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DEL NIDO VERSUS CONVENTIONAL CARDIOPLEGIA COMPARISON IN TERM OF MYOCARDIAL PROTECTION USING CARDIAC ENZYMES IN PATIENTS UNDERGOING CORONARY ARTERY BYPASS SURGERY

Rehan Shahid[a*], Syed Sardar Rahim[a], Hafiz Moazzam Ali[a], Ahmad Shahbaz[a], Amna Shafqat[a]

[a]Punjab Institute of Cardiology, Lahore.

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ABSTRACT:

INTRODUCTION: *Myocardial protection is the major component in cardiac surgery affecting the patient's outcome (morbidity and mortality). The key components are cardiopulmonary bypass (CPB), hypothermia and the cardioplegia solution.*

AIMS & OBJECTIVE: *To compare conventional vs Del Nido cardioplegias using Cardiac Troponin-I (CTnI) and CK MB release as the primary outcome variable in patients with preserved left ventricular ejection fraction undergoing coronary artery bypass surgery.*

MATERIAL & METHODS: *Retrospective comparative study conducted at Punjab Institute of Cardiology, Cardiac Surgery Department. After informed consent, patients undergoing coronary artery bypass surgery were included in the study. Data was analyzed by comparing Del-Nido with Conventional Cardioplegia using CTnI and CKMB release as the primary outcome variable.*

RESULTS: *A total of 140 patients were divided in two groups 70 (50%) in Del-Nido group and 70 (50%) in conventional group. In Del Nido group the mean Cardioplegia volume given was 1271.43 ± 447.91 ml and in Conventional Cardioplegia mean volume given was 2142.86 ± 584.48 ml with p-value <0.005. The comparison of Troponin I (ug/ml) levels post-operatively after 6, 9, 12 and 24 hours and on 5th day in Del Nido and conventional Cardioplegia groups showed insignificant p-values of 0.797, 0.977, 0.956, 0.496 and 0.297 respectively, which depicted that there is no remarkable difference in Troponin I levels regarding times in both groups. The comparison of CKMB (IU/L) levels in both groups after 6 hours 24 hours and on 5th day of CABG showed significant p-value of 0.032, 0.027 and 0.001 respectively and determined the difference in both groups. Whilst the comparison of CKMB (IU/L) levels post-operatively after 9 and 12 hours of CABG in both groups showed insignificant p-values of 0.706 and 0.476 respectively which implied that there is no major difference in CKMB levels regarding times in both groups.*

CONCLUSION: *The key benefits of Del Nido cardioplegia, which makes it preferable to conventional cardioplegia, are less volume needed and an uninterrupted operation. While time related troponin I and CKMB levels changes showed almost similar results in both groups. So we can say both groups are equally safe and have same outcomes.*

KEY WORDS: *Del Nido Cardioplegia, Conventional Cardioplegia, CKMB, Troponin I, Coronary artery bypass surgery.*

Correspondence : Rehan Shahid, Punjab Institute of Cardiology, Lahore. Email: rehan230@hotmail.com

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INTRODUCTION:

Myocardial protection is the key point in the intra-operative and post-operative cardiac surgery period so it can better preserve the functioning of the heart. So myocardial protection is the challenging job for whole cardiac surgery team as the metabolic need of the loaded beating heart is 10ml/100mg myocardium per minute so using CPB and aortic cross clamp will reduce the coronary perfusion flow and increase myocardial oxygen demand so during this period there will be high risk of myocardial injuries and necrosis. Keeping this concept in mind the myocardial protection could be achieved by adapting different techniques to preserve myocardial preservation by reducing load of the heart by CPB (reduce the oxygen demand to the heart by 6ml/100mg myocardium each minute, lower temperature (hypothermia) as hypothermia decreases 7% myocardial oxygen demand and rate of metabolism for each Celsius, Ischemic preconditioning and Hypothermic fibrillatory arrest.

The hypothermia concept was first introduced to the modern cardiac surgery era by Bigelow, and Cardioplegia was presented in the start of 1950 by Melrose[1-2]. The concept of the myocardial protection is gradually developed and in the modern era the protection of myocardium is achieved now a days by warm blood Cardioplegia, cold blood Cardioplegia, microplegia, crystalloid Cardioplegia, Del Nido Cardioplegia, hypothermic fibrillatory arrest and so on.[3-4]

Cold blood cardioplegia is given at the start to stop the heart beat and then multiple dose of cold blood cardioplegia given at the prefixed timing to maintain the arresting of the heart. The Buckberg protocol of giving antegrade cardioplegia followed by repeating dose of cold cardioplegia by retrograde manner to maintain cardioplegia hot short during removing of cross clamp for achieving better protection of myocardium[5]. Because of the use of multiple dosing of crystalloid Cardioplegia, lead to long cross clamp timing i-e various cardiac surgery and other less invasive procedure could be subsided to alternative Cardioplegia solution.

As we know the high expenses and the dilution of the blood in small body surface area, reduction of sodium level is potential of re-warming of the heart resulting in risk to RV protection have opened the vision to find out a better other technique for myocardial preservation[6]. In recent era the alternative cardioplegia such as Del Nido Cardioplegia, is an extracellular cardioplegia, given in induction as a single shot to arrest the heart for about 90 minutes. When it was initially presented in the market, it was used in congenital heart surgeries especially in paediatric population, but when a new concept made that it can have better role in the adult cardiac surgery too, so it has encouraging outcome in adult population as well[7].

MATERIALS AND METHODS:

This retrospective comparative study was carried-out at department of cardiac surgery, Punjab Institute of Cardiology, Lahore over a period of 12 months from January 2019 to December 2019. The purpose of the research was to determine the better agent for cardioplegia during cardiac surgery for myocardial protection. Total number of 140 post-op cardiac surgery patients were included. The adult patients undergoing elective CABG were enrolled using non-randomized sampling technique. After fulfilling the inclusion criteria, patients were enrolled in the study. Both genders adult patients undergoing coronary artery bypass surgery and patients with LVEF >45 were enrolled. Emergency cases, patients undergoing elective CABG plus any other surgery like valvular surgery, unwilling patients, patients with Pre-operative LV ejection less than 45% and patients with history of previous cardiac surgery were excluded from the study.

OPERATIONAL DEFINITIONS:

Conventional Cardioplegia:

Cardioplegia is the solution to cause asystole of the heart, or heart paralysis. Conventional Crystalloid Cardioplegia is blood cardioplegia with crystalloid, Potassium, Magnesium, Mannitol, NaCO3, lidocaine, etc. and used to stop the heart so that surgical procedures can be done in a still condition and bloodless field.

Del Nido cardioplegia:

Del Nido's single dose composition includes mainly 2g of 50% magnesium sulfate, 26 mEq/L of potassium chloride, 3.2 g/L of 20% mannitol, 13 mL of 1% lidocaine, 13 mEq/L of sodium bicarbonate, and 1000 mL of Plasma-Lyte A which stops the heart from 60 to 90 minutes reducing

the cross clamp and Cardio pulmonary bypass (CPB) time.

STATISTICAL ANALYSIS:

Collected data was analyzed through SPSS 25. Chi square test was applied for comparison of postoperative complications in both groups. Statistically significant value was taken as p-value ≤0.05.

RESULTS:

Total 140 patients were studied who underwent cardiac surgery. Variables like LVEF, age, cross clamp time, bypass time, Troponin I and CK MB (cardiac enzymes) were expressed as mean ± SD. Variables like risk factors and gender were expressed as frequencies and percentages.

In Del Nido group, the average age of patients was 54.61 ± 9.129 years and in Conventional Cardioplegia group average age was 53.91 ± 10.39 years. In Del Nido Cardioplegia group the mean Cardioplegia volume administered was 1271.43 ± 447.91 ml and in Conventional Cardioplegia mean volume administered was 2142.86 ± 584.48 ml with p-value <0.005. (Table 1)

The comparison of Troponin I (ug/ml) levels post-operatively after 6, 9, 12 and 24 hours and on 5th day in Del Nido and conventional Cardioplegia groups shows insignificant p-values of 0.797, 0.977, 0.956, 0.496 and 0.297 respectively. There is insignificant difference in Troponin I levels regarding times in both groups Del-Nido and Conventional Cardioplegia. (Table-2)

The comparison of CKMB(IU/L) levels in Del-Nido and conventional cardioplegia groups after 6 hours 24 hours and on 5th day of CABG shows significant p-value of 0.032, 0.027 and 0.001 respectively and determine the difference in both groups. Whilst the comparison of CKMB (IU/L) levels post-operatively after 9 and 12 hours of CABG in Del Nido and conventional Cardioplegia groups shows insignificant p-values of 0.706 and 0.476 respectively which demonstrated insignificant difference in CKMB levels regarding times in both groups Del-Nido and Conventional Cardioplegia. (Table-3)

Table 1: Statistical analysis of demographical data

	Del Nido's Group	Conventional group	P-Value
Age	54.61 ± 9.129	53.91 ± 10.39	0.234
Pre-EF Mean	55.00 ± 5.71	54.71 ± 5.89	0.764
Post-EF Mean	57.54 ± 5.56	56.86 ± 5.46	
Cardioplegia solution volume (ml)	1271.43 ± 447.91	2142.86 ± 584.48	<0.005
Bypass time (min)	116.87 ± 27.25	106.58 ± 29.19	0.004
Cross Clamp Time (min)	66.04 ± 22.12	51.64 ± 18.05	0.95

Table 2: Comparison of Troponin Levels in both groups regarding time

	Cardioplegia Type				P-Value
	Del Nido's group (n=70)		Conventional group (n=70)		
Troponin(ng/ml), after 6 Hours	**Mean±S.D**	0.137±0.20	**Mean±S.D**	0.146±0.20	**0.797**
	Min-Max	0.01-0.90	**Min-Max**	0.01-0.90	
Troponin(ng/ml), after 9 Hours	**Mean±S.D**	0.134±0.20	**Mean±S.D**	0.135±0.18	**0.977**
	Min-Max	0.01-0.90	**Min-Max**	0.01-0.8	
Troponin(ng/ml), after 12 Hours	**Mean±S.D**	0.145±0.22	**Mean±S.D**	0.147±0.19	**0.956**
	Min-Max	0.01-0.90	**Min-Max**	0.01-0.88	
Troponin(ng/ml), after 24 Hours	**Mean±S.D**	0.0987±0.09	**Mean±S.D**	0.110±0.11	**0.496**
	Min-Max	0.01-0.50	**Min-Max**	0.01-0.50	
Troponin(ng/ml), at 5th day	**Mean±S.D**	0.05±0.04	**Mean±S.D**	0.06±0.05	**0.297**
	Min-Max	0.00-0. 0	**Min-Max**	0.01-0.30	

Table-3: Comparison of CKMB Levels in both groups regarding time

	Cardioplegia Type				P-Value
	Del Nido's group (n=70)		Conventional group (n=70)		
CKMB (IU/L) CKMB(IU/L), After 6 Hours	Mean±S.D	55.93±17.29	Mean±S.D	48.71±21.89	0.032
	Min-Max	25-90	Min-Max	20-110	
CKMB(IU/LAfter 9 Hours	Mean±S.D	39.60±16.21	Mean±S.D	40.61±15.53	0.706
	Min-Max	25-110	Min-Max	25-110	
CKMB(IU/L), After 12 Hours	Mean±S.D	38.51±13.78	Mean±S.D	40.33±16.14	0.476
	Min-Max	25-110	Min-Max	25-110	
CKMB(IU/L), After 24 Hours	Mean±S.D	24.10±3.56	Mean±S.D	22.77±3.45	0.027
	Min-Max	20-33	Min-Max	20-30	
CKMB(IU/L), At 5th day	Mean±S.D	17.14±4.22	Mean±S.D	19.63±4.80	0.001
	Min-Max	10-30	Min-Max	10-30	

DISCUSSIONS:

This current study was conducted to compare the difference in Troponin I and CK MB levels between both studied groups in adult population with a preserved LV function undergoing CABG. In our study, there were two groups: 70(50%) patients were enrolled in each group. Demographic data expressed the average age of the Del Nido's group was 54.61 ± 9.129 years and in conventional cardioplegia group was 53.91 ± 10.39 years. In a study by Kavala et al, the average age in Del Nido's group and blood cardioplegia group was 69.53 ± 6.73 years and 67.63 ± 5.56 years respectively.[8]

In our study, the post-operative mean LV ejection fraction (LVEF) of Del Nido and conventional cardioplegia groups was 57.54 ± 5.56 % and 56.86 ± 5.46 % respectively. The LVEF insignificant p-value (0.764) denotes there is no difference in post-operative outcomes after CABG in Del Nido and conventional cardioplegia group. O'Donnell et al, reported the insignificant p-value of LVEF i.e 0.43, which supported our study[9].

In Del Nido group, the mean cardioplegia volume administered was 1271.43 ± 447.91ml and in conventional group it was 2142.86 ± 584.48ml. The result showed a remarkable difference in the volume of cardioplegia administered to both groups as denoted by p-value is <0.005.

Kavala et al, studied Del Nido group with conventional group and noted the similar findings which depicted lower cardioplegia volume (Del Nido group = 884.33±156.8 mL, p-value = 0.001, conventional group = 1130.00 ± 194.1 mL).[8] In a study by Pourmoghadam et al, similar findings were observed in which the volume of cardioplegia doses was significantly higher in conventional group (p-value <0.001).[10] These results are inline with our study.

The average cardio-pulmonary bypass (CPB) time in Del Nido's group was 106.58 ± 29.19 minutes and conventional group was 116.87 ± 27.25 minutes. In Del Nido group, the mean cross-clamp time was 66.04 ± 22.12 minutes and in conventional group was 51.64 ± 18.05 minutes. Ucak et al, reported that lover cross-clamp time and CPB times in Del Nido Cardioplegia group as compared to conventional group (43.7 ± 8.6 minutes, 54.3 ± 9.7 minutes and 67.9 ± 11.5 minutes, 77.2 ± 14.1 minutes) respectively.[11]

The comparison of Troponin I (ug/ml) levels post-operatively after 6, 9, 12 and 24 hours and on 5th day in Del Nido and conventional Cardioplegia groups shows insignificant p-values of 0.797, 0.977, 0.956, 0.496 and 0.297 respectively, which demonstrated insignificant difference in Troponin I levels regarding times in both groups Del Nido and Conventional Cardioplegia. Kavala et al, studied the comparison of Trop I levels showed no difference at first hour with insignificant p-value 0.099. Similarly, research by Ucak et al, strongly support our p-value at 6 hours, 12 hours and 24 hours (p-value=0.086, 0.153 and 0.094) respectively showing no statistically remarkable difference of Trop I in both groups.[8,11]

The comparison of CKMB(IU/L) levels in Del-

Nido and conventional cardioplegia groups after 6 hours 24 hours and on 5th day of CABG shows significant p-value of 0.032, 0.027 and 0.001 respectively and determine the difference in both groups. The comparison of CKMB (IU/L) at first hour and on 24th hour in a literature by Kavala et al, also reported significant difference with p-value=0.041 and p-value=0.001 respectively in both groups[8]. In another study by Hamad et al, (2017) post-operative CKMB was significant (p-value=0.011). This result supported our study[12]. Whilst the comparison of CKMB (IU/L) levels post-operatively after 9 and 12 hours of CABG in Del Nido and conventional Cardioplegia groups shows insignificant p-values of 0.706 and 0.476 respectively which depicted insignificant difference in CKMB levels regarding times in both groups. In another study by Ucak et al, (2018) the CKMB level at 9 hours post-operatively showed insignificant p-value of 0.098 which support our study[11].

The laboratory data outcomes in patients undergoing coronary artery surgery using both types of cardioplegia (Del Nido's and conventional) are quite reasonable. The key benefits of Del Nido cardioplegia solution, which makes it preferable to conventional cardioplegia, is the need for a lesser volume of cardioplegia and minimum interruptions in operation. The comparison of CKMB(IU/L) levels in Del Nido and conventional cardioplegia groups after 6 hours 24 hours and on 5th day of CABG shows significant p-value of 0.032, 0.027 and 0.001 respectively and determine the difference in both groups. However other time related CKMB and Troponin I values are similar for both groups so we can say both groups are equally safe and have same outcomes.

STUDY LIMITATIONS:

This is a single centred study and larger studies involving multiple centres are to be carriedout.

CONCLUSION:

The key benefits of Del Nido cardioplegia, which makes it preferable to conventional cardioplegia, are less volume needed and an uninterrupted operation. While time related troponin I and CKMB levels changes showed almost similar results in both groups. So we can say both groups are equally safe and have same outcomes.

References:

1. Bigelow WG, Lindsay WK, Greenwood WF. Hypothermia: its possible role in cardiac surgery: an investigation of factors governing survival in dogs at low body temperatures. Annals of surgery. 1950 Nov;132(5):849.
2. Melrose DG, Dreyer B, Bentall HH, Baker JB. Elective cardiac arrest. The Lancet. 1955 Jul 2;266(6879):21-3.
3. Matte GS, Pedro J. History and use of del Nido cardioplegia solution at Boston Children's Hospital. The Journal of extra-corporeal technology. 2012 Sep;44(3):98.
4. Ismail A, Semien G. Myocardial Protection. StatPearls [Internet]. 2021 Feb 17.
5. Marzouk M, Lafreniere-Bessi V, Dionne S, Simard S, Pigeon C, Dagenais F, Ad N, Jacques F. Transitioning to Del Nido cardioplegia for all-comers: the next switching gear?. BMC cardiovascular disorders. 2020 Dec;20:1-8.
6. Valooran GJ, Nair SK, Chandrasekharan K, Simon R, Dominic C. del Nido cardioplegia in adult cardiac surgery-scopes and concerns. Perfusion. 2016 Jan;31(1):6-14.
7. Shu C, Hong L, Shen X, Zhang W, Niu Y, Song X, Kong J, Zhang C. Effect of Del Nido cardioplegia on ventricular arrhythmias after cardiovascular surgery. BMC Cardiovascular Disorders. 2021 Dec;21(1):1-1.
8. Kavala AA, Turkyilmaz S. Comparison of del Nido cardioplegia with blood cardioplegia in coronary artery bypass grafting combined with mitral valve replacement. Brazilian journal of cardiovascular surgery. 2018 Sep;33:496-504.
9. O'Donnell C, Wang H, Tran P, Miller S, Shuttleworth P, Boyd JH. Utilization of Del Nido Cardioplegia in Adult Coronary Artery Bypass Grafting—A Retrospective Analysis—. Circulation Journal. 2018 Dec 7:CJ-18.
10. Pourmoghadam KK, Ruzmetov M, O'Brien MC, Piggott KD, Plancher G, Narasimhulu SS, Benjamin T, Decampli WM. Comparing del Nido and conventional cardioplegia in infants and neonates in congenital heart surgery. The Annals of thoracic surgery. 2017 May 1;103(5):1550-6.
11. Ucak HA, Uncu H. Comparison of Del Nido and intermittent warm blood cardioplegia in coronary artery bypass grafting surgery. Annals of Thoracic and Cardiovascular Surgery. 2019;25(1):39-45.
12. Hamad R, Nguyen A, Laliberté É, Bouchard D, Lamarche Y, El-Hamamsy I, Demers P. Comparison of del Nido cardioplegia with blood cardioplegia in adult combined surgery. Innovations. 2017 Sep;12(5):356-62.