ORIGINAL RESEARCH PAPER

Cardiac Surgery

COMPARATIVE STUDY BETWEEN DEL NIDO VERSUS ST. THOMAS CARDIOPLEGIA FOR AORTIC VALVE REPLACEMENT SURGERY.

KEY WORDS: Cardioplegia, del Nido, St. Thomas, Valve surgery

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ABSTRACT

Aim To assess and compare del Nido versus St. Thomas cardioplegia during aortic valve replacement surgery. Variables assed include cross-clamp time, cardiopulmonary bypass (CPB) time, time required from cross-clamp removal to weaning/separation from CPB and post cross clamp defibrillation/cardioversion requirement between two groups

Methods and Materials Patients admitted in between the period of January 2015 to June 2018 for isolated aortic valve replacement surgery were included in this retrospective study. Patients were divided into two groups each comprising of 30 patients, according to type of cardioplegia received during surgery.

Results The aortic cross-clamp, CPB time, time required to wean from CPB were shorter with del Nido cardioplegia (77.1 ± 12.97 vs 84.2 ± 14; 107.3 ± 16.5 vs 120.2 ± 16.8; and 30.2 ± 5.1 vs 36.4 ± 8.9 minutes, respectively). The post cross-clamp removal defibrillation requirement was also less with del Nido cardioplegia (13% vs 36%).

Conclusion The use of Del Nido cardioplegia has shown to decrease cross-clamp time, CPB time, time from cross-clamp removal to wean from CPB and the requirement of defibrillation post cross-clamp removal.

INTRODUCTION

Elective myocardial arrest was first reported of 1955 by Melrose et al (1). Since then many advances in myocardial protection were introduced/occurred. Cardiac arrest with cardioplegia solution is an essential and integral method for myocardial protection during on pump cardiac surgeries where aorta needs clamping. Today, variety of cardioplegia solutions are used for myocardial protection during on-pump cardiac surgery. The del Nido cardioplegia solution has been widely used during paediatric cardiac surgery. However, its use in adult cardiac surgery is still not so popular.

The goal of this study to compare cross-clamp time, CPB time, time required to wean from CPB and rate of fibrillation after removal of cross-clamp among the patients receiving del Nido cardioplegia vs. St. Thomas cardioplegia during aortic valve replacement surgery.

MATERIALS AND METHODS

This is a single centre study. Patients who underwent elective isolated aortic valve surgeries between January 2015 to June 2018 were included in the study. Inclusion criteria were all adult patients who underwent elective aortic valve replacement surgery for isolated aortic valve disease. Patients with diabetes, ischemic heart diseases, renal failure, previous open heart surgery and ejection fraction <45% were excluded from study. They were divided into two groups based on the type of cardioplegia administered during the surgery.

In group A, we included patients who received St. Thomas cardioplegia (n=30) and in group B, we included patients who received del Nido cardiplegia solution (n=30) for myocardial protection. All procedures were performed using a standard general anaesthesia protocol, median sternotomy approach, cardiopulmonary bypass with systemic hypothermia (28 to 30C) and aortic valve replacement with either mechanical or bioprosthetic valve.

Cardioplegia Administration Protocol:

Myocardial protection was achieved either with St. Thomas cardioplegia or del Nido cardioplegia as follows. In both the groups the heart was arrested with an induction dose of cold (4C) cardioplegia using antegrade delivery. At our institute St. Thomas cardioplegia was prepared from commercially available St. Thomas solution based concentrate. One ampule of 20ml solution contains about 16 mmol of potassium, 16 mmol of magnesium and 1 mmol of procaine. It was added along with 20 ml Soda bicarbonate, 20 ml Mannitol in 4:1 ratio of blood to crystalloid. The induction dose of standard blood cardioplegia were given immediately after aortic cross-clamping in the dose of 20ml/kg. The subsequently re-administered dose was prepared from oxygenated pump blood without addition of crystalloid and given at dose of 10ml/kg after every 20-25 minutes except for the rare occurrence of electrical activity.

The crystalloid component of del Nido caridoplegia were prepared with 1000 ml of Plasma-Lyte A solution to which 13 ml potassium chloride (2 mEq/ml), 13 ml sodium bicarbonate, 4 ml Magnesium sulphate (50%), 16 ml Mannitol (20%), 6.5 ml Lidocaine (2%). It was given immediately after aortic cross-clamping in 1:4 ratio of blood to crystalloid ratio at dose of 20 ml/kg with typical re-dose after 90 minutes at dose of 10ml/kg.

RESULTS:

Total 60 patients underwent isolated aortic valve replacement surgery. Group A includes 30 patients who received St. Thomas cardioplegia with average age 50.2 (11.7) years, body weight 54.1 (10.6) kg and body surface area (BSA) of 1.5 (0.17) m^2. The group B includes 30 patients who received del Nido cardioplegia during surgery with average age of 48.5 (11.8) years, body weight of 56.1 (11.4) kg and BSA of 1.5 (0.15) m^2. (Table-1)

TABLE 1- Preoperative observations

Observations		Group A (St. Thomas cardioplegia)	Group B (del Nido cardioplegia)	Test	p-value
Age		50.2 (11.7)	48.5 (11.8)	Unpaired t test	0.56
Weight (kg)		54.1 (10.6)	56.1 (11.4)	Unpaired t test	0.47
Body surface area (m^2)		1.5 (0.2)	1.5 (0.2)	Unpaired t test	0.57
Predominant aortic valve lesion	Severe Stenosis	26	25	NA	NA
	Severe Regurgitation	4	5		

In group A, average cross-clamp time, cardiopulmonary bypass time (CPB) and time for separation from CPB in group A were 84.2 (14), 120.2 (16.8) & 36.4 (8.9) minutes (Table -2). The average requirement of St. Thomas cardioplegia was 3.5 (0.7). the rate of defibrillation in group A was 36%.

In group B, the requirement for cardioplegia were 1.03 (0.2) with cross clamp time, CPB time and weaning time from CPB was of 77.1 (12.97), 107.3 (16.5) and 30.1 (5.1) minutes. About 13% patients in group B received defibrillation. (Table -2)

TABLE 2 - Intraoperative observations

Observations	Group A (St. Thomas cardioplegia)	Group B (del Nido cardioplegia)	Test	p-value
Cross-clamp time (min)	84.2 (14)	77.1 (12.97)	Unpaired t test	<0.05
CPB time (min)	120.2 (16.8)	107.3 (16.5)	Unpaired t test	0.003
Weaning time from CPB(min)	36.4 (8.9)	30.2 (5.1)	Unpaired t test	0.001

DISCUSSION:

The term cardioplegia (cardio, heart and plegia, paralysis) was first introduced by Lam in 1957 (2). Cardioplegia protects the heart from ischemic injury during cardiopulmonary arrest. It is well accepted mandatory tool for myocardial protection, though there is still controversy regarding various aspects including its composition and temperature (3). A variety of cardioplegic solutions are being used today to arrest the heart and choice of solution varies from institute to institute.

In 1990, Pedro del Nido and his team at University of Pittsburg developed a novel formulation for myocardial protection of immature myocardium of paediatric patients. Modifications have been made to the original solution and it is now referred to as del Nido cardioplegia (4). Hearse et al developed 'St. Thomas Solution' in St. Thomas Hospital in London which provided reliable cardiac arrest with reasonable myocardial protection (5). It is commonly used cardioplegia in adult cardiac surgery. But it needs to be administered repeatedly at shorter intervals to maintain electromechanical arrest and to provide myocardial protection.

The del Nido cardioplegia when compared with traditional blood cardioplegia, has shorter cross-clamp and CPB time, less cardioplegia re-dosing time and less post cross-clamp removal defibrillation/shock requirements (6). In our study we also found shorter cross-clamp time and cardiopulmonary bypass time during surgery in a group where del Nido cardioplegia were utilized for myocardial protection. This is attributed to reduced requirement to administer cardioplegia repeatedly to maintain safe electromechanical arrest. Frequent re-dosing cardioplegia for myocardial protection interrupted surgical workflow during surgery utilizing standard blood cardioplegia.

In our study we found less time required from cross-clamp removal to weaning from CPB and decreased rate of defibrillation requirements in patients group who received del Nido cardioplegia for myocardial protection. Weaning from CPB is transition from mechanical pump assisted circulation to spontaneously working heart with sufficient flow and pressure to maintain systemic circulation. Ventricular fibrillation is common after cross-clamp removal especially after valve replacement surgeries, more so in the aortic position. Its treatment involves administration of direct current shock. But ventricular fibrillation and its treatment with defibrillation / cardioversion, both leads to myocardial injury (7). The del Nido cardioplegia contains Plasma-Lyte A as base solution to which mannitol, magnesium sulphate, sodium bicarbonate, lidocaine, potassium chloride and patient's blood added. There is no calcium in Plasma-Lyte A. Mannitol acts as oxygen free radical scavenger and reduces myocardial tissue edema. Lidocaine is sodium channel blocker and frequently used as antiarrythmogenic. The polarising agents like lidocaine and magnesium, decreases the rate of energy consumption and intracellular accumulation of the detrimental calcium ion (4). This reduced accumulation of calcium ion during cardiac arrest, might prevent myocardial injury and ventricular fibrillation after cross-clamp removal during reperfusion (8). The del Nido cardioplegia decreases ventricular fibrillation and requirement of defibrillation post cross-clamp removal. So it is more effective cardioplegia solution for myocardial protection (9).

In conclusion, del Nido cardioplegia is effective cardioplegia during aortic valve surgeries. The surgeon can work uninterrupted during cross-clamp, leading to shorter cross clamp time and cardiopulmonary bypass time. This is because frequent re-dosing of cardioplegia solution is not required with del Nido. The time from cross-clap removal to weaning/separation from CPB is also less. The ventricular fibrillation and requirements of defibrillation is also less with del Nido cardioplegia.

LIMITATIONS:

This is a single centre, retrospective study with small sample size. In this study only intraoperative observations were assessed.

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