Original Article

Effectiveness of Del Nido Cardioplegia on Post Cardiac Surgery Ventricular Arrhythmias

Waqas Hamid, Muhammad Ali Khan and Barira Ahmad

ABSTRACT

Objective: To evaluate the effectiveness of DNC cardioplegia as a prophylactic treatment for ventricular arrhythmias associated with cardiovascular surgery in adults.

Study Design: Cross sectional observational study

Place and Duration of Study: This study was conducted at the cardiac surgery department of Chaudhary Pervaiz Elahi Institute of cardiology, Multan from December 2019 to June 2024.

Methods: Study was started after approval from hospital ethical committee. Baseline characteristics, including age, medical history, APACHE II score, and left ventricular ejection fraction (EF), were recorded. 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 ventricular arrhythmia, and ICU stay length.

Results: The mean post EF% in DNC and STH groups was 61.90±5.48 and 62.40±3.75, respectively. (p=0.682). Mean CK-MB in DNC and STH group was 43.32±4.95 U/L and 33.37±7.13 U/L (p<0.001). The mean CK of the DNC and STH group was 562.30±16.76 U/L and 587.80±19.04 U/L, respectively (p<0.001). The mean length of stay of the DNC group was less than the STH group, 1.50±0.51 days and 2.47±0.50, respectively (p<0.001).

Conclusion: Del Nido cardioplegia 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.

Key Words: Del Nido cardioplegia, Ventricular arrhythmias, Cardiac Surgery, Hospital stay, Ejection fraction

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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%. Del Nido cardioplegia (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[2].

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Despite the findings mentioned above, del Nido cardioplegia (DNC) use in adult patients remains limited, as more robust clinical evidence is needed to generalize its application in postoperative myocardial protection for adults[3]. 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[4].

Studies have demonstrated the superiority of delnido cardioplegia in providing myocardial protection in adults[5]. 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[6].

Del Nido cardioplegia, 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[7]. 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. The potential benefits of Del Nido cardioplegia in adult cardiac surgery are

significant, although the evidence regarding its effectiveness in lowering postoperative ventricular arrhythmias in adult populations remains limited and inconclusive[8].

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

METHODS

Study was conducted at cardiac surgery department of Chaudhary Pervaiz Elahi Institute of cardiology, Multan from December 2019 to June 2024. The study planned to evaluate the effect of the Del Nido Cardioplegia (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 DNC cardioplegia 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 adhered to the Declaration of Helsinki and was approved 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 ventricular arrhythmia, 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 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

Our study, which included 60 patients, was designed to provide a comprehensive understanding of the patient population. The patients were divided into DNC and STH groups, with 30 patients (50.0%) in each group. The mean age of the DNC and STH group was 64.87±6.72 years and 62.83±6.26 years (p=0.230). In the DNC group, there were 24 (80.0%) males and 6 (20.0%) females, while the STH group had 16 (53.3%) males and 14 (46.7%) females (p=0.028). Importantly, our study found no statistical differences in key variables such as APACHE II, pre-EF (%), diabetes, hypertension, pre-ventricular arrhythmia, AB time, CBP time, K+max, and type of surgery in both groups (p>0.050). This lack of significant differences provides a strong foundation for our study's conclusions. (Table. I).

The mean post EF% in DNC and STH groups was 61.90±5.48 and 62.40±3.75, respectively. (p=0.682). Mean CK-MB in DNC and STH group was 43.32±4.95 U/L and 33.37±7.13 U/L (p<0.001). The mean CK of the DNC and STH group was 562.30±16.76 U/L and 587.80±19.04 U/L, respectively (p<0.001). The mean length of stay of the DNC group was less than the STH group, 1.50±0.51 days and 2.47±0.50, respectively (p<0.001). (Table. 2).

Table No.1: Demographic and baseline variables of the patients

Variable	Group		Test of sig.
	DNC	STH	
Age (years)	64.87±6.72	62.83±6.26	t=1.21, d.f=58, p=0.230
Gender			
Male	24 (80.0)	16 (53.3)	χ^2=4.80, d.f=1, p=0.028
Female	6 (20.0)	14 (46.7)	
APACHE II	13.96±3.75	13.53±3.66	t=542, d.f=58, p=0.653
Pre-EF (%)	60.26±3.64	61.43±3.50	t=-1.26, d.f=58, p=0.211
Diabetes	9 (30.0)	8 (26.7)	χ^2=0.82, d.f=1, p=0.774

Hypertensive	14 (46.7)	12 (40.0)	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)	3.17±0.83	4.33±1.12	t=-4.56, d.f=58, p<0.001
AB time (minutes)	83.70±18.54	85.50±13.19	t=-0.433, d.f=58, p=0.666
CBP time (minutes)	100.35±17.77	100.47±11.29	t=-0.031, d.f=58, p=0.975
K+ max (mmol/L)	5.15±2.36	5.56±2.17	t=-0.713, d.f=58, p=0.479
Type of surgery			
Heart valve	15 (50.0)	12 (40.0)	χ^2=1.40, d.f=5, p=0.843
Isolated CABG	4 (13.3)	7 (23.3)	
Aortic aneurysm	5 (16.7)	4 (13.3)	
CABG, Heart Valve	3 (10.0)	3 (10.0)	
Heart valve, aortic Aneurysm	3 (10.0)	4 (13.3)	
CABG, aortic aneurysm	0 (0.0)	0 (0.0)	
mean±s.d, n (%)			

Table No.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	5 (16.7)	5 (16.7)	χ^2=0.000, d.f=58, p=1.000
Length of ICU stay (day)	1.50±0.51	2.47±0.50	t=3.254, d.f=58, p<0.001
Mean ± SD, n (%)			

DISCUSSION

There is no established consensus on the safety and efficacy of del Nido cardioplegia (DNC) in various types of cardiac surgeries. However, our study demonstrated that DNC may play a role in reducing the incidence of postoperative ventricular arrhythmias[9]. Specifically, the overall incidence of ventricular arrhythmias in the DNC group was 16.7%, notably similar to that in the standard cardioplegia (STH) group (16.7%, P=0.040). These findings align with the observations of Amatya et al[10] and Sadr Ameli et al[11], who reported an incidence of ventricular tachyarrhythmia's ranging from 24.4% to 26.6% in Asian populations following cardiac surgery, a result consistent with the outcomes of our study.

The study demonstrated that myocardial enzyme levels, including serum CK-MB and CK, were higher in the DNC group than the STH group, likely due to myocardial injury associated with prolonged operation time and aortic cross-clamp duration in the DNC group. Additionally, research by Charette et al[12] confirmed no significant difference in outcomes between the DNC and STH groups in the 90-minute-plus arm of the study when adjusting for the risk of congenital heart surgery (RACHS) (P = 0.6).

A single dose of del Nido cardioplegia (DNC) perfusion has been demonstrated to effectively maintain myocardial protection for 90 minutes, reducing the need for repeated perfusions and minimizing the number of intraoperative interventions required. Studies conducted by O'Donnell et al[13] and Yerebakan et al[14] highlighted that using DNC solution was associated with significantly shorter aortic cross-clamp times, improving surgical efficiency.

Gambardella et al[15] provided compelling evidence that the DNC solution outperformed traditional multi dose cardioplegia 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 Nido cardioplegia (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[16] 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[17] reported that the use of Del Nido cardioplegia 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 Nido cardioplegia could be a beneficial strategy in optimizing postoperative recovery and reducing complications in the cardiovascular surgical setting.

A study by Ota et al[18] aimed to evaluate the short-term outcomes in aortic valve replacement (AVR) patients. The study included 240 patients, 178 in Group A, where Del Nido solution was used, and 62 in Group B, where whole blood solution was used. The results showed that Group A had shorter aortic cross-clamp and bypass times than Group B.

CONCLUSION

Del Nido cardioplegia 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.

Author's Contribution:

Concept & Design of Study:	Waqas Hamid
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Final Approval of version:	By all above authors

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