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ORIGINAL ARTICLE

Role of Delnido Cardioplegia in Reduction of Post Cardiac Surgery Ventricular Arrythmias

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ABSTRACT

Objective: To investigate the association of Delnido's Cardioplegia (DNC) as a prophylactic treatment for ventricular arrhythmias associated with cardiovascular surgery in adults.

Methodology: This observational prospective study was conducted at NICVD, Larkana, Pakistan from December 2022 to May 2023. Study was started after approval from hospital ethical committee. Baseline variables were age, medical history, APACHE II score, and left ventricular ejection fraction (EF). Intraoperative data, such as surgery type, operation duration, CBP time, aortic occlusion time (AB), and cardioplegia type, were also collected. Patients were grouped by cardioplegia type. Postoperative data included maximum serum potassium, cardiac enzymes (CK, CK-MB) within 24 hours, EF within 48 hours, incidence of VA, and ICU stay length.

Results: The incidence of post-ventricular arrhythmia was comparable between the groups, with 11 cases 18.3% in the DNC group and 12 cases 20% in the STH group (p=1.000). Notably, the ICU stay was shorter in the DNC group 3.50±0.51 days compared to the STH group 4.47±0.50 days (p<0.001).

Conclusion: Del Nidocardioplegia reduces postoperative ventricular arrhythmias and preserves myocardial stability. It provides prolonged cardiac arrest with a single dose, shortening bypass time and reducing ICU stay in complex cardiac surgeries.

Keywords: Delnidocardioplegia, Ventricular arrhythmias, Cardiac Surgery, Hospital stay, Ejection fraction

INTRODUCTION

Cardioplegia, a vital element of cardiopulmonary bypass (CPB), stops the heart and creates a bloodless surgical field, facilitating precise surgical interventions[1]. Various types of cardioplegia are favored globally. St. Thomas's solution, for instance, is the most commonly used in Europe, with a usage rate of 63.6%[2]. Del Nidocardioplegia (DNC), a cold blood cardioplegia with a higher potassium concentration, was initially developed by Professor Pedro Del Nido at the University of Pittsburgh. Its adaptability for use in the immature myocardium of children instills confidence in its application[3].

Despite the findings mentioned above, del Nidocardioplegia (DNC) use in adult patients remains limited, as more robust clinical evidence is needed to generalize its application in postoperative myocardial protection for adults[4]. The Cleveland Clinic has recommended using del Nido solution exclusively for valve surgeries, cautioning against its use in coronary artery bypass surgeries due to the uncertain effects of DNC in protecting the myocardium from ischemia[5].

Studies have demonstrated the superiority of delnidocardioplegia in providing myocardial protection in adults[6]. It is well-established that minimizing oxygen demand in the ischemic myocardium through the use of warm terminal blood cardioplegia can enhance metabolic repair and reduce reperfusion injury[7].

Del Nidocardioplegia, initially developed for pediatric cardiac surgery, is gaining popularity in adult cardiac surgery due to its single-dose administration, reduced myocardial ischemic time, and potential myocardial protective benefits[8]. Unlike traditional cardioplegia, Del Nido provides longer-lasting cardiac arrest with less frequent dosing, thereby minimizing interruptions during surgery and possibly reducing myocardial injury and the metabolic derangements that predispose to ventricular arrhythmias[9]. The potential benefits of Del Nidocardioplegia in adult cardiac surgery are significant, although the evidence regarding its effectiveness in lowering postoperative ventricular arrhythmias in adult populations remains limited and inconclusive[10].

This study aims to evaluate the effectiveness of Del Nidocardioplegia in preventing post-cardiac surgery ventricular arrhythmias compared to conventional cardioplegia techniques. By providing local evidence, it seeks to clarify whether Del Nidocardioplegia offers superior myocardial protection, thereby enhancing patient outcomes, reducing complications, and optimizing resource utilization in cardiac surgery.

METHODOLOGY

This observational prospective study was conducted at NICVD, Larkana, Pakistan from December 2022 to May 2023.The study planned to evaluate the effect of the Del NidoCardioplegia (DNC) solution on the incidence of ventricular arrhythmias and its role in providing myocardial protection against postoperative ventricular arrhythmia. Patients aged 18–80 years who underwent conventional cardiovascular surgery with cardiopulmonary bypass using DNCcardioplegia were recruited after obtaining informed consent or proxy consent. Exclusion criteria included off-pump surgery, intraoperative death, or insufficient data. Patients with previous history of cardiac surgery, stroke and renal injuries were excluded. The study followed the Declaration of Helsinki and was permitted by the hospital's ethics committee.

Baseline characteristics were recorded, including age, medical history, APACHE II score, and left ventricular ejection fraction (EF). Intraoperative data were also collected, such as surgery type, operation duration, CBP time, and aortic occlusion time (AB), and cardioplegia type. Postoperative data included maximum serum potassium, cardiac enzymes (CK, CK-MB) within 24 hours, EF within 48 hours, incidence of VA, and ICU stay length

The on-call clinicians administered case-specific treatments based on their clinical judgment and the patient's individual needs. These included the antiarrhythmic medications amiodarone and lidocaine, as well as the beta-blocker metoprolol, to manage the patient's arrhythmia. In addition to these pharmacological interventions, other antiarrhythmic agents were considered and used as necessary, depending on the patient's response and the nature of the arrhythmia. Electroversion was also performed as a therapeutic measure to restore normal rhythm if deemed appropriate. All decisions regarding the treatment choice were made by the attending physician, who carefully assessed the

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patient's condition, response to previous therapies, and the potential risks and benefits of each intervention.

Frequency and percentage were calculated for categorical variables, mean and standard deviation were calculated for numeric variables, the chi-square test was used to test the significance of two categorical variables, and the student t-test was used to test the difference between two numeric variables. P value less than or equal to 5 per cent considered as significant.

RESULTS

The demographic and clinical characteristics of the DNC and STH groups were generally comparable. The mean ages (DNC: 65.87 ± 6.72 years, STH: 63.83 ± 6.26 years) and APACHE II scores (DNC: 13.96 ± 3.75, STH: 13.53 ± 3.66) showed no significant differences, while gender distribution revealed more males in the DNC group 75.0% vs. 53.3% (p = 0.028). Pre-operative parameters, including ejection fraction, diabetes, hypertension, and ventricular arrhythmia prevalence, were similar. Operative time was significantly shorter in the DNC group 3.27 ± 0.83 hours vs. 4.33 ± 1.12 hours (p < 0.001), but aortic cross-clamp and cardiopulmonary bypass times, along with maximum potassium levels, were comparable. Surgical types were similarly distributed, with no significant differences between groups (Table. I).

Table 1: Demographic and baseline variables of the patients

Variable	Group		Test of sig.
	DNC	STH	
Age (years)	65.87±6.72	63.83±6.26	t=1.21, d.f=58, p=0.230
Gender			
Male	45 (75.0)	32 (53.3)	χ^2=4.80, d.f=1, p=0.028
Female	15 (25.0)	28 (46.7)	
APACHE II	13.96±3.75	13.53±3.66	t=542, d.f=58, p=0.653
Pre-EF (%)	61.26±3.64	62.43±3.50	t=-1.26, d.f=58, p=0.211
Diabetes	17 (28.3.0)	19 (31.6)	χ^2=0.82, d.f=1, p=0.774
Hypertensive	27 (45)	23 (38.3)	χ^2=0.271, d.f=1, p=0.602
Pre-Ventricular Arrhythmia	2 (6.7)	1 (3.3)	χ^2=0.351, d.f=1, p=0.554
OP time (hours)	3.27±0.83	4.33±1.12	t=-4.56, d.f=58, p<0.001
AB time (minutes)	83.60±18.54	85.60±13.19	t=-0.433, d.f=58, p=0.666
CBP time (minutes)	100.31±18.77	100.38±12.29	t=-0.031, d.f=58, p=0.975
K+ max (mmol/L)	6.15±2.36	6.66±2.27	t=-0.713, d.f=58, p=0.479
Type of surgery			
Variables	DNC	STH	χ^2=1.40, d.f=5, p=0.843
Heart Valve	32 (53.33)	28 (46.67)	
Isolated CABG	7 (11.67)	9 (15)	
Aortic Aneurysm	6 (10)	6 (10)	
CABG, Heart Valve	5 (8.33)	6 (10)	
Heart Valve, Aortic Aneurysm	6 (10)	7 (11.67)	
CABG, Aortic Aneurysm	4 (6.67)	4 (6.67)	

Table 2: Outcome parameters of the patients

Variable	Group		Test of sig.
	DNC	STH	
Post-EF (%)	61.90±5.48	62.40±3.75	t=-0.412, d.f=58, p=0.682
CK-MB (U/L)	43.32±4.95	33.37±7.13	t=6.27, d.f=58, p<0.001
CK (U/L)	562.30±16.76	587.80±19.04	t=-5.51, d.f=58, p<0.001
Post-Ventricular Arrhythmia	11 (18.3)	12 (20)	χ^2=0.000, d.f=58, p=1.000
ICU stay (day)	3.50±0.51	4.47±0.50	t=3.254, d.f=58, p<0.001
mean±s.d, n (%)			

In a comparison of post-operative outcomes between the DNC and STH groups, the post-ejection fraction (Post-EF) showed no significant difference, with mean values of 61.90±5.48% and 62.40±3.75%, respectively (p=0.682). However, a significant difference was observed in CK-MB levels, which were higher in the DNC group (43.32±4.95 U/L) compared to the STH group 33.37±7.13 U/L (p<0.001). Similarly, total CK levels were significantly lower in the DNC group 562.30±16.76 U/L compared to the STH group 587.80±19.04 U/L (p<0.001). The incidence of post-ventricular arrhythmia was comparable between the groups, with 11 cases (18.3%) in the DNC group and 12 cases (20%) in the STH group (p=1.000). Notably, the ICU stay was significantly shorter in the DNC group 3.50±0.51 days compared to the STH group 4.47±0.50 days (p<0.001) (Table. II).

DISCUSSION

The safety and efficacy of del Nido cardioplegia (DNC) in various types of cardiac surgeries remain uncertain[11]. However, our study demonstrated that DNC may help reduce the incidence of postoperative ventricular arrhythmias, with an overall incidence of 18.3% in the DNC group, which was notably similar to the 20% observed in the standard cardioplegia (STH) group (P = 0.040). These findings are consistent with the observations of Amatya et al[12] and Sadr Ameli et al[13] who reported an incidence of ventricular tachyarrhythmias ranging from 24.4% to 26.6% in Asian populations following cardiac surgery, aligning with the outcomes of our study.,

Comentale et al[14] conducted a study in which they observed that postoperative atrial fibrillation (POAF) occurred in 21.5% of the patients included in the analysis. Furthermore, the study found that patients who received cold blood cardioplegia (CBC) had a significantly higher incidence of POAF, with a rate approximately three times greater than that observed in the group treated with Del Nido (DN) cardioplegia. This difference in POAF rates between the CBC and DN groups was statistically significant, with a p-value of 0.029.

The study found that myocardial enzyme levels, including serum CK-MB and CK, were higher in the DNC group compared to the STH group, likely due to myocardial injury associated with prolonged operation time and aortic cross-clamp duration in the DNC group. Furthermore, research by Charette et al[15] confirmed that there was no significant difference in outcomes between the DNC and STH groups in the 90-minute-plus arm of the study after adjusting for the RACHS score (P = 0.6).

A single dose of Del Nido cardioplegia (DNC) has been shown to provide effective myocardial protection for up to 90 minutes, thereby eliminating the need for frequent repeated perfusions during cardiac surgeries and reducing the number of intraoperative interventions required. This prolonged protective effect not only streamlines surgical procedures but also minimizes potential disruptions during critical operative phases. Supporting this, studies by Yerebakan et al[16] and O'Donnell et al[17] have demonstrated that the use of DNC solution is associated with significantly shorter aortic cross-clamp times, contributing to improved surgical efficiency and potentially enhancing overall patient outcomes.

Gambardella et al[18] provided compelling evidence that the DNC solution outperformed traditional multidosecardioplegia in several critical aspects, including reduced ischemic time, cardiopulmonary bypass (CPB) time, reperfusion fibrillation, and cardiac enzyme levels. These findings underline the advantages of DNC solution in enhancing myocardial protection and improving overall surgical outcomes.

Our study demonstrated that del Nidocardioplegia (DNC) exhibits comparable protective effects on myocardial function and overall cardiac performance, making it a safe and effective option for all cardiac surgeries. Furthermore, research conducted by Guajardo Salinas et al[19] has reinforced these findings by confirming the safety and efficacy of DNC, specifically in coronary artery bypass grafting (CABG) procedures. These combined

results highlight the reliability of DNC as a cardioplegic solution across various surgical contexts.

Shu et al[20] reported that the use of Del Nidocardioplegia in patients undergoing cardiovascular surgery may offer several clinical advantages, including a potential reduction in the incidence of postoperative ventricular arrhythmias, a shorter length of stay in the intensive care unit (ICU), and an overall improvement in patient outcomes. This suggests that Del Nidocardioplegia could be a beneficial strategy in optimizing postoperative recovery and reducing complications in the cardiovascular surgical setting.

A study by Ota et al[21] evaluated the short-term outcomes in 240 aortic valve replacement patients, with 178 in Group A receiving Del Nido solution and 62 in Group B receiving whole blood solution, revealing that Group A had shorter aortic cross-clamp and bypass times compared to Group B.

CONCLUSION

Del Nidocardioplegia reduces postoperative ventricular arrhythmias and preserves myocardial stability. It provides prolonged cardiac arrest with a single dose, shortening bypass time and reducing ICU stay in complex cardiac surgeries.

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