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Custodiol Versus Cold Crystalloid Enriched Blood Cardioplegia on Postoperative Outcome in Patients Undergoing CPB

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Abstract

During cardiac surgery, cardioplegia is the method used to stop and protect myocardial function. A crucial strategy for minimizing myocardial problems during and following cardiac surgery is myocardial protection. The study's objective is to evaluate the postoperative prognosis in patients having various difficult cardiac surgeries by contrasting Custodiol with cold crystalloid-enriched blood cardioplegic solution. The study was carried out in Alzahraa university hospital and Ain Shams university Hospital from (February 2022) to (October 2022). A total of 40 patients underwent different complex cardiac surgery using cardiopulmonary bypass aged 21 to 65 years, ASA class II-III was randomly assigned to either the Custodiol single dose (group1, n =20) or the traditional blood cardioplegic solution (group2, n =20) to induce cardiac arrest. Need for inotropic support was more significant in group 2 than in group 1. How ever, there was no statistically significant difference between either group with respect to the number of patients who required inotropes, those who had AKI and the length of ICU stay. When compared to cold blood cardioplegia, a single dose cardioplegia method (Custodiol) for myocardial protection offers the benefit of not requiring repeated administration.

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Keywords: Custodiol, Blood Cardioplegia, Cardiac Surgery.

1. Introduction

One of the key developments in cardiac surgery was the creation of cardioplegic solutions, which allowed doctors to execute difficult surgical procedures for longer than three hours without endangering the function of the myocardium [1].

The best cardioplegic solution should offer great myocardial protection, create less electrolyte imbalance throughout the body, and last for a long time to reduce the need for repeated administration. Both intracellular and extracellular formulations

are possible for cardioplegic solutions. Blood cardioplegia, for example, necessitates constant infusion every 20 minutes to offer enough cardiac protection [2]. Cold blood cardioplegia with high potassium levels has traditionally been the cornerstone of myocardial preservation operations, however this necessitates periodic re-administration throughout surgery, frequently at crucial points in the procedure [3].

Due to its low salt and calcium content, the Custodiol® histidine-tryptophan-ketoglutarate (HTK) solution (Essential Pharma, Newtown, PA, US) is categorized as an intracellular, crystalloid cardioplegia. Myocardial cell plasma membrane hyperpolarization results in cardiac arrest in diastole when sodium levels in the extracellular space are low. High histidine concentrations buffer the acidosis brought on by the buildup of anaerobic metabolites during the ischemia phase, while tryptophan stabilizes cell membranes and ketoglutarate enhances adenosine triphosphate synthesis upon reperfusion. We should assess the effectiveness of Custodiol with cold blood cardioplegia because a single dose of cardioplegia is reported to provide cardiac protection for up to three hours [4].

2. Patients and Methods

A prospective randomized study was carried out on 40 patients, ASA II and III, aged 21 to 65, of either sex, who underwent various complex cardiac surgeries using cardiopulmonary bypass at Alzahraa university hospital and Ain Shams university hospital from February 2022 to October 2022 after receiving approval from the regional ethical committee and obtaining informed consent. patients were randomized using computer-generated randomization (Random Allocation Software, M. Saghaei, Isfahan, Iran).

20 patients were randomly assigned to each of two groups, Group 1 receiving Custodiol as a cardioplegic solution, and Group 2 receiving conventional blood as a cardioplegic solution. Patients who have neurological symptoms, ASA IV, severe pulmonary hypertension, renal impairment, EF less than 40 % and a history of heart failure were excluded from the study.

2.1 Anesthesia Technique

Prior to surgery, all patients underwent a pre-anesthetic check-up in which they were evaluated, and the necessary investigations were checked, such as liver and renal function tests, complete blood counts, coagulation profile including prothrombin time, partial thromboplastin time, international normalized ratio (INR), prothrombin concentration, and arterial blood gases.

The peripheral intravenous line was placed when the patients arrived at the operating room, and midazolam 5–10 mg IV was administered to all of them as premedication. A five-lead ECG, a pulse oximeter, and noninvasive arterial blood pressure are all used in a full monitor. For invasive blood pressure monitoring, an arterial cannula was put in the radial artery while the patient was under local anesthesia. Additionally, it helped us collect arterial blood gases (ABG) samples throughout the procedure. Fentanyl (3-5 g/kg), propofol (0.5-2 mg/kg), and rocuronium (0.5 mg/kg) were used to induce anesthesia following preoxygenation for 3 minutes by 5 L/min O2. Following confirmation of the endotracheal tube's placement, the respiratory rate {12-14 c/m} and tidal volume {4-6 mL/kg} were adjusted to maintain an end-tidal carbon dioxide (EtCO2) value between 35 and 40 mmHg, respectively, of ideal body weight (IBW).

Additionally measured were the minute volume and peak inspiratory pressure. A mixture of oxygen and air (1:1) and isoflurane at 1-2% minimum alveolar concentration (MAC) were used to maintain anesthesia. Under strict aseptic circumstances, a central venous catheter (CVC) was inserted into the right internal jugular vein. As a starting point, activated

clotting time (ACT) samples from CVC were taken. During the procedure, a urinary catheter was inserted to monitor urine output. The nasopharyngeal probe was also used to record core body temperature. a transesophageal echocardiographic (TEE) probe was placed. To assess cardiac contractility and any valves area defect. A median sternotomy was performed as a surgical technique. Pumps, cannulas, tubing, a reservoir, an oxygenator, a heat exchanger, and an arterial line filter were all employed in the CPB circuit. Prior to arterial cannulation, heparin 300–500 IU/kg IV was given to achieve ACT (measured after 3 min.) of greater than 400 Sec. Systolic pressure during arterial cannulation should be less than 100 mm Hg to lower the risk of aortic dissection. In order to provide volume resuscitation in the event that hypotension due to venous cannulation occurred, aortic cannulation was performed first. Cardioplegia was administered for a brief period of time or over an extended period of time depending on the type of cardioplegic solution used to achieve diastolic cardiac arrest at a pressure of 250-300 mmHg. Transthoracic aortic cross-clamping was then initiated. Through an aortic root cannula that was put in the ascending aorta close to the cross-clamp, the solution was given in antegrade manner. Line pressure was measured to rule out dissection after the aortic cannula was attached to the tubing. The venous clamp was gradually released during venous cannulation in order to develop full CPB before breathing was turned off. Patients of Custodiol group were administered 20mL/Kg (Bretschneider HTK, Bensheim, Germany) over 5-7 minutes once in an antegrade form. Patients in the cold crystalloid cardioplegia group (St. Thomas' solution at 4 - 8°C) received doses of cold crystalloid-enriched blood cardioplegic solution in an antegrade way at first 20 ml/kg and thereafter 10 ml/kg every 20 minutes as needed. For myocardial preservation, a cold blood (4°C–6°C) high intensity cardioplegic solution was utilized. To create a ratio of 4 parts blood to 1-part cardioplegia solution, this was combined with the patients' blood that was removed from the CPB circuit. A cardioplegia module, which cools the combination to about 4°C, was used to administer the mixture.

Once the patients were rewarmed to 35–37°C, weaning from CPB began, and then the venous cannula and filter were removed. After then, protamine sulphate (1–1.5 mg/kg) was administered in a 1-1.3 ratio with heparin to abolish the consequences of the latter and restore normal ACT before the cross-clamp disconnection. We looked for any arrhythmias or instances of hypokalemia and acidosis to be adjusted after declamping. The Valsalva maneuver was used to deair the heart following open-heart surgery. TEE can be used to evaluate how well deairing is working. Due to the right coronary artery' s anterior placement, air embolism frequently affects it, which can result in arrhythmias, ST-elevation, and myocardial failure. It was managed by raising the perfusion pressure and keeping the venous line partially clamped to maintain pulsatile perfusion.

Assessments were made on contractility, rhythm, and heart rate. Atropine and/or beta-adrenergic agonists were utilized to treat sinus bradycardia, while epicardial pacing was employed to treat persistent atrioventricular block. With circumstances like severe aortic stenosis that causes left ventricular hypertrophy, removing the aortic cross-clamp may result in ventricular fibrillation. Using internal paddles with a biphasic energy of 5–20 J, defibrillation was accomplished. For persistent dysrhythmias, antiarrhythmic medications including amiodarone, lidocaine, and magnesium may be administered.

According to our study, the majority of patients required inotropic assistance throughout CPB weaning. After starting mechanical ventilation, the perfusionist filled the heart while gradually occluding venous return and lowering pump output. Postoperative data were collected, and patients were intubated and put on

mechanical ventilation before being moved to the critical care unit.
The primary outcome is to determine how many patients require inotropic support and for how long. The secondary outcomes: Counting the number of patients who had AKI and ICU stays, as well as pre- and postoperative echocardiogram.

2.2 Sample Size Justification

Statistical calculator based on 95% confidence interval, and power of the study (80% with error 5%), the MedCalc® version 12.3.0.0 programme "Ostend, Belgium" was used. A prior study (Hamed and Ghaffar, 2018) revealed that group A (100%) required more inotropic support than group B (65%). Therefore, it may be assumed that this study's sample size calculation, which was based on this supposition, yielded a minimum sample size of 38 instances, which was sufficient to detect this difference. assuming a 5% dropout rate. Therefore, based on calculations, there will be 20 in each group, for a total sample size of 40 cases.

2.3 Statistical Analysis

Statistical Package for Social Sciences (SPSS) program, version 23.0, was used to tabulate and statistically analyze the gathered data.
For numerical parametric data, descriptive statistics were performed using the mean, SD (standard deviation), minimum and maximum of the range; for numerical nonparametric data, they were performed using the median and first and third interquartile ranges; and for categorical data, they were performed using the number and percentage.
For quantitative variables, inferential analyses were performed using the independent t-test when there were two independent groups and parametric data, and the Mann Whitney U when there were two independent groups and non-parametric data.
The Chi square test for independent groups was used for inferential analyses of qualitative data. P values less than 0.050 were used to determine the significance level; values beyond this threshold are non-significant. The p-value is a statistical indicator of the likelihood that the findings of a study may have been the result of chance.

3. Results

As shown in Table 1, demographic information and preoperative echocardiography revealed no statistically significant differences between group 1 and group 2.
As shown in Table 2 in group 1, there was no appreciable variation between the laboratory results from preoperative and postoperative procedures (K, Na, HCT, urea, and creatinine).
As shown in Table 3 While group 2 preoperative and postoperative laboratory results (K, Na, HCT, urea, and creatinine) were compared, postoperative K had a statistically significantly higher mean, while postoperative HCT had a statistically considerably lower mean. There is no statistically significant difference between pre-operative and post-operative Na, Urea, or Create levels in group 2.
As show in table 4 According to echo cardiography in group 1 there was no statistically significant difference between pre-operative and post-operative. As show in table 5 pre-operative and post-operative according to echo cardiography in group 2, there was statistically significant lower mean EF% in post-operative compared to pre-operative. While there was a statistically significant higher mean ESD in post-operative compared to pre-operative. As for the FS% and EDD (mm) there was no statistically significant difference between pre-operative and post-operative in group 2.
As shown in table 6, according to pre- and post-operative echocardiography, there was no statistically significant mean difference between the two groups.

As shown in table 7 in terms of operating duration in "hrs," group 2 had a notably higher meaning than group 1, but there was no statistically significant difference between the two groups in terms of cross clamping and bypass time in "min".

As show in table 8 according to the amount of time taken with inotropes, group 2 had a considerably higher mean than group 1. As for the patients needing inotropes, ICU stay, and patients developed AKI there was an insignificant higher frequency in group 2 compared to group 1(table8).

Table (1): Baseline investigation and pre-operative patient characteristics

Demographic data	Group 1 (n=20)	Group 2 (n=20)	Total (n=40)	Test value	p-value
Age (years)					
Mean ± SD	48.70±12.52	52.10±7.81	50.40±11.14	t:1.030	0.309
Range	24-60	40-62	24-62		
Sex					
Female	6 (30.0%)	6 (30.0%)	12 (30.0%)	x^2:0.000	1.000
Male	14 (70.0%)	14 (70.0%)	28 (70.0%)		
BMI [wt/(ht)^2]					
Range	20-25	20-24.8	20-25	t:0.291	0.773
Mean ± SD	23.28±1.93	23.11±1.76	23.23±1.82		
ASA					
II	14 (70.0%)	10 (50.0%)	24 (60.0%)	x^2:1.667	0.197
III	6 (30.0%)	10 (50.0%)	16 (40.0%)		
Type of operation					
Aortic dissection	2 (10.0%)	3 (15.0%)	5 (12.5%)	x^2:7.200	0.206
ASD closure	4 (20.0%)	2 (10.0%)	6 (15.0%)		
AVR	2 (10.0%)	1 (5.0%)	3 (7.5%)		
CABG	10 (50.0%)	10 (50.0%)	20 (50.0%)		
MVR	0 (0.0%)	4 (20.0%)	4 (10.0%)		
PAVC repair	2 (10.0%)	0 (0.0%)	2 (5.0%)		
Preoperative echo cardiography					
EF%					
Mean ± SD	59.60±7.84	62.90±6.27	61.25±7.20	t:-1.470	0.150
Range	41-70	53-73	41-73		
FS%					
Mean ± SD	35.50±5.74	36.70±5.56	34.10±6.17	t:0.672	0.506
Range	21-40	28-45	21-45		
ESD (mm)					
Mean ± SD	36.90±8.74	34.60±1.90	36.75±8.82	t:1.150	0.257
Range	26-55	29-35	26-55		
EDD (mm)					
Mean ± SD	52.20±5.27	50.60±5.35	55.40±7.15	t:0.953	0.347
Range	48-67	44-60	44-67		

Using: t-Independent Sample t-test; x^2: Chi-square test p-value >0.05 NS; *p-value <0.05 S; **p-value <0.001 HS

Table (2): Pre-operative and post-operative laboratory data in Group 1 (n=20).

Laboratory data	Pre operation	Post-operative	MD±SE	p-value
K mEq/L	3.73±0.98	4.14±1.13	0.41±0.13	0.090
Na mEq/L	137.80±6.75	139.30±7.60	1.50±0.43	0.217
HCT %	37.84±4.78	34.20±3.91	-3.64±0.58	0.085
Urea mg/dl	50.40±24.97	53.50±26.32	3.10±0.45	0.180
Creat mg/dl	1.02±0.28	1.10±0.41	0.08±0.03	0.170

Using: z-Wilcoxon Signed-Rank Sum test p-value >0.05 NS

Table (3): Pre-operative and post-operative laboratory data in Group 2 (n=20).

Laboratory data	Pre operation	Post-operative	MD±SE	p-value
K mEq/L	3.38±1.39	4.18±1.52	0.80±0.07	0.024*
Na mEq/L	139.90±8.28	140.10±3.60	0.20±2.17	0.601
HCT %	41.04±7.33	36.10±4.99	-4.94±2.15	0.033*
Urea mg/dl	42.50±15.89	52.25±25.38	9.75±3.54	0.109
Creat mg/dl	1.14±0.27	1.23±0.35	0.09±0.03	0.102

Using: z-Wilcoxon Signed-Rank Sum test
p-value >0.05 NS; *p-value <0.05 significant; **p-value <0.001 highly significant

Table (4): Pre-operative and post-operative echo cardiography in Group 1 (n=20).

Echo cardiography	**Pre operative**	**Post-operative**	**MD±SE**	**p-value**
EF%	59.60±7.84	59.90±4.22	0.30±1.05	0.940
FS%	35.50±5.74	35.60±4.64	0.10±0.47	0.517
ESD (mm)	36.90±8.74	37.00±7.81	0.10±0.51	0.737
EDD (mm)	52.20±5.27	52.50±5.64	0.30±0.55	0.889

Using: z-Wilcoxon Signed-Rank Sum test
p-value >0.05 NS, EF% ejection fraction, FS% fraction shortening, ESD end systolic dimension, EDD end diastolic dimension

Table (5): Pre-operative and post-operative echocardiography in Group 2 (n=20).

Echo cardiography	Preoperative	Post-operative	MD ± SE	P-value
EF%	62.90±6.27	62.10±5.59	-0.80±0.25	0.006*
FS%	36.70±5.56	37.20±5.80	0.50±0.83	0.923
ESD (mm)	34.60±1.90	35.50±2.31	0.90±0.42	0.033*
EDD (mm)	50.60±5.35	51.20±4.37	0.60±0.43	0.221

Using: z-Wilcoxon Signed-Rank Sum test

p-value >0.05 NS; *p-value <0.05 significant, EF% ejection fraction, FS% fraction shortening, ESD end systolic dimension, EDD end diastolic dimension

Table (6): Mean difference between both groups (pre-post-operative) according to echocardiography.

Mean difference (Pre-Post-operative)	Group 1 (n=20)	Group 2 (n=20)	Total (n=40)	P-value
	Mean ± SE	Mean ± SE	Mean ± SE	
EF%	0.30±1.05	-0.80±0.25	-0.25±0.54	0.291
FS%	0.10±0.47	0.50±0.83	0.40±0.34	0.675
ESD (mm)	0.10±0.51	0.90±0.42	0.80±0.44	0.206
EDD (mm)	0.30±0.55	0.60±0.43	0.30±0.24	0.278

Using: U-Mann-Whitney test

p-value >0.05 NS; *p-value <0.05 significant, EF% ejection fraction, FS% fraction shortening, ESD end systolic dimension, EDD end diastolic dimension.

Table (7): Operative characteristics of study groups:

	Group 1 (n=20)	Group 2 (n=20)	Total (n=40)	t-test	p-value
Time of operation (hrs)					
Mean ± SD	3.75±0.41	4.22±0.82	3.99±0.68	-2.295	0.027*
Range	3-4.25	3.2-6	3-6		
Time of cross clamping (min)					
Mean ±S D	68.20±16.08	63.50±12.54	65.85±14.43	1.031	0.309
Range	50-98	50-92	50-98		
Bypass time (min)					
Mean ± SD	95.70±12.56	90.10±20.44	92.90±16.99	1.044	0.303
Range	80-118	70-130	70-130		

Using: t-Independent Sample t-test p-value >0.05 NS; *p-value <0.05 S

Table (8): post-operative complication in both groups.

Post-operative	Group 1 (n=20)	Group 2 (n=20)	Total (n=40)	Test value	p-value
Patients need isotopes	16 (80.0%)	18 (90.0%)	34 (85.0%)	x^2:0.784	0.376
Time on isotopes (hrs)					
Mean ± SD	8.75±3.89	16.44±9.19	12.82±8.10	U:-3.106	0.004*
Range	1-12	8-36	1-36		
Reoperation	0 (0.0%)	0 (0.0%)	0 (0.0%)	x^2:0.000	1.000
ICU stay (days)					
Mean ± SD	1.35±0.65	1.60±0.79	1.48±0.72	U:-1.094	0.281
Range	1-3	1-3	1-3		
patients developed AKI	2 (10.0%)	6 (30.0%)	8 (20.0%)	x^2:2.500	0.114

Using: U-Mann-Whitney test; x^2: Chi-square test; p-value >0.05 NS; *p-value <0.05 S AKI acute kidney injury

4. Discussion

Myocardial damage caused by cardiac surgery is usually present and complex, with ischemia-reperfusion injury being the main cause of intraoperative myocardial damage. Rapid ischemia arrest with a "cardioplegic" solution is one of the preventative strategies meant to lessen ischemic harm. Cardioplegia is used to lower metabolism, induce myocardial arrest, and promote normal physiology during ischemia. In order to compare Custodiol with cold crystalloid-enriched blood cardioplegic solution in patients having various difficult cardiac surgeries, this study's goal was to assess the postoperative outcomes.

According to demographic information and preoperative echocardiography results comparing both groups, we discovered no statistically significant difference between group 1 and group 2 in the current study with a p-value (p>0.05).

Except for K, who exhibits statistically significant higher mean in post-operative in group 2, we discovered in the current study that irrelevant value according to laboratory data in both groups in the preoperative compared to the post-operative. While the mean Hct in group 2 was post-operatively statistically significantly lower.

In contrast to our research, Bai et al. [5] found that there was a statistically significant difference in serum sodium during bypass, with group A having lower levels (127.03±5.786) than group B having higher levels (133.77±3.326) (P≤0.001).This study involved 146 neonates who had on-pump heart surgery with single-shot HTK perfusion were divided into two groups according to HTK dosages: a standard-dose (SD) group (n = 63, 40 mL/kg < HTK ≤ 60 mL/kg) and a high-dose (HD) group (n = 83, HTK >60 mL/kg).

In contrary to our study, Lin et al. [6] studied 88 high-risk patients (aortic cross-clamp time, >120 min) divided into two groups, either receiving a single HTK solution perfusion for myocardial protection (HTK group) or receiving traditional St. Thomas crystalloid cardioplegia (St group). They claimed that following clamping, the HTK group's

observed alterations in serum sodium levels dramatically diminished.

According to the results of the current investigation, group 1's echocardiogram revealed no statistically significant difference between pre- and post-operative conditions. In group 2, the mean EF was statistically substantially lower in the postoperative period than in the preoperative period. While mean ESD was statistically higher in the postoperative group than the preoperative group. In contrast, there was not a noticeable distinction between postoperative and preoperative mean FS and EDD in group 2. In the current study, we discovered that the mean difference between groups 1 and 2 was not statistically significant ($p>0.05$).

In accordance with our study, Hoyer et al [7]. examined the effects of isolated aortic valve replacement (AVR) on short- and long-term outcomes after comparing custodial cardioplegia with blood cardioplegia. Insignificant mean EF was found in Group A (Custodiol) after an analysis of 7263 patients, while it was found in Group B (cold blood cardioplegia) to be 50.24± 6.79.

Bibevski et al.'s [3] single-center retrospective evaluation of 132 patients receiving biventricular surgery is in line with our work. 27 individuals received several doses of blood cardioplegia, whereas 106 patients received single doses of Custodiol. The two groups' echocardiographic data were compared. declared that no statistically significant link between the two groups' EF% and FS% values for myocardial function had been found.

Like our study, Giordano et al [8]. showed no significant change in the biventricular function (LVEF, LVFS) between the Custodiol group and cold crystalloid enriched blood.

However, according to Jin et al [9]. who conducted a study on patients undergoing mitral valve repair for regurgitation, 15% to 20% of patients experience left ventricular dysfunction (ejection fraction 50%–55%) despite having a normal baseline. In the Custodiol group, EF was 53.17±7.73 compared to 49.06±7.170 in the cold crystalloid enriched blood cardioplegic group ($P=0.031$). The myocardium is more vulnerable to ischemia-reperfusion injury due to mitral regurgitation, which also causes mitochondrial oxidative stress, creating postoperative cardiac dysfunction.

According to Barbero et al [10]. st. Thomas group and Custodiol group preoperative LVEF values were comparable (group 1 57±8.1, group 2 57±9.4; P ¼ .63). As the frequency of the two modalities varied between groups, the EF assessed by intraoperative trans esophageal echocardiography was computed. 8 people lacked the 24-hour EF, either because 2 patients failed to report their EF value or because 6 patients did not receive an echocardiography.

According to Boros et al [11]. the difference in LVEF (left ventricular ejection fraction) between the Custodiol and conventional crystalloid-enriched blood cardioplegic groups was not time-dependent. (P ¼ .60). The mean LVEF in the Custodiol group was roughly 58% (95% confidence interval, 56-59), whereas the mean LVEF in the usual cardioplegia group was roughly 57% (95% confidence interval, 56-59). The upper limit of the standard cardioplegia group's mean LVEF ratio for the Custodiol group was 1.041, indicating that this ratio is statistically substantially lower than 1.05.

according to the study's time of operation “hrs", group 2's mean was significantly higher than group 1's, with a p-value of 0.05. There is no statistically significant difference between the bypass time "min" and the cross-clamping time ($p>0.05$).

In agreement with our work, Yavorovskiy et al [12]. revealed that when comparing Custodiol with cold blood cardioplegia, there was no significant difference in the aortic cross-clamp time between the cold cardioplegia and HTK group (73 ± 3 vs 75 ± 3 minutes; P = 0. 81).

In line with our work, Mylonas et al [13]. showed that there is no statistical difference between the cardiopulmonary bypass time in Group A and Group B, which is 99.4 ± 8.46 and 95.6 ±12.27, respectively. In Group A, the mean cross clamp time was 72.2 ± 89.36 seconds; in Group B, it was 68 ± 12.58 seconds.

Awad et al [14] conducted research on 50 patients who underwent mitral valve replacement (MVR), which contrasts with our study. They claimed that there was no discernible variation in the length of the procedure among the two groups (P-value > 0.05). The variety of different cardiac surgery types included in our analysis may account for this discrepancy, but there was no significant difference in the length of CPB or aortic cross-clamping time (ACC) between the two groups.

According to the time on inotropes, we discovered in the current study that group 2's mean was significantly higher than group 1's, with a p-value of (p0.05). ICU stays, reoperations, patients requiring inotropes, and patients developing AKI were not statistically different between the two groups (p>0.05).

In line with our work, Kotani et al [15] demonstrated that the custodial blood group had a substantially lower inotrope score (9.3±2.6) than the cold crystalloid-enriched blood group (10.4 + 3), with a p-value of 0.03. Within the first 48 hours following surgery, scores were calculated for each patient, and the highest calculated score was recorded. However, we evaluated the inotropic support differently because the maximum scores for the first 24 and 48 hours were taken.

Also, EL-Sokkary et al [16]. reported that although other postoperative characteristics (such as the length of time spent on a ventilator, in an intensive care unit, and in the hospital) were comparable between the two groups, the duration of inotropic support was considerably higher in cold crystalloid-enriched blood cardioplegic than in HTK.

HTK versus cold blood cardioplegia was mentioned by Braathen et al [17] in relation to pediatric surgery. Although the difference in CPB length between the two groups was minimal, cold blood cardioplegia needed much greater inotropic dose and usage time than HTK. Additionally, spontaneous recovery of the heart was higher in the HTK group.

In contrast to our work, Edelman et al [18] demonstrated decreased right ventricular ejection fraction, lower cardiac indices, and a longer duration of inotrope use in patients with Custodiol cardioplegia and poor preoperative right ventricular function. Reviews that evaluated Custodiol to traditional cardioplegia (blood or extracellular crystalloid) in adult patients were independently compiled by reviewers.

5. Conclusion

A single dose cardioplegia method (Custodiol) for myocardial protection has various benefits as compared to cold blood cardioplegia, which necessitates preparation and repeated administration for the purpose of performing heart surgery, particularly complex cardiac surgeries.

Limitation

A limitation of the study may be that the sickest patients (severe cardiac or renal failure, aortic arch procedures, multiple valves, etc.) were not included, which might have given other results. Enrolment of a larger number of patients, or even more high-risk patients, would have been ideal, but clinical studies are continuously challenged by changes in clinical practice over time, which again challenge the validity of the results. Also, short follow-up period is one of limitations.

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