

**Original Research Article**

Comparison of Del Nido and St. Thomas Cardioplegia in adult cardiac surgery

Authors

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Dr Sumanta DasMob: +919836230551, Email: drsumantadas@yahoo.co.in**Abstract**

Introduction: Del Nido (DN) cardioplegia was invented specially for pediatric cardiac surgery in the 1990s and has longer ischaemic time (less redosing) than ST Thomas cardioplegia (ST).

Aim of Study: To evaluate the safety/efficacy of DN over ST for adult cardiac surgery.

Materials and Methods: The study was conducted among 100 adult patients who underwent CABG/MVR/DVR/AVR. Patients were divided in 2 groups: group 1- who received DN cardioplegia (n=50) and group 2- who received ST cardioplegia (n=50). Cross clamp time (X clamp time), cardiopulmonary bypass time (CPB time), inotropic support and post cross clamp defibrillation rates were analysed.

Results: The aortic cross clamp and bypass times were shorter with DN than ST (91.94 ± 34.16 vs 106.44 ± 32.63 and 126.26 ± 37.50 vs 139.84 ± 37.84 , p value < 0.05 respectively). ST group needed higher inotropic support than DN group (14.62 ± 3.83 vs 11.42 ± 2.84 , p value < 0.05). DN group showed significant reduction in Post X clamp defibrillation rate than ST group (5 vs 15, p value < 0.05).

Conclusion: DN reduces X clamp and CPB time over ST, and less inotropic support and post X clamp removal defibrillation is required when using DN in adult cardiac surgery.

Keywords: Del nido, ST Thomas, cardioplegia, adult cardiac surgery.

Introduction

The search for Ideal cardioplegia for open heart surgery is still in vogue. Various solutions have been developed over decades for maintaining cardiac quiescence during cardiac surgery. In the early 1990s, Dr. Pedro del Nido developed a cardioplegic solution for neonatal and pediatric cardiac surgery. This extracellular Del Nido (DN) cardioplegia solution induces a depolarizing arrest

during cardiac surgery and is more dilute (1 : 4, blood : crystalloid) as compared to the traditional 4:1 blood cardioplegia^[1]. St.Thomas' cardioplegic solution No. 2 (ST) is a crystalloid cardioplegia which needs to be administered repeatedly at short intervals during the surgery to maintain cardiac silence. The DN's potential practical advantage is the fact that it provides a long period of arrest before a subsequent dose is needed^[2].

Materials and Methods

The retrospective study was conducted from January 2016 to January 2018. The aim of this study is to evaluate the efficacy and safety of DN as compared to ST in adults undergoing elective coronary artery bypass grafting (CABG) and valve replacement (VR) surgery. All patients undergoing elective on pump coronary artery bypass grafting (CABG), mitral valve replacement (MVR), aortic valve replacement (AVR), double valve replacement (DVR) were included in the study. Patients were divided in 2 groups: group 1- who received DN cardioplegia and group 2- who received ST cardioplegia. Cardioplegia was administered as follows - After initiating standard CPB via median sternotomy, antegrade cold (4°C) 1 L cardioplegic solution (DN or ST) was administered and half of first dose i.e. 500 ml was repeated after 20 minutes interval in ST group and after 60 minutes in DN group or earlier if cardiac activity returned.

Clinical outcome data was obtained from perfusion chart, anaesthesia record, post operative ICU chart and patients files. Cross clamp time (X clamp time), cardiopulmonary bypass time (CPB time), inotropic support and post cross clamp defibrillation rates were studied. Inotropic support was calculated by IS or VIS⁽³⁾ whichever is applicable.

Wernovsky IS = dopamine dose (mcg/kg/min) + dobutamine dose (mcg/kg/min) + $100 \times$ epinephrine dose (mcg/kg/min)

VIS = IS + $10 \times$ milrinone dose (mcg/kg/min) + $10,000 \times$ vasopressin dose (U/kg/min) + $100 \times$ norepinephrine dose (mcg/kg/min).

Data was analysed using MICROSOFT excel 2007. Continuous variables were reported as mean \pm standard deviation and compared using the independent samples *t*-test (2 tailed). Categorical variables were reported as frequency and percentage of the total group and compared using Pearson's χ^2 test. All *p*-values ≤ 0.05 were considered significant.

Results

Total 100 patients were included in the study. 50 patients received DN cardioplegia and 50 patients received ST cardioplegia. Minimum and maximum ages were 25 and 75 respectively in our study. Data is summarised in table 1 and table 2.

Patients undergoing CABG & AVR didn't show significant statistical difference in X clamp time or CPB time in DN and ST group. However DVR and MVR showed reduction in X clamp time or CPB time in DN group than ST group which was statistically significant. As a whole, patients in DN group showed significant reduction in x clamp time (91.94 ± 34.16 vs 106.44 ± 32.63 , *p* value = 0.032394) and CPB time (126.26 ± 37.50 vs 139.84 ± 37.84 , *p* value < 0.00001) than patients in ST group. All patients in ST group needed higher inotropic support than DN group as evidenced by significantly higher IS or VIS (14.62 ± 3.83 vs 11.42 ± 2.84 , *p* value < 0.00001). Patients undergoing CABG/ AVR/ DVR/ MVR didn't show significant statistical difference in Post X clamp defibrillation rate between DN and ST group individually, however - as a whole patients in DN group showed significant reduction in Post X clamp defibrillation rate than patients in ST group (5 vs 15, *p* value = 0.012419).

Table 1 Age Comparison of Patients

	DN	Age (years)	ST	Age (years)	Total
CABG	17	60.18 ± 9.35	19	58.73 ± 8.92	36
DVR	11	35 ± 6.92	10	35.2 ± 7.73	21
MVR	11	33.18 ± 6.45	12	33.42 ± 5.18	23
AVR	11	46.45 ± 12.02	9	49 ± 9.41	20
total	50	45.68 ± 14.49	50	46.2 ± 13.7	100

Table 2 Comparing effect of DN and ST cardioplegia

variable	procedure	DN	ST	p-value
X clamp time (mean±SD)	CABG	78.76±21.66	87.84±14.31	0.143188
	DVR	147.73±5.08	161.2±10.63	0.001316
	MVR	63.45±8.02	94.92±22.73	0.000287
	AVR	85±14.65	100.22±20.22	0.066653
	total	91.94±34.16	106.44±32.63	0.032394
CPB time (mean±SD)	CABG	114.35±26.41	119.16±17.86	0.522977
	DVR	184.45±6.44	206±15.64	0.000569
	MVR	92.55±11.35	125.92±24.97	0.000564
	AVR	120.18±18.57	100.22±20.22	0.106821
	total	126.26±37.50	139.84±37.84	<0.00001
IS or VIS	CABG	10.29±2.49	12.68±2.71	0.009648
	DVR	14.82±2.48	19.9±1.85	0.000044
	MVR	9.82±1.47	13.08±2.81	0.002453
	AVR	11.36±1.91	14.89±3.33	0.008183
	total	11.42±2.84	14.62±3.83	< 0.00001
Post X clamp defibrillation(DC shock)	CABG	1(5.88%)	5(26.32%)	0.100524
	DVR	1(9.09%)	3(30%)	0.222969
	MVR	1(9.09%)	3(25%)	0.314648
	AVR	2(18.18%)	4(44.44%)	0.202288
	total	5(10%)	15(30%)	0.012419

Table 3 Composition of DN and ST cardioplegia

DN cardioplegia (4:1 crystalloid: blood)	ST cardioplegia (crystalloid)
Preparation	preparation
Mannitol (20%)- 16.3 ml	Plegiocard – 20 ml
Magnesium sulfate (50%)- 4 ml	Inj NaHCO ₃ ⁻ (8.4%)-10 ml
Sodium bicarbonate (8.4%)- 13 ml	Ringer solution- 1litre
Lidocaine (1%)- 13 ml	
Potassium chloride (2 mEq/ml)- 13 ml	
Plasma lyte A- 1000 ml	
Patients own blood from bypass circuit - 265 ml	
composition	Composition
Sodium 150 mmol/l	Na ⁺ 120 mmol/l
Chloride 132 mmol/l	K ⁺ 16 mmol/l
Potassium 24 mmol/l	Mg ²⁺ 32 mmol/l
Magnesium 6 mmol/l	Ca ²⁺ 2.4 mmol/l
Calcium 0.4 mmol/l	Cl ⁻ 160 mmol/L
Lidocaine 140 mg/l	NaHCO ₃ ⁻ 10 mmol/l
Mannitol 2.6 g/l	
Sodium Bicarbonate 26 mmol/l	

Discussion

Composition of St Thomas II (ST) and del Nido (DN) cardioplegia Solutions is given in table 3.

In 1976, an extracellular, potassium-based cardioplegia solution containing magnesium (acting as calcium channel blocker-unique at that time) was introduced at St. Thomas Hospital in London, England, and was named “St. Thomas solution”⁽⁴⁾. St. Thomas solution can be administered as a crystalloid solution or combined with blood. Further investigation to improve the solution were made resulting in increased

potassium concentration and decreased sodium and calcium concentrations and in 1981, St. Thomas no. 2⁽⁴⁾ solution came in market. Typically, St. Thomas solution is administered every 20 minutes after cross-clamping to maintain electrical arrest and provide myocardial protection.

Del Nido cardioplegia solution was developed in 1990s at the University of Pittsburgh for protecting neonatal, infant, and pediatric patients immature and developing myocardium^(1,5). Mannitol functions as oxygen free radical

scavenger and prevents myocyte edema, Magnesium acts as a calcium channel blocker⁽¹⁾. Sodium bicarbonate is used as buffer and rapid depolarized arrest is provided by potassium chloride. Lidocaine prevents accumulation of sodium within the cell during depolarized arrest⁽¹⁾. The addition of blood with cardioplegia prolongs aerobic metabolism and provides physiological buffering to promote anaerobic glycolysis⁽¹⁾. Reported protocols demonstrate re-dose times ranging between 20 and 60 minutes^(6,7).

Although DN was developed for addressing the needs of immature myocardium, now it is also being used for adult cardiac surgery^(7,8,9). The proposed benefit of DN over standard cardioplegia is the avoidance of redosing, which leads to shorter X-clamp and CPB times as well as provides uninterrupted surgical field for longer period. Some studies have also showed superior protection of heart by DN over standard cardioplegia for adult cardiac surgery⁽⁷⁻¹⁰⁾. The DN solution preserves myocardial function by preventing reperfusion injury⁽¹¹⁾. Also lesser defibrillation rates after Xclamp removal has been reported when using DN over ST⁽¹²⁾.

Conclusions

In our study, we have found that using DN cardioplegia significantly reduces ionotrope requirement in post operative period than ST cardioplegia. Shorter X clamp and CPB time with DN is in part due to longer ischaemic time and less frequent redosing than ST cardioplegia. Also post X clamp removal defibrillation rate was significantly lower when using DN than ST.

Limitations of the study

Our study was a retrospective/descriptive in nature and the cohort size was small. Only some clinical parameters were used to assess efficacy of DN in adult cardiac surgery in the study, while biochemical / radiological parameters such as cardiac enzymes / post operative echo could have enabled better analysis of effect of DN. Also, no long-term follow-up of myocardial function was

performed. Prospective long term studies/RCTs are needed to explore wider applications of DN cardioplegia.

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Conflicts of interest: None declared

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