post-ICU phases, was notably shorter in Group I (6 ± 2.9 days) than in Group II (8 ± 3.4 days), reflecting a 29% reduction ($p= 0.037$) (Table 3).

Moreover, Group I not only experienced a significant 60% reduction in the duration required for inotropic weaning (17.3 ± 14.9 hours) compared to Group II (42.7 ± 21.2 hours) but also demonstrated a parallel 60% reduction in the time taken for ventilation weaning compared to Group II (from 45.4 ± 22.7 hours to 18.2 ± 15.7 hours) (Table 3).

The immediate troponin concentration in the ICU (T1)

Troponin level was lower in Group I (3.2 ± 1.6 ng/ml) than in Group II (4.1 ± 1.7 ng/ml); however, these differences were not significant ($p = 0.072$) (Table 3).

T2-Troponin (24 hours)

After 24 hours, a significant difference in troponin levels was observed between Group I (2.2 ± 1.7 ng/ml) and II (3.8 ± 1.4 ng/ml) ($p < 0.001$).

CK-MB

Immediate postoperative CK-MB1

In the present study, Group 1 displayed a statistically significant 38.7% reduction in immediate postoperative CK-MB1 levels (20.27 ± 8.03 u/l) in contrast to Group II (33.1 ± 10.2 u/l) (Table 3).

24-hour postoperative CK-MB2

Group I demonstrated a notable 47.9% reduction in mean CK-MB2 levels (12.3 ± 2.7 u/l), establishing a statistically significant difference compared to Group II (23.6 ± 6.8 u/l).

Hospital mortality

In Group I, three individuals (13.1%) died, while seven individuals (30.4%) died in Group II, with no significant difference between the two groups (Table 3).

Table 3: Comparison of the postoperative data between patients who received modified Del Nido cardioplegia (Group I) and those who received traditional cardioplegia (Group II). Data are presented as mean and SD or numbers and percentages

Variable	Group I	Group II	*p* value
Postoperative GCS	2.26 ±1.1	2.8 ± 0.68	0.052
Duration on inotropes	17.3 ±14.9	42.7 ± 21.2	<0.001
Ventilation times	18.2 ± 15.7	45.4 ± 22.7	<0.001
Cardiac enzymes			
T1 (ng/ml)	3.2 ± 1.6	4.1 ± 1.7	0.072
T2 (ng/ml)	2.2 ± 3.9	3.8 ± 1.4	<0.001
CK-MB1 (µ/L)	20.3 ± 8.03	33.1 ± 10.2	<0.001
CK-MB2 (µ/L)	12.3 ± 2.7	23.6 ± 6.8	<0.001
Stay in days			
ICU stay	2.8 ± 1.7	3.8 ± 1.4	0.035
Hospital	3.2 ± 1.7	4.5 ± 1.7	0.012
Total stay	5.9 ± 2.9	7.7 ± 3.4	0.037
Mortality rate	3 (13.1%)	7 (30.4%)	0.284

GCS: Glasgow Coma Scale, T: Troponin, ICU: Intensive care unit.

Discussion

Cardioplegia temporarily arrests the heart during cardiac surgery to prevent ischemic injury. The traditional method uses a high-potassium solution, while the newer approach, modified Del Nido cardioplegia, has shown promise in reducing the risk of heart damage during adult cardiac surgery [10]. Modified Del Nido cardioplegia combines elements from traditional and original Del Nido formulations and was initially used for pediatric surgery. A lower potassium concentration lowers the risk of heart damage. Preventive agents, such as lidocaine and magnesium, can be used to enhance heart protection. When administered at less frequent intervals, this approach reduces the need for frequent dosages during surgery, minimizing potential interruptions [10].

To the best of our knowledge, there are paucity of data on using modified Del Nido cardioplegia in adult cardiac surgery in Egypt. The main goal of this study was to assess the outcomes of modified Del Nido cardioplegia compared to conventional cardioplegia in cardiac patients with low ejection fraction (EF). The secondary objectives included evaluating postoperative outcomes, such as ICU stay and changes in cardiac enzymes (troponin I and CK-MB). From July 2022 to June 2023, 46 diverse cardiac patients with poor ejection fraction (EF) who underwent combined surgeries were included. The patients were divided into two groups: Group I (23 patients) received modified Del Nido cardioplegia, and Group II (23 patients) received conventional cardioplegia.

All operative details were recorded, including bypass time, aortic cross-clamp duration, drug dosages, inotropic support (converted to a score), and defibrillator usage. Postoperative data, such as ICU and hospital stay durations, troponin and CK-MB levels (immediately and 24 hours post-surgery), weaning, and respiratory support durations, were documented.

Preoperative analysis of both study groups, including sex, age, NYHA class, ejection fraction (EF), and vital signs, revealed minimal differences. Surgical procedures, whether valvular, double or triple valve disease, were comparable and mainly involved valve replacement. This demographic similarity enhances internal validity and minimizes the impact of extraneous factors on statistical comparisons, as noted by Chen et al. (2021) [11].

This study examined the impact of modified Del Nido (MDN) cardioplegia on cardiopulmonary bypass and aortic cross-clamp times in cardiac surgery patients. Group II, which had traditional cardioplegia, had a longer CPB and ischemic times. Prior studies have consistently shown significant reductions in both cardiopulmonary bypass and aortic cross-clamp times with MDN compared to conventional methods. Chen et al. (2021) [11] noted a 17% decrease in bypass time and a 19% decrease in clamp time. Hamad et al. (2017) [12] and Brown et al. (2023) [13] reported reductions of 15.5% and 13.4%, respectively, in bypass time and clamp duration. Consistent with these findings, our study revealed a 16% decrease in both cardiopulmonary bypass time and aortic cross-clamp duration in patients treated with the MDN cardioplegia approach. These outcomes indicate the effectiveness of the MDN solution in reducing the time needed for cardiac arrest and cardioplegia administration, potentially contributing to a shorter overall operation duration.

This study assessed suitable MDN cardioplegia dosages compared to standard doses in individuals who underwent valve surgery alone or with CABG. Conflicting findings in adult cardiac surgery efficacy between MDN and blood-based cardioplegia were noted in studies by Hamad et al. (2017) [12]. There was a reduction in cardioplegia doses in patients with MDN. Therefore, MDN cardioplegia may accelerate surgeries and improve patient outcomes due to its dose advantages over standard cardioplegia. The dosage and results of MDN cardioplegia need additional research. These data clarify cardiac surgery's benefits for patients with MDN cardioplegia. Changes in the dosage and efficacy of MDN cardioplegia should be examined in larger patient cohorts.

The present study revealed a significant 20% reduction in inotropes associated with modified Del Nido cardioplegia. This finding aligns with prior research by Hamad et al. (2012) [12], who showed improved myocardial protection and a decreased need for inotropic support in patients with modified Del Nido cardioplegia, with inotropic score reductions ranging from 26.8% to 34.4%. This finding suggests improved myocardial protection and better patient outcomes.

The study showed a difference in defibrillator use between Groups I and II. A lower percentage of patients in Group I required defibrillation (13%) than did patients in Group II (39.1%). These findings align with previous research by Shah et al. (2020) [14], who reported that patients with modified Del Nido cardioplegia need reduced arrhythmias and defibrillation. These results contribute to the increasing evidence supporting the efficacy of modified Del Nido cardioplegia for decreasing arrhythmias during cardiac surgery.

Consistent with our study, Group I patients had a shorter ICU stay than Group II. These findings align with those of, Stamou et al., Timek et al. (2020) and Kossar et al. (2023) [15-17], indicating a similar reduction in ICU stay in adult cardiac surgery patients with modified Del Nido cardioplegia. Modified Del Nido cardioplegia reduced postoperative ICU stays and mechanical ventilation according to Stamou et al. (2019), Timek et al. (2020) and Kossar et al. (2023), [15 - 17], who reported that modified Del Nido cardioplegia reduced postoperative ICU stays by 28% to 36.8%. Together with the findings of Stamou et al. (2019), Timek et al. (2020) and Kossar et al. (2023) [15–17], our study consistently showed that modified Del Nido cardioplegia reduces hospital stays in cardiac surgery patients. These studies reported a 1-3 day reduction, with our study revealing a 1.3-day decrease (29%). These collective findings suggest that adopting the modified Del Nido solution holds promise for shortening hospital stays and improving outcomes in cardiac surgery. Our findings align with those of Seleem et al. (2023) [18], who reported a 36% reduction in hospital stay in patients with Del Nido compared to patients with traditional cardioplegia.

This study aligns with the findings of Chen et al. (2021) and Fresilli et al. (2023) [11, 19] on 'the impact of cardioplegia on postoperative heart healing and inotropic weaning. Fresilli et al. (2023) [19] noted a shorter time to discontinue inotropes in patients with modified Del Nido cardioplegia. Chen et al. (2021) [11] reported a 50% reduction in the median duration of terminated inotropes in patients with modified Del Nido cardioplegia compared to patients with standard cardioplegia.

In our study, we noted a 60% decrease in the inotropic weaning interval in Group I. These results reinforce that the cardioplegia method chosen in cardiac surgery significantly influences postoperative inotropic support duration. The shorter weaning period in Group I suggested that modified Del Nido cardioplegia may enhance heart healing and recovery efficiency.

Our study demonstrated a significant reduction in ventilation weaning time in patients with modified Del Nido cardioplegia compared to patients with traditional cardioplegia. These findings align with research by Ziazadeh et al. (2017) [20] on the impact of modified Del Nido cardioplegia on ventilation time in cardiac surgery, who reported a 23.2% reduction in ventilation time during aortic valve replacement surgery with modified Del Nido cardioplegia. This study builds upon previous findings, reporting a more substantial 60% reduction in ventilation weaning time in patients with modified Del Nido cardioplegia than in those with traditional cardioplegia. These results suggest that modified Del Nido cardioplegia may be a more effective strategy for shortening the duration of mechanical ventilation in cardiac surgery patients. The study's implications are significant. A shorter mechanical ventilation duration offers benefits, reducing ventilator-associated complications, enhancing patient comfort, and reducing healthcare costs. Modified Del Nido cardioplegia may improve patient outcomes and optimize resource utilization in cardiac surgery by decreasing mechanical ventilation duration.

While the difference between Groups I and II was not statistically significant, Group I exhibited less myocardial injury than Group II. Additionally, Group I had lower troponin levels 24 hours after surgery than Group II. The immediate postoperative CK-MB (CK-MB1) level in Group I was lower than in Group II. The modified Del Nido cardioplegia solution may be more effective at reducing postoperative myocardial damage in individuals undergoing cardiac surgery [21, 22]. Ler et al. (2020) demonstrated a 55% reduction in postoperative CK-MB levels. Additionally, troponin I levels are reduced by 44% after surgery [21].

Our study, combined with that of Mick et al. (2015) [22], indicates that modified Del Nido cardioplegia provides myocardial protection and may enhance postoperative cardiac function. However, divergent findings regarding NYHA class improvements and EF changes among studies underscore the need for additional research to better comprehend the potential benefits of this technique. The study by Sanetra et al. (2023) [23] compared the effects of modified Del Nido cardioplegia and traditional cardioplegia on arterial blood gas and hemoglobin levels in patients undergoing coronary artery bypass grafting. The study revealed no significant differences in arterial blood gas or hemoglobin levels between the two groups at any point during the perioperative period. The present investigation verified the same findings.

Limited data exist on mortality rates between patients treated with modified Del Nido and those treated with traditional cardioplegia. Several studies suggest that the mortality of patients is lower with modified Del Nido [23, 24]. An et al. (2019) [24] reported reduced in-hospital mortality and shorter ICU stay after CABG surgery. The choice of cardioplegia varies based on patient and surgeon factors. The study 'could not confirm a significant decrease in mortality associated with modified Del Nido cardioplegia in Group I. Although a decreasing trend in mortality was observed, this change may be influenced by our center's surgeons. Koponen et al. (2019) and Sun et al. (2024) [25, 26] highlighted the impact of vasoactive-inotropic 'medications on cardiac surgery mortality. The current study explored the correlations between cardioplegia agent use, VIS, and mortality, revealing that modified Del Nido cardioplegia reduces VIS and mortality, with a one-third decrease in VIS and a subsequent 20% decrease in mortality. Other studies demonstrated comparable outcomes between del Nido and blood cardioplegia in patients with low ejection fraction [27].

Additional research on modified Del Nido cardioplegia in diverse cardiac surgeries, emphasizing long-term outcomes in larger patient groups is recommended. The study is limited by the small sample size and the single center experience.

Conclusion

In combined cardiac surgery patients with low ejection fraction, modified Del Nido cardioplegia may be as effective as traditional cardioplegia, with the added benefit of shorter cross-clamp and cardiopulmonary bypass times. Additionally, modified Del Nido cardioplegia may result in less inotropic support.

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