An-Najah National University

Faculty of Graduate Studies

COLD BLOOD CARDIOPLEGIA VERSUS COLD CRYSTALLOID CARDIOPLEGIA FOR CORONARY ARTERY BYPASS GRAFTING (CABG) IN PATIENTS WITH LOW EJECTION FRACTION -IN THREE LARGE HOSPITAL IN PALESTINE

By

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This Thesis is Submitted in Partial Fulfillment of the Requirements for the Degree of Master of Critical Care Nursing, Faculty of Graduate Studies, An-Najah National University, Nablus, Palestine.

2023

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This Thesis was Defended Successfully on 15/03/2023 and approved by

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Dedication

إلى أبي العطوف قدوتي، ومثلي الأعلى في الحياة؛ فهو من علَّمني كيف أعيش بكرامة وشموخ.

إلى أمي الحنونة لا أجد كلمات يمكن أن تمنحها حقها، فهي ملحمة الحب وفرحة العمر، ومثال التفاني والعطاء.

إلى زوجتي ايناس أسمى رموز الإخلاص والوفاء ورفيقة الدرب.

إلى روحي وقُرَّة عيني ونبض فؤادي ابنائي (كنان، توليب، اوركيد، مكة).

إلى إخوتي واخواتي جهاد، طارق، عمرو، رشا، رنا سندي وعضدي ومشاطري أفراحي وأحزاني.

الى من زرعوا في حب العلم وروح الاصرار، قدوتي واساتذتي الفاضلين.

الى الذين يفرحهم نجاحنا ويحزنهم فشلنا، الأقارب دما وقلبا ووفاء.

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Acknowledgment

I would like to thank all faculty members in critical care nursing master's program who make the path clear by providing me useful information from their reflective knowledge and experience throughout my graduate study. I also would like to express my deepest gratitude to my thesis supervisors Dr. Eman AL Shawishfor their advice, insightful comments, suggestions, and follow up step by step; which enabled me to complete this research.

I am grateful for the hospitals including Al-Najah University Hospital, Palestinian Medical Complex, and AL-Makassed Hospital; for allowing me to conduct my study in their facilities.

Special thanks to the reviewer and editor of this research which improved the manuscript`s quality. Last but not least, I would like to express my sincere appreciation to everyone provided support, encouragement, and contribution to fulfil this project.

Declaration

I, the undersigned, declare that I submitted the thesis entitled:

COLD BLOOD CARDIOPLEGIA VERSUS COLD CRYSTALLOID CARDIOPLEGIA FOR CORONARY ARTERY BYPASS GRAFTING (CABG) IN PATIENTS WITH LOW EJECTION FRACTION -IN THREE LARGE HOSPITAL IN PALESTINE

I declare that the work provided in this thesis, unless otherwise referenced, is the researcher's own work, and has not been submitted elsewhere for any other degree or qualification.

Student's Name _____

Signature _____

Date 15. 3. 2023

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COLD BLOOD CARDIOPLEGIA VERSUS COLD CRYSTALLOID CARDIOPLEGIA FOR CORONARY ARTERY BYPASS GRAFTING (CABG) IN PATIENTS WITH LOW EJECTION FRACTION -IN THREE LARGE HOSPITAL IN PALESTINE

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Abstract

Myocardial protection during cardiopulmonary bypass surgery for coronary artery bypass graft surgery (OPCABG) is still a controversial topic. The primary method of protecting the myocardium during cardiac surgery is cardioplegia, which also facilitates surgery by providing a quiet, bloodless surgical field. These cardioplegia solutions include: Cold-crystalloid vs. cold-blood cardioplegia. However, there is still a debate about which solution for cardioplegia in cardiac surgery is the best solution.

The Main goal of this study is to Comparing Cold-Blood Versus Cold Crystalloid Cardioplegia for Coronary Artery Bypass Grafting (CABG) Surgery in Patients with Low Ejection Fraction - To Determine Which Type is Appropriate for Surgical Myocardial Conservation in Three Major Palestinian Hospitals, after CABG surgery and reduce complications.

A retrospective observational cohort design was used in this study. All patients with multi vessel coronary artery disease, who were admitted to an eligible hospital between January 1st, 2020 and December 30th 2021, aged ≥40 years and <80 years and require OPCABG surgery, were included in this study. Data were collected by reviewing patient medical records from the hospital information system.

According to the findings, there is no significant difference between cold blood and cold crystalloid cardioplegia when it comes to intra-operative ejection fraction, cardioplegia volume, cardiopulmonary bypass time, blood loss between 4 and 6 hours after surgery, time spent on mechanical ventilation after surgery, time spent using pharmacological cardiac support after surgery, creatinine level after surgery, or post-operative complications.

The findings demonstrate that there are considerable disparities between the Cold Blood Cardioplegia group and the Cold Crystalloid Cardioplegia group only in Ejection fraction pre operation, the mean of the Ejection fraction pre operation in the CBC group is (Mean=38%) which is considerably greater than the average in the CCC group (Mean=36%), the P-value of the test is 0.002, but this difference does not mean anything clinically because it happened before the cardioplegia was given.

Significant differences exist at the 0.05 level. in the amount of Blood loss 2 hours post-operation, the mean in the CBC group is (Mean=153.8) which is considerably less than the average in the CCC group (Mean=183.8), the P-value of the test is 0.032.and there are significant differences at 0.05 level in Creatinine levels pre-operation, the mean in the CBC group is (Mean=0.78) which is significantly higher than the mean in the CCC group (Mean=0.63), the P-value of the test is 0.020. when using cold crystalloid cardioplegia as opposed to cold blood cardioplegia at a significant level of P value (0.05),and this difference does not mean anything clinically because it happened before the cardioplegia was given.

This study concludes that the use of cold-blooded cardioplegia has the same myocardial preservation and complications as cold crystalloid cardioplegia.

For clinical practice, it is recommended that cold crystalloid cardioplegia be used to decrease the cost of cold blood cardioplegia use when using the traditional methods and also it facilitates vision for the surgeon, and presenting the results of this study to the Palestinian Ministry of Health to make a comprehensive protocol and guidelines for all hospitals to follow cold crystalloid cardioplegia.

Keywords: Cold Blood Cardioplegia, Cold Crystalloid Cardioplegia, Myocardium Protection, Ejection Fraction, Coronary Artery Bypass Graft.

Chapter One

Introduction

1.1 Background

The most frequent procedure still carried out by cardiac teams is CABG. Since its inception in the 1950s, CABG has seen numerous technological and clinical advancements. Advances in intraoperative techniques and perioperative care have reduced complications and adverse events (WASAY et al.).

CABG is an open-heart surgery, in which a section of blood vessel (graft) is transplanted from a coronary artery into the aorta, to bypass a blocked segment of the coronary artery and restore blood supply to the heart muscle(WASAY et al.).

Patients undergoing coronary artery bypass graft (CABG) surgery often have a lower-than-average left ventricular ejection fraction before surgery (LVEF). Despite improvements in medical care and surgical methods, managing patients having this CABG with moderate or mild left ventricular dysfunction is still difficult, and those with low LVEF are more likely to experience problems after surgery. this leads to have a high mortality rate after CABG (WASAY et al.).

The primary indicator of left ventricular systolic function is the LVEF. and continues to be the primary factor for classifying heart failure (HF).which calculated as ([SV/EDV] x 100) ((Kolkailah, Del Val, Kaneko, & Aranki, 2018).

Low ejection fraction is defined as an EF of 40% or less (≤ 40%) and occurs in approximately 46% of hospitalized heart failure patients (Mentzer & Hsich, 2019).

Cardioplegia is defined as medication given to purposefully and momentarily stop the heart during a heart surgery. The first solution is used during cardiopulmonary bypass in open heart surgery. Dr. Melrose in the early 1950s defined high concentrations of potassium citrate as it is leading to a reversible cardiac arrest (Tabaei et al., 2018).

Potassium homeostasis minimizes membrane potential and disallows repolarization, leading to diastolic cardiac arrest. Potassium is not the only ion found in cardioplegia. Other ions such as sodium, calcium and magnesium are all involved in minimizing

contraction and protecting myocardium. Additionally, some ingredients can be added for additional protection, such as lidocaine, bicarb, and even glucose (Doty, 2012).

Cardiopulmonary bypass includes cardiac arrest, which has the main purpose of lowering myocardial oxygen demand by causing electrical quiescence and chilling the myocardium to lessen the ischemic consequences of bypassin addition to protecting the myocardium, cardioplegia use also provides a bloodless, motionless surgical field. There are different types of cardioplegia solutions and different techniques for managing them (Lopes & Santos, 2017).

Myocardial protection and a motionless, bloodless surgical field are indications for cardioplegia during on-pump cardiac surgery in either anterograde or retrograde technique. The perfusionist is in charge of administering cardioplegia by choosing the temperature, ingredients, volume, flow rate, and timing of each dose(Baker et al., 2013).

Cardioplegia varies by delivery method, temperature, composition, and additives. However, all cardioplegia solutions should contain potassium chloride (15-35 meq/L), which is important for crystalloid cardioplegia, and it reduces ischemic damage by using potassium chloride concentrations below 26 mEq/L and additives such as glucose and sodium bicarbonate that provide protection for 60 minutes(Mishra et al., 2016).

Blood cardioplegia 4:1 Blood is created and considered as an ideal solution for administration because it has a natural buffer system, normal osmotic pressure, enhances oxygenation, and innate mechanisms for scavenging free radicals. It is a crystalloid composition. It is Used to prevent hemodilution and edema. Potassium chloride causes cardiac arrest and low doses of other electrolytes such as Ca2+, Mg2+ and Cl-. Na+ and bicarbonate were added to adjust the pH of the solution as needed(Carvajal, Goyal, & Tadi, 2021).

When undergoing CABG surgery, patients with poor EF typically require more intensive care unit (ICU) and hospitalization, longer breathing, cardiac support, intra-aortic balloon pump, and postoperative morbidity and mortality than those with normal left ventricular function. (Dobson, Faggian, Onorati, & Vinten-Johansen, 2013).

Myocardial protection during cardiopulmonary bypass surgery forOPCABGis still a controversial topic. Despite the publication of a considerable number of experimental

and clinical studies over the years, researchers have to agree on the ideal way to protect the already compromised myocardium (Hausenloy, Boston-Griffiths, & Yellon, 2012).

The most important method of protecting the myocardium during cardiac surgery is cardioplegia, which is considered as means of cardiac arrest by hypothermia and hyperkalemia, and also facilitates the surgical procedure by providing a calm, bloodless surgical field (Nardi et al., 2018).

In general, various cardioplegia solutions are available to induce cardioplegia, optimize myocardial protection, and mitigate ischemia-reperfusion injury. These solutions include cold-crystallin and cold-blooded cardioplegia. However, there is still a debate about which solution for cardioplegia in cardiac surgery is the best(Mahrose, Shorbagy, Shahin, & Elwany, 2020).

A number of studies has shown a comparison of cold-blooded versus cold-crystalloid cardioplegia in CABG surgery. From these studies, a study that is a prospective study; done in (2020) by Mahrose et al from January to July 2019 in a cardiothoracic department, Ain Shams University hospitals. The aim was to compare cold crystalloid; to antegrade warm-blooded cardioplegia during her CABG in a patient with low EF.The researcher concluded that patients who received antegrade warm cardioplegia had better postoperative outcomes(Mahrose et al., 2020).

To the best of knowledge, there is no study has been conducted in Palestine to describe CBC versus CCC in low ejection fraction of CABG patient.

Despite the high proportion of multi vessel disease (MVD) patients who require CABG in open heart units in Palestine, their myocardium protection and post-operative complication remain unclear and poorly defined. Therefore, this study aims to compare the CBC versus CCC for CABG surgery in patients with low ejection fraction -in three large hospitals in Palestine; to define which type is better to increase myocardium preservation through operation and reduce the complication after CABG operation.

1.2 Problem Statement

As more and more patients with multivascular disease (MVD) require CABG surgery worldwide, researchers investigate the best ways to preserve myocardium during surgery and prevent post-CABG complications Now (Spadaccio & Benedetto, 2018).

At the same time, protection of the myocardium in CABG patients with different types of cardioplegia (CCC and cold CBC) is a challenge faced by perfusionists and cardiac surgeons during CABG surgery in patients with low EF and thisis a global issue to be addressed. All countries in the world that affect mechanical ventilation time, inotropic drug use and time, and intra-aortic balloon pump use,ICU and hospitalization.Therefore, identifying which type of cardioplegia is more effective and feasible to support and develop myocardium protection (Nardi et al., 2018).

As a result, numerous researches with contradictory findings have been released, sparking additional discussion about whether approach is preferable for myocardium protection. Therefore, this retrospective observational cohort study was carried out to determine which type is better to increase myocardium preservation through operation and reduce the complication after CABG operation.

1.3 Significance of the Study

This study supports which type of cardioplegia is more effective in protecting the myocardium in patients with low ejection fraction (CBC, CCC),decreasing the complication of cardioplegia to reap the benefits that return the patient, their family, the hospital, and societyon low EF CABG patient. Secondly,this study is the first in comparing antegrade cold crystalloid cardioplegia and antegrade cold-blooded cardiac arrest in Palestine. Thirdly, Its objective is to raise the health team's level of awareness. in the cardiac surgery center about more effective method of cardioplegia for myocardium preservation in low EF CABG patient.

Last but not least,it reduces the cost of CABG surgery, because best preservation of the myocardium reduces patient hospitalization and treatment costs.

1.4 Aims of the Study

This study aimed to compare CBC Versus Cold CCC for (CABG) Surgery in patients with Low Ejection Fraction,to determine which type is appropriate for surgical myocardial conservation in three major Palestinian Hospitals after CABG surgery and reduce complications; through achieving the following objectives:

1. Comparison the EF difference between preoperative and intraoperative in two groups of the study (CBC or CCC).
2. Comparison the cardioplegia volume difference when using CBC or CCC.
3. Comparison the extracorporeal time difference when using CBC or CCC.
4. Comparison the cross-clamp time difference when using CBC or CCC.
5. Comparison the postoperative time staying on mechanical ventilator difference when using CBC or CCC.
6. Comparison the postoperative time staying on cardiac support difference whenusing CBC or CCC.
7. Comparison the blood loss volume on 2,4,6 hrs. postoperative difference whenusing CBC or CCC.
8. Comparison the incidence of complication postoperative difference when using CBC or CCC.
9. Comparison the increase in Creatinine level difference when usingCBC or CCC.

1.5 Questions of the Study

This study aims to explore the following questions:

1. What is the EF difference between preoperative and intraoperative in two groups of the study (CBC or CCC) in three large hospitals in Palestine?
2. What is the cardioplegia volume difference when CBC or CCC is usedin three large hospitals in Palestine?
3. What is the extracorporeal time difference when CBC or CCC is usedin three large hospitals in Palestine?
4. What is the cross-clamp time difference when CBC or CCC is usedin three large hospitals in Palestine?
5. What is the postoperative time staying on mechanical ventilator difference when CBC or CCC is used in three large hospitals in Palestine?

6. What is the postoperative time staying on cardiac support difference when CBC or CCC is usedin three large hospitals in Palestine?
7. What is the blood loss volume on 2,4,6 hrs. postoperative difference when CBC or CCC is usedin three large hospitals in Palestine?
8. What is the incidence of complication postoperative difference when CBC or CCC is usedin three large hospitals in Palestine?
9. What is the increase in Creatinine level difference when CBC or CCC is used in three large hospitals in Palestine?

1.6 Study Hypotheses

This study aims to test the following statistical hypotheses (null hypothesis):

H_0: There is no significant difference between EF preoperative and intraoperative in two group of the study (CBC or CCC) in three large hospitals in Palestine at a significance level of P-value = 0.05.

H_0: There is no significant difference in cardioplegia volume when CBC or CCC is used in three large hospitals in Palestine at a significance level of P-value = 0.05.

H_0: There is no significant difference in extracorporeal time when CBC or CCC is used in three large hospitals in Palestine at a significance level of P-value = 0.05.

H_0: There is no significant difference in cross-clamp time when CBC or CCC is used in three large hospitals in Palestine at a significance level of P-value = 0.05.

H0: There is no significant difference in postoperative time staying on mechanical ventilator when CBC or CCC is used in three large hospitals in Palestine at a significance level of P-value = 0.05.

H0: There is no significant difference in postoperative time staying on cardiac support when CBC or CCC is used in three large hospitals in Palestine at a significance level of P-value = 0.05.

H0: There is no significant difference in blood loss volume on 2,4,6 hrs. postoperative when CBC or CCC is used in three large hospitals in Palestine at a significance level of P-value = 0.05.

H0: There is no significant difference in incidence of complication postoperative when CBC or CCC is used in three large hospitals in Palestine at a significance level of P-value = 0.05.

H0: There is no significant difference in increase in Creatinine level when CBC or CCC is used in three large hospitals in Palestine at a significance level of P-value = 0.05.

1.7 Conceptual Framework

1.7.1 Conceptual Definition

Myocardial protection: is amaintenance of myocardial function by reducing myocardial oxygen demand resulting from hypothermia during cardiac surgery (Melrose, et al., 1955), providing a bloodless and motionless surgical field to facilitate surgery(Kırali & Saçlı, 2015).

Cardioplegia:represents the primary strategy aimed at preserving myocardial function during cardiac surgery and facilitating surgery by providing a quiet, bloodless surgical field(Nardi et al., 2018).

Cold Blood Cardioplegia (CBC): is a cardioplegia technique that utilizes a separate pump head for coronary artery perfusion, a disposable cooling coil, and cold blood with potassium content of 30 mEq per liter. The left ventricle can be vented using an aortic perfusion cannula. (Buckberg, 1987).

Cold Crystalloid Cardioplegia (CCC):A form of cardioplegia that lowers oxygen consumption and offers some protection during the bypass period and is connected to mild to moderate hypothermia. This improves visibility when performing distal coronary artery anastomosis(Nardi et al., 2018).

Coronary Artery Bypass Graft:A procedure in which a healthy blood vessel is taken from another part of the body and used to create a new blood vessel around a heart artery that is obstructed. As a result, the heart's supply of oxygen and nutrients is restored and known as an aortocoronary bypass(Ong & Serruys, 2006).

Low ejection fraction: is defined as an EF of 40% or less (≤ 40%) and occurs in approximately 46% of hospitalized heart failure patients (Mentzer & Hsich, 2019).

Age: The duration of existence of a thing. The period of life or existence up to a specified time."Or a human being measured in years from birth characterized by a particular stage or degree of mental or physical development, legal responsibility, and legal capacity." duration of existence(U. Dictionary, 2002).

Gender: male or female condition (usually associated with social and cultural differences rather than biological differences(O. E. Dictionary, 2020)**.**

1.7.2 Operational Definition

Cold Blood Cardioplegia (CBC): antegrade intermittent cold blood cardioplegia From January 2220 to sept 2021, 75 patients underwent isolated on-pump CABG. (Buckberg, 1987).

Cold Crystalloid Cardioplegia (CCC): antegrade cold crystalloid cardioplegia From January 2220 to sept 2021, 75 patients underwent isolated on-pump CABG.30 meq kcl in 500 ml ringer solution which improves visibility when performing distal coronary artery anastomosis(Nardi et al., 2018).

Coronary Artery Bypass Graft:The restricted or obstructed coronary artery is covered by a blood vessel that is taken from another area of the body, typically the chest, leg, or arm..A graft is the name for this fresh blood artery. The number of grafts necessary is based on the degree of coronary artery disease and the number of constricted coronary arteries. The patient should not be conscious during the operation as it is performed under general anesthesia. usually lasts 3 to 6 hours(Alexander & Smith, 2016).

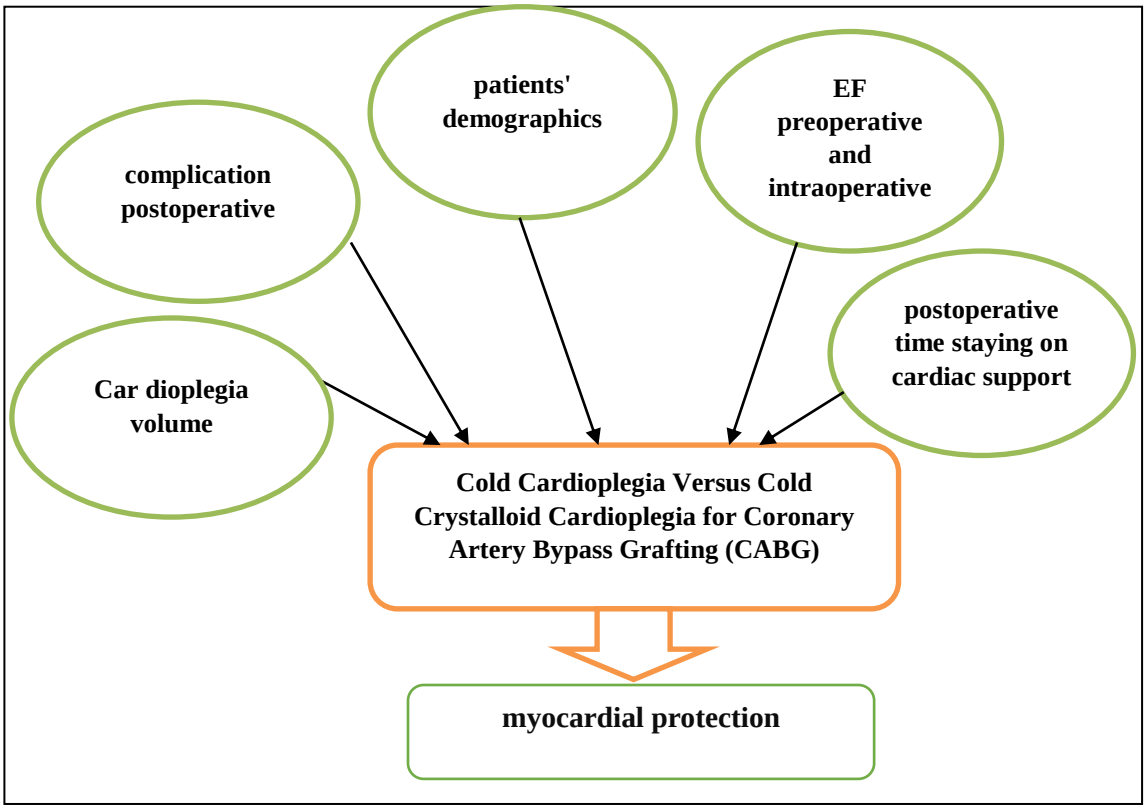
Age: Adult patients are who are over the age of 40 years and under 80.

Gender**:** In this study, both genders (males and females) were assessed.

1.7.3 Framework

Figure 1

Framework for Cold Cardioplegia Versus Cold Crystalloid cardioplegia for Coronary Artery Bypass Grafting (CABG)



Chapter Two

Literature review

2.1 Introduction

The literature relating to the main concepts of this study is examined in this chapter. The literature review serves as a solid foundation for writing a research paper. It contributes to the study's basis and may elicit fresh research ideas. The report's early literature analysis gives readers a foundation for understanding current knowledge about the issues and emphasizes the significance of the new study. It contains two parts: background and previous studies.

2.2 Search Strategy

A thorough literature search was carried out; utilizing a variety of electronic databases, including Springer, Google Scholar, PubMed, and CINAHL. The study thoroughly examined crucial topics such as myocardium protection, cold blood cardioplegia, and cold crystalloid cardioplegia, which were previously found in similar studies.

For literature that is likely to be relevant, checklists of selected articles were searched. The relevancy of the selected articles was established by drawing abstracts of the papers. This method has led to the discovery of a vast volume of literature. The papers were then organized into categories based on the study's keywords and subjects. Original research was identified in journals that were available in English in full text.

2.3 Background

2.3.1 Coronary Artery Bypass Grafting (CABG)

The primary surgical operation known as CABG employs a harvested venous or arterial line to circumvent an atheromatous blockage in a patient's coronary arteries. Bypass improves function and viability of the ischemic myocardium while reducing angina symptoms. Although medical therapy and substitute choices like percutaneous coronary intervention (PCI) are inadequate, over 400,000 of his CABG surgeries are carried out annually, making them the most frequently done major surgical procedure. Surgery is becoming less popular as use rises. This activity explains the justifications for coronary artery bypass surgery and emphasizes the importance of expert teams in the treatment of CAD patients(Alexander & Smith, 2016).

Adam Hammer identified the pathophysiology of coronary artery disease in 1876. He proposed that interruption of the coronary blood supply is what causes angina pectoris (an imbalance between the supply and demand of coronary blood flow), and that at least one coronary artery becomes blocked before a myocardial infarction takes place(Diodato & Chedrawy, 2014).

Cardiopulmonary bypass (CPB), which was made possible by Dr. John Gibbon's construction of a heart-lung machine in the late 1930s, led to the beginning of heart surgery. In order to cure cardiac ischemia and angina pectoris, Vineberg and Buller of McGill University in Montreal, Quebec, Canada, performed the first transplant of the internal mammary artery (IMA) into the heart in 1950. Coronary artery surgery advanced significantly in the 1960s. Getz and co.,in 1961, have credited with carrying out the first successful human coronary artery bypass graft surgery(Diodato & Chedrawy, 2014).

In general, CABG is advised in cases with significant blockage in either; the major coronary arteries or cases where percutaneous coronary intervention (PCI) has failed to remove the blockage. According to the 2011 ACCF/AHA Guidelines, Class 1 recommendations include:

>70% of patients with proximal LAD involvement and left main coronary artery disease of the three coronary arteries.

Loss of function in the LAD and another significant coronary artery.

More than 70% of patients with substantial angina symptoms and receiving the most effective medical care also have one or more major stenosis.

Vascular disease is found in almost 70% of people who have survived sudden cardiac death with ischemia-related ventricular tachycardia. (Bachar & Manna, 2018).

After the patient enters the operating room and is linked to a regular monitor, the surgery starts. Before inducing general anesthesia, an anesthesiologist may set up an arterial line to invasively monitor a patient's blood pressure. A central venous access line, pulmonary artery catheter, and trans esophageal echocardiographic transducer are inserted after the patient has been put under general anesthesia and intubated. Before the

surgical incision, the patient is prepared, wrapped in a sterile garment, and given time to rest. The doctor makes a median sternotomy and is ready to take out LIMA, so that it can be used as a conduit. Using open or video-assisted technology, a trained assistant (often a physician assistant, emergency medical technician, or other surgeon) extracts the saphenous vein from one or both legs at once. In order to prepare for cardiopulmonary bypass, the surgeon recommends anticoagulant medication, typically in the form of heparin, following appropriate induction (CPB). The cardiopulmonary bypass circuit is connected with tubing after the patient's aorta and heart center are cannulated. A harvested conduit is anastomosed into the coronary arteries distal to the occlusion after CPB has been started by stopping the heart in a hyperkalemia cardioplegia. The lead is joined to the new ostium made in the proximal aorta after the surgeon anastomoses the distal part. When the heart starts to beat and the cardioplegia is removed, the surgeon can assess the graft's blood flow and capacity as well as any bleeding at the anastomosis site. After that, The patient is subsequently moved to the critical care unit for monitoring of hemodynamic stabilization and extubating after the chest is closed with a sternum wire(Wang, Bilbao, Miller, O'Donnell, & Boyd, 2020).

CABG complications include death, atrial fibrillation following surgery, wound infection, graft failure, and renal failure.Due to the features of the patient and stroke risk factors including advanced age, aortic atherosclerosis, a history of stroke, perioperative atrial fibrillation, peripheral arterial disease, and diabetes.(Miller, 2012).

Although re-establishing blood flow to the myocardium is the fundamental goal of CABG, there are numerous ways to do it. The use of cardiopulmonary bypass or on-pump and off-pump is the first thing to take into account. Most CABG cases were carried out on the pump instead of the beating heart, which was the norm prior to the introduction of cardiopulmonary bypass and cardioplegia. Off-pump coronary artery bypass graft (OPCAB) surgery, however, became more popular in the 1990s.

Results from around 2000 OPCAB patients were presented by Benetti et al. and Buffalo et al., demonstrating the safety of the procedure. OPCAB is said to have advantages, including less organ damage to the lower extremities. Renal failure, cerebral vascular accident (CVA), diminished cognitive and psychomotor impairment, diminished transfusion rate, diminished overall inflammatory response(van den Brand et al., 2002).

Robotic and less invasive techniques have also been developed. CPB is not used during minimally invasive heart surgery, which also allows for fewer incisions. The LIMA to LAD transplant is the most popular application of this strategy. Other advantages include faster recovery times, less need for blood transfusions, less time spent in the ICU, and less pain than with typical CABG surgeries. Additionally, there are additional savings of up to 40%(Langer & Argenziano, 2016).

2.3.2 Cold Blood Cardioplegia

The most crucial tactic for maintaining myocardial function during cardiac surgery is cardioplegia, which also makes surgery easier by creating a silent and bloodless operating room. Initially, cardioplegia was used to treat the hypothermia-hyperkalemia syndrome. After then, it was discovered that blood was a crucial delivery system for potassium cardioplegia(Nardi et al., 2018).

We describe a cardioplegic procedure utilizing a potassium-and-draft blood (10 °C) cardioplegic solution (30 mEq. per liter). Coronary artery perfusion is performed using a separate pump head and a disposable cooling coil. The left ventricle can be vented using an aortic perfusion cannula. With great outcomes, this technique was applied to 73 of her consecutive juvenile cardiac procedures and 125 of her consecutive patients who underwent coronary revascularization.(Barner et al., 1979).

It has been suggested for myocardial protection on the grounds that blood cardioplegia, as opposed to crystalloid solutions, may improve postoperative cardiac outcomes since blood is compatible with normal physiology and touted as a safe and dependable cardiac protection technology. The myocardium can handle oxygen transport better or worse depending on how blood thins. The best cardioplegia for cardioprotection during cardiac surgery is still up for dispute, though(Barner, 1991).

Technique

To provide cold blood, we have created a disposable heat exchanger that is easily accessible to deliver cold blood. The arterial line receives Y connector. This causes the blood to travel through a heat exchange coil and then fall into a tiny puddle of slush at your feet.

In the field, A 14-gauge plastic cannula with a small piece of plastic tubing was pierced into it. It is inserted from the tip into the ascending aorta with a purse-string suture and fixed. A plastic tube segment helps secure the appropriate depth of the cannula.

When performing an intracardiac surgery, the venting of air needle can be utilized for both the initial delivery of cardioplegic fluids and the subsequent venting of air. Blood is taken into a 50 m3 tube with 1.5 mEq of potassium chloride when the systemic perfusate reaches a temperature of 28 °C (30 mEq. per liter).

Next, inject cold blood at 10°C into the aorta root. The content of the cardioplegic solution thus produced depends on part of the filling time of the pump. Prime currently in use (1,300ml lactated Ringer's solution. 20% mannitol, 50 mEq. and sodium bicarbonate.

Received after doing a bypass. 25–28°C systemic hypothermia is attained and sustained. With each infusion of cold blood potassium (CBK), sterile crushed ice produced from lactated Ringer's solution is given to the heart. It can be changed more frequently if needed. For ascending aorta dissection procedures, a coronary artery cannula can be attached to a cold perfusion line and used for infusionCBK to coronary ostia. First, inject the contents of (300-400 ml), then 200 ml. Given every 20 to 30 minutesIf there is substantial aortic regurgitation, her CBK can be cannulated directly into the coronary ostium or injected into the aortic root while massaging the heart. During coronary revascularization, cardioplegic fluid is administered after each distal anastomosis. The aortic root cannula is attached to a gravity drainage tube during infusion, which effectively decompresses the left ventricle. The cross clamp is let go once the distal anastomosis is finished. A vent needle is used to give CBK during pediatric heart surgery. The vent is connected to the vent's gravity drain after the cross clamp has been released.

The dosage is roughly 50 mL per 5 kg of body weight, and the injection is given again every 20 to 30 minutes. Deep systemic hypothermia (20°C tympanic temperature) and sporadic intervals of very low flow or full cessation of circulation are characteristics of chemically induced cardioplegia. As a result, surgeries that were previously time-limited by full cardiac arrest can now be done.(Mahrose et al., 2020).

2.3.3 Cold Crystalloid Cardioplegia

Cardioplegia protects the heart from ischemic injury during cardiopulmonary arrest and postoperative heart failure. Originally, crystalloid cardioplegia was introduced as means of facilitating termination of hypothermic hyperkalemia. With mild to severe hypothermia, cold crystalloid cardioplegia offers the benefit of lowering oxygen consumption and offers some protection during times of low flow or low perfusion pressure. Furthermore, distal coronary anastomosis visibility is enhanced by crystalloid cardioplegia (Nardi et al., 2018).

The cardioplegic solution was a modified version of St. Thomas II. Ingredients in one liter of crystalloid cardioplegic solution include: pH 6.3; temperature range of 4°C to 8°C; potassium concentration: 19.6 mmol/L; magnesium concentration: 16.7 mmol/L; calcium concentration: 2.0 mmol/L; sodium concentration: 128.0 mmol/L; procaine hydrochloride concentration: 1.0 mmol/L.(Braathen & Tønnessen, 2010).

Hypothermic crystalloid cardioplegia, in theory, guards the myocardium through electromechanical arrest and hypothermia. Both lessen the metabolic demands on the myocardium and increase its resilience to ischemia. There are two distinct forms of cold crystalloid cardioplegia solutions based on the pharmacological method of action.

solutions with intracellular and extracellular components. Extracellular crystalloid solutions have high quantities of sodium, calcium, and magnesium while intracellular crystalloid solutions have no or very low concentrations of sodium and calcium. Both include between 10 and 20 mmol/l of potassium and may also include mannitol, local anesthetics like lidocaine or procaine, and buffering agents like bicarbonates or amino acids. Brettschneider's solution (CUSTODIOL-MMCTSLink 86) and St. His Thomas Hospital's solution #2 are illustrations of intracellular and extracellular crystalloid cardioplegia (Plegisol, MMCTSLink 87)(Carvajal et al., 2021).

Surgical Technique:

The patient receives standard cardiopulmonary bypass. Although the majority of surgeons favor mild or moderate hypothermia (28–34 C), some surgeons prefer to expose their patients while normothermic, particularly if the anticipated cross-clamp time is brief. Consider using a cold crystalloid cardioplegiaA catheter is introduced into

the ascending aorta close to the clamp after the aorta has been clamped, and cardioplegic fluid is then injected into the aortic root.The ascending aorta is excised and carefully cannulated under direct vision in order to treat aortic regurgitation. This procedure is performed around 2 cm above the level of the coronary ostium.For this use, a variety of catheter designs of various sizes are offered commercially. Due to misplaced coronary calcification and embolization, it is typically unsuitable to use a 3.5–4.0 mm diameter cannula with a 135 angle for the left coronary ostium and a 90 angle for the right coronary ostium.

Unrecognized coronary abnormalities, such as isolated ostia of the LAD and LCX, might cause cardioplegia to be delivered. Crystalloid cardioplegia infusion is started once a route of antegrade cardioplegic administration (either by aortic root catheter or selective administration to the coronary ostia and ice (4° C.)) is established. Depending on the solutions used and the institution's experience, the amount of cardioplegic fluid administered overall and the rate at which it is administered will differ significantly. According to general guidelines, antegrade delivery perfusion pressures can be kept between 50 and 80 mmHg, and a volume of about 1000 mL is enough to successfully induce cardiac arrest in the majority of adult patients. After all mechanical and electrical activity of the heart has fully halted, some surgeons prefer to continue the cardioplegic injection for an additional 1-2 minutes.If the heart begins to electrically contract during the procedure or if a lengthy cross-clamp time is anticipated, further doses of 200–500 mL of cardioplegia solution may be given at regular intervals. It should be remembered that hemodilation during CPB time is considerably aided by the dose of crystalloid cardioplegia solution.By cutting a hole in the right atrium and aspirating the circulating cardioplegic fluid as it leaves the coronary sinus after bicaval cannulation with total CPB, this hemodilution impact can be reduced. If desired, a coronary sinus cannula with or without a self-inflating cuff can be used to retrogradely give cold crystalloid cardioplegia through the coronary sinus. To prevent the development of myocardial edema, the retrograde cardioplegia injection's perfusion pressure shouldn't be higher than 40 mmHg.(Guru, Omura, Alghamdi, Weisel, & Fremes, 2006).

2.4 Previous Studies

Protection of the myocardium during open-heart surgery is still an issue that researchers are still investigating to agree on the ideal method, to protect the already compromised myocardium. Despite the publication of a considerable number of experimental and clinical studies over the years, a literature search comparing cardioplegia with crystalloid versus cold-blooded cardioplegia in patients with CABG included seven international studies conducted around the world.

A clinical study by Ibrahim et al, (1998) comparing the cardioprotective effects of crystalloids or blood-based cardioplegia solutions was implemented. Twenty-five patients were included in each group, and randomization was achieved using a computer-generated randomization allocation table. After the investigators' analysis, in a high-risk group of patients undergoing elective cardiac surgery (EF, 40%), adding blood to established crystalloid cardioplegia solutions, reduced arrhythmias and provided myocardial protection, concluded that it was significantly improved(Ibrahim, Venn, Young, & Chambers, 1999).

In 1999, a second investigation was conducted. In a prospective, random experiment, Jacquet et al. (1999) compared intermittent antegrade warm blood cardioplegia with intermittent antegrade and retrograde CCC. Two groups of 200 patients each scheduled for isolated coronary artery bypass graft surgery were chosen at random. Group 1 (n = 92) received intermittent antegrade warm-blooded cardioplegia with systemic normothermia, while group 2 (n = 108) received cold crystalloid cardioplegia with mild widespread hypothermia. Data were gathered prospectively before, during, and after surgery. According to the release of cardiac-specific markers, they came to the conclusion that intermittent antegrade warm-blooded cardioplegia results in less damage to cardiomyocytes than cold crystalloid cardiac arrest.(Jacquet et al., 1999).

In contrast, Øvrum, et al. in 2004 undertook prospectively randomized trials of large patient series to demonstrate potential disparities in clinical course.440 study participants between the ages of 37 and 89 made up the sample (Group C, n = 719; Group B, n = 721). All significant demographic, preoperative, and surgical factors were comparable between groups. The researchers came to the conclusion after discussing the findings that there was no discernible difference between using cold-blooded or cold

crystalloid cardioplegia during aortic cross-clamping. Also, avoid paying additional expenses related to blood cardioplegia(Øvrum et al., 2004).

Compared to crystalloid cardioplegia:"Is blood better?" is a question that was addressed in 2006 by Guru, et al. in their meta-analysis of randomized clinical trials. English-language papers of peer-reviewed randomized controlled trials comparing blood and crystalloid cardioplegia in adult patients were mostly used to solve the question. Two reviewers assessed and summarized each paper in blind. Everything had been completed. 34 studies in all were included. 18 individuals (n) who were having elective CABG surgery participated in the majority of the investigations.Blood-cardiac arrest significantly decreased the likelihood of LOS (OR 0.54; 95% CI 0.34 to 0.84; P 0.006; 879 patients, 10 studies). Incidences of MI and deaths were comparable across treatment groups (MI: or 0.78; 95% CI, 0.54-1.13; 4316 patients, 23 studies; Deaths: or 0.80; 95% CI, 0.46-1.40; 4022 patients, 17 studies). Blood cardioplegia patients' postoperative CKMB release was reduced at 5.9 U/L (95% CI, 1.6 to 10.2; P0.007; 821 patients, 7 studies) in 24 hours.Blood-cardiac arrest significantly decreased the likelihood of LOS (OR 0.54; 95% CI 0.34 to 0.84; P 0.006; 879 patients, 10 studies). Incidences of MI and deaths were comparable across treatment groups (MI: or 0.78; 95% CI, 0.54-1.13; 4316 patients, 23 studies; Deaths: or 0.80; 95% CI, 0.46-1.40; 4022 patients, 17 studies). Blood cardioplegia patients' postoperative CKMB release was reduced at 5.9 U/L (95% CI, 1.6 to 10.2; P0.007; 821 patients, 7 studies) during 24 hours(Guru et al., 2006).

Another study was done in (2018) in Cardiac Surgery Division, Tor Vergata University Hospital, Rome, Italy by Nardi et al. This study looked back at whether patients having coronary artery bypass graft (CABG) surgery for intermittent antegrade WBC or intermittent antegrade CCC St. Thomas cardioplegia had different in-hospital outcomes. 330 patients in a row got isolated on-pump CABG from January 2015 to October 2016. Warm-blooded cardioplegia (WBC group, n = 297) or cold crystalloid cardioplegia (CCC group, n = 33) were used, depending on the surgeon's preference, to induce cardiac arrest. Results showed that warm-blooded cardioplegia required shorter dosing intervals to achieve better myocardial protection (Nardi et al., 2018).

A prospective study conducted by Mahrose et al. in 2020 from January to July 2019 in a cardiothoracic surgery operating room at the institutions affiliated with Ain Shams University aimed to compare the dose of inotropic support, postoperative cardiac

enzyme level, length of the mechanical ventilation postoperative left ventricular ejection fraction, intensive care unit stay, patient survival between cold crystalloid cardioplegia and antegrade warm blood cardioplegia during CABG in patients with low EF (30–40%).A computer-generated randomized classification list divided the 100 adult patients participating in this interventional, randomized, prospective trial into two equal groups. The patients were receiving selective low ejection fraction (30–40%) CABG.Intermittent antegrade cold crystalloid cardioplegia was placed in Group I of the list, while Group II was placed in the list (intermittent antegrade warm-blooded cardioplegia). Studies have shown that patients who received antegrade warm blood cardioplegia rather than cold crystalloid cardioplegia had better postoperative outcomes and needed less inotropic support and IABP. They also found that postoperative CK-MB and troponin I are higher in group I patients than in group II patients.(Mahrose et al., 2020).

Chapter Three

Methodology

The study methodology was thoroughly addressed in this chapter. Design, setting, sample and population, inclusion and exclusion criteria, instruments, reliability, validity, and ethical issues are among the things to mention.

3.1 Study Design

The study used a retrospective observational cohort design to follow up on data from medical records that were related to the Cold blood cardioplegia versus cold crystalloid cardioplegia for coronary artery bypass grafting (CABG) in patients with low ejection fraction.

This design has several advantages, including the fact that cohort studies generally allow researchers to study multiple exposures and outcomes simultaneously.The benefits of a retrospective design include the time investigators have to use existing databases to conduct their intended studiesand cost savings(Berger, Mamdani, Atkins, & Johnson, 2009)**.**

3.2 Site and Setting

The research was carried out in three medical centers in Palestine: AN-Najah University Hospital, Al-Makased Hospital- Jerusalem and Palestine Medical Complex - Ramallah. These hospitals reflect two important dimensions: they have the highest number of CABG patients in the targeted area, and they have both governmental and non-governmental health settings.Communication and data collecting are also easier at these institutions; nevertheless, each hospital has its own computerized health system. This necessitated specialized training for data collectors.

3.3 Sample Population and Sampling

The participants in this study include all patients with CAD with low EF (30-40%) thatoperated OPCABG at AN-Najah UniversityHospital,Al-Makased Hospitaland Palestine Medical Complex - Ramallah from (January 2020- Dec 2021).

The sample was chosen in order by date from patients with CAD with low EF (30-40%) thatoperated OPCABG at Al-Najah UniversityHospital,Al-Makased Hospitaland

Palestine Medical Complex –Ramallah from (January 2020- Dec 2021) which will include (75) patients fromAN-Najah UniversityHospital and Palestine Medical Complex – Ramallah and (75) patients from Al-Makased Hospital according to the following criteria:

Accor

ding to the demographics and the equation utilized, the sample size was determined to be 75 patients, or 3–4 patients per month. The Stephen-Tampson equation was used to determine the sample size.

N: The population's size.

Z: Class standard, which is equal to the level of significance (0.95), (1.96)

Q:The error rate is the same as (0.05)

P: Ratio has a neutral quality and is equivalent to (0.50).

3.4 Inclusion and Exclusion Criteria

Patients with CAD who are gone to OPCABG were included in the study if they were over the age of 40 years old and less than 80 years, regardless of gender or educational level. They were also admitted to the surgical CCU departments of the targeted hospitals.

On the other hand, patients under the age of 40 years or over the age 80 years, or who were outside of the surgical CCU department, or outside of the targeted hospitals were excluded.

3.4.1 Inclusion Criteria

- Patients have coronary artery disease (CAD)
- patient with low EF (≤40%)
- Patients operated on pump CAPG in cardiac surgical department
- Aged 40 -80yrs

3.4.2 Exclusion Criteria

- Patients have ejection fraction > 40%.
- Aged <40 or >80 yrs.
- Patient with vulvar disease.
- Patient with one graft only.
- Patient with renal failure and on dialysis therapy

3.5 Period of the Study

Data collection included all files from January 2020 to December 2021 retrospectively.

From January 2020 to December 2021, data was extracted for all CAD patients who are gone to on pump CABG and admitted to threesurgical CCU at three hospitals between January 1st, 2020 and December 30th, 2021; to meet the quantitative sample size criterion.

3.6 Data Collection Tool and Process

After reviewing related literature (Mahrose et al., 2020), the researcher developed a data sheet (Appendix A), which was divided into six sections. The first section of the sheet contains 4 questions about basic demographic information such as gender (Male, Female), age, weight, and height, while the second section focuses on the patients' clinical characteristics, such asmedical diagnosis, operation type,type of anesthesia,history of medical or surgical disease, allergyand ejection fraction. The third section is concerned with the operation data such as cardioplegia solution type,cardioplegia method,extracorporeal time (min), aortic cross clamp time (min)Pt. temperature through operation,cardioplegia temperature, cardioplegia volume (ml),cardioplegia frequency,use hot shout before decamping?Pt take blood unit (PRBC) through CPB time?and Use hemofiltration through CPB time? the fourth section is concerned with the post-operation data,post-op time staying on mechanical ventilator,post-op time staying on cardiac support(Pharmacological), other cardiac support: if yes, how many times stay on it?Pt. need for pacemaker?CVP reading post operation, amount of Blood loss,Pt take blood unit (PRBC) post CPB time? and if yes, how many units did the patient take?the fifth section post-operative complication like (The Patient needs redo operation? post-operative myocardial infarction,post- op Atrial

fibrillation, stroke, and minor neurologic event andfinally the six section which containstheblood test (troponin, creatinine level,blood sugar level,HGB).

The data sheets were divided into two major groups based on the cardioplegia type, and then data filled in tables consist of four columns.Data was obtained from patients' computerized records, with the researcher retrieving data from patients' records in each institution using an authorized account after receiving approval. Data retrieval was similar between different Health Information Systems (HIS) of hospitals based on the researcher's clinical expertise and previous training, whereas the researcher did it all by himself for all hospitals. missing data from the patient's records is left blank on the data sheet and is treated as a missing value by statistical analysis software, that statistical measures were done according to “all sample” value.

3.7 Validity and Reliability

The data sheet was developed by the researchers and then reviewed by perfusionist and three critical care experts, including an intensivist doctor who has supervised the treatment of OPCABG patients in surgical CCU, and an academic doctor who specializes in critical care nursing. Their comments wereconsidered when developing the data collection tool to its final form; in order to collect data in the most appropriate way for obtaining the best possible data and for the data analysis process.

When an instrument is used repeatedly under the same conditions with the same subjects, it is said to be reliable if its measurements are consistent.(Kimberlin & Winterstein, 2008).

3.8 Statistical Analysis

The data acquired from the medical records analyzed using The Statistical Package for Social Sciences (SPSS) version 20 software on windows operating system, using the descriptive and analytical (inferential) functions. The descriptive results included generating frequencies, percentages, mean and standard deviation for the variables related to patients’ demographic data, clinical Characteristics, laboratory tests, Post-operation Data, complications, and length of stay. Moreover, analytical results included the differentiation between cold blood cardioplegia and cold crystalloid cardioplegia in their data, including all of the mentioned variables, using Chi-square test for the

differentiation according to categorical variables and independent sample t-test for the differentiation according to scale variables.

3.9 Ethical Considerations

The research presented in this thesis was carried out in compliance with the Helsinki Declaration. The Faculty of Medicine and Health Sciences at AN-Najah National University's Institutional Review Board (IRB) (Appendix B) granted permission to start collecting data. After that, a facilitating paper was obtained from the Palestinian Ministry of Health in order to collect data from governmental hospitals(Palestine medical complex (PMC)while facilitation papers were obtained from each non-governmental hospital (AN NajahNational University Hospital and Al-MakasadHospital),Appendix (C) for its own purposes. Furthermore, the data was kept anonymous; participant information and the results obtained were retained in a secure location where no one could access them; and the data was collected only for research purposes.

Chapter Four

Findings of the Study

Statistical Methods

SPSS Version 20 is used for data analysis. Descriptive statistics (frequencies, percentages, Means, and Standard Deviations) are used. The following Tests and Methods were used to analyze the results based on that the P-Value < 0.05 is considered significant, and so the hypotheses of no differences in means or percentages between study groups will be rejected:

1. Chi-Square test: testing for qualitative or discrete differences across patient groups based on factors such (Gender, Surgery Type, History of Medical or Surgical Disease, Allergy,use hemofiltration through CPB time, use hot shout before decamping, Pt Take blood unit (PRBC) through CPB time, Pt need for pacemaker, Pt Take blood unit (PRBC) post CPB time, and post-operative complications).
2. Two Different Samples T test: evaluates the distinctions between patient groups for quantitative or continuous variables, including(Days of staying in hospital, Age, Weight, Height, Ejection fraction pre operation, Ejection fraction intra operation, Extracorporeal Time (min), Aortic cross lamp time (min), Pt. temperature through operation, Cardioplegia volume, Cardioplegia frequency/20 min, Post-op time staying on mechanical ventilator, Post-op time staying on cardiac support(Pharmacological), CVP reading post operation, Amount of Blood loss, and Blood Test).

This chapter will present the most important findings of the study in accordance with the questions and hypotheses from which the study was launched.

The results of the tests for normality for the continuous variables are listed below to help you determine whether to analyze this study's data using parametric or non-parametric statistical tests.

Table 1

Tests of Normality results

Variable	Cardioplegia solution type	Kolmogorov-Smirnov[a]	
		Statistic	Sig.
Days of Staying in Hospital	Cold Blood Cardioplegia	0.362	0.000
	Cold Crystalloid Cardioplegia	0.311	0.000
Age	Cold Blood Cardioplegia	0.102	0.052
	Cold Crystalloid Cardioplegia	0.138	0.065
Weight	Cold Blood Cardioplegia	0.090	0.200
	Cold Crystalloid Cardioplegia	0.109	0.200
Height	Cold Blood Cardioplegia	0.100	0.064
	Cold Crystalloid Cardioplegia	0.117	0.200
Ejection Fraction Pre operation	Cold Blood Cardioplegia	0.417	0.000
	Cold Crystalloid Cardioplegia	0.342	0.000
Ejection Fraction Intra operation	Cold Blood Cardioplegia	0.290	0.000
	Cold Crystalloid Cardioplegia	0.274	0.000
Extracorporeal Time (min)	Cold Blood Cardioplegia	0.155	0.000
	Cold Crystalloid Cardioplegia	0.252	0.000
Aortic Cross Clamp time (min)	Cold Blood Cardioplegia	0.166	0.000
	Cold Crystalloid Cardioplegia	0.268	0.000
Pt. TemperatureThrough Operation	Cold Blood Cardioplegia	0.390	0.000
	Cold Crystalloid Cardioplegia	0.409	0.000
Cardioplegia Volume	Cold Blood Cardioplegia	0.136	0.002
	Cold Crystalloid Cardioplegia	0.326	0.000
Cardioplegia Frequency/20 min	Cold Blood Cardioplegia	0.306	0.000
	Cold Crystalloid Cardioplegia	0.364	0.000
Post-op Time Staying on Mechanical Ventilator	Cold Blood Cardioplegia	0.302	0.000
	Cold Crystalloid Cardioplegia	0.355	0.000
Post-op Time Staying on Cardiac Support (Pharmacological)	Cold Blood Cardioplegia	0.180	0.000
	Cold Crystalloid Cardioplegia	0.252	0.000
CVP Reading Post Operation	Cold Blood Cardioplegia	0.141	0.001
	Cold Crystalloid Cardioplegia	0.191	0.001
Amount of Blood Loss 2 Hours	Cold Blood Cardioplegia	0.130	0.003
	Cold Crystalloid Cardioplegia	0.167	0.009
Amount of Blood Loss 4 Hours	Cold Blood Cardioplegia	0.116	0.015
	Cold Crystalloid Cardioplegia	0.186	0.002
Amount of Blood Loss 6 Hours	Cold Blood Cardioplegia	0.088	0.200
	Cold Crystalloid Cardioplegia	0.208	0.000
PreTroponin	Cold Blood Cardioplegia	0.429	0.000
	Cold Crystalloid Cardioplegia	0.488	0.000
Pre CreatinineLevel	Cold Blood Cardioplegia	0.072	0.200
	Cold Crystalloid Cardioplegia	0.117	0.200
Pre BloodSugar Level	Cold Blood Cardioplegia	0.200	0.000
	Cold Crystalloid Cardioplegia	0.283	0.000
Pre HGB	Cold Blood Cardioplegia	0.099	0.071
	Cold Crystalloid Cardioplegia	0.095	0.200
Post Creatinine Level	Cold Blood Cardioplegia	0.097	0.084
	Cold Crystalloid Cardioplegia	0.215	0.000
Post Blood Sugar Level	Cold Blood Cardioplegia	0.160	0.000
	Cold Crystalloid Cardioplegia	0.319	0.000
Post HGB	Cold Blood Cardioplegia	0.092	0.194
	Cold Crystalloid Cardioplegia	0.105	0.200

The results of normality tests show that some of the continuous variables are normally distributed (P-value>0.05). The others are not according to the study groups (Cardioplegia solution type).So, we need to use both the non-parametric Mann-Whitney test and the parametric Two Independent Samples T test, but since we have more than 15 cases in each study group, we decided to use the parametric Two Independent Samples T test in all the analysis.

Table 2

Frequencies and Percentages of Cardioplegia Solution Type

Group	Frequency	Percentage
Cold Blood Cardioplegia	75	50%
Cold Crystalloid Cardioplegia	75	50%
Total	150	100%

The sample of the study contained 75 cases in the Cold Blood Cardioplegia group and 75 cases in the Cold Crystalloid Cardioplegia group.

Part One: Demographic Data Which Included the Patients Information

The following table shows the results of differences between the study groups in Demographic data:

Table 3

The results of differences between Cardioplegia Solution Types in Demographic data

Indicator or Variable	Cardioplegia Solution Type		Total N=150	Test Statistic	P-value
	Cold Blood Cardioplegia (CBC) N=75	Cold Crystalloid Cardioplegia (CCC) N=75			
Days of Staying in Hospital	5.03±2.54	4.93±2.14	4.98±2.34	0.244	0.808
Age	61.12±7.85	60.93±8.44	61.03±8.12	0.140	0.889
Gender					
Male	55(73.3%)	56(74.7%)	111(74%)	0.035	0.852
Female	20(26.7%)	19(25.3%)	39(26%)		
Weight	83.35±11.68	79.6±11.93	81.47±11.92	1.943	0.054
Height	165.45±6.62	164.39±6.69	164.92±6.66	0.981	0.328
Died	1(1.3%)	4(5.3%)	5(3.3%)	1.862	0.172

The data in the table above demonstrates that there are no statistically significant differences between the Cold Blood Cardioplegia group and the Cold Crystalloid Cardioplegia group at the 0.05 level for any of the demographic variables examined (all the P-values are higher than 0.05).

Part Two: Clinical Characteristics

The following table shows the results of differences between the study groups in Clinical Characteristics:

Table 4

The results of differences between Cardioplegia Solution Types in Clinical Characteristics

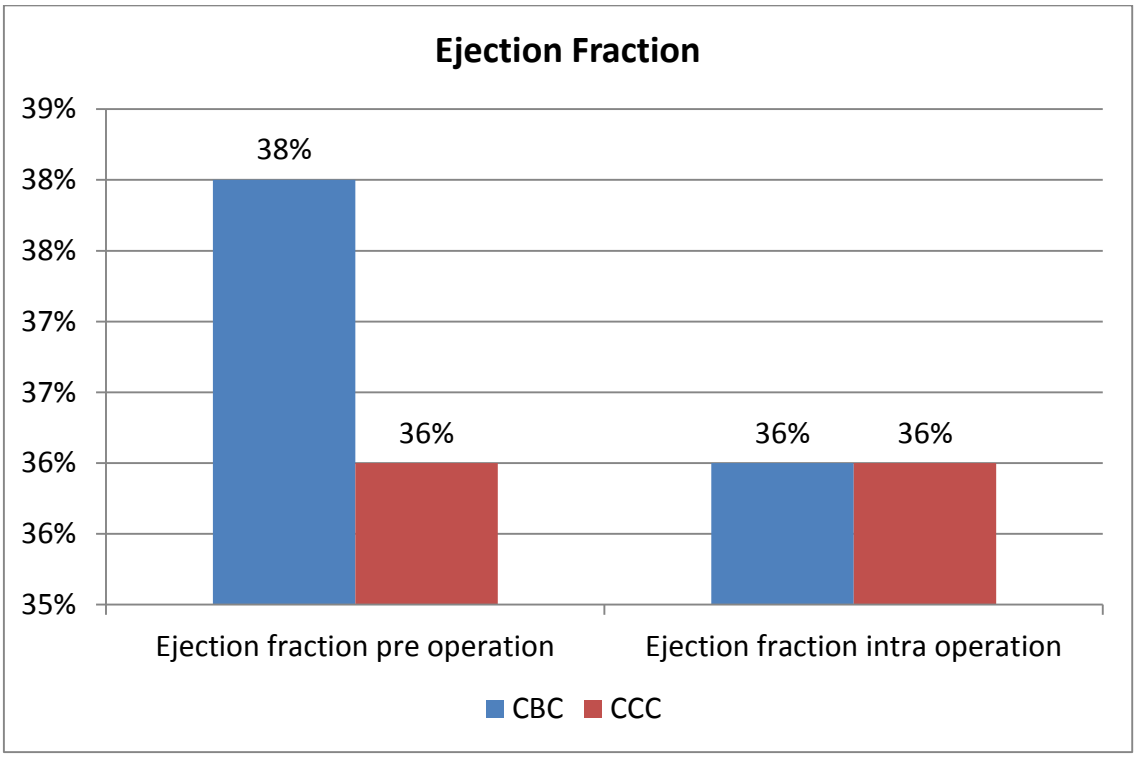
Indicator or Variable	Cardioplegia Solution Type		Total N=150	Test Statistic	P-value
	Cold Blood Cardioplegia (CBC) N=75	Cold Crystalloid Cardioplegia (CCC) N=75			
Operation Type					
CABG*3	36(48%)	42(56%)	78(52%)		
CABG*4	35(46.7%)	29(38.7%)	64(42.7%)	1.024	0.599
CABG*5	4(5.3%)	4(5.3%)	8(5.3%)		
History of Medical or Surgical Disease					
HTN	50(66.7%)	57(76%)	107(71.3%)	1.597	0.206
D.M	39(52%)	32(42.7%)	71(47.3%)	1.310	0.252
COPD	5(6.7%)	8(10.7%)	13(8.7%)	0.758	0.384
Asthma	1(1.3%)	2(2.7%)	3(2%)	0.340	0.560
Breast Cancer	1(1.3%)	0(0%)	1(0.7%)	1.007	0.316
CVA	2(2.7%)	0(0%)	2(1.3%)	2.027	0.155
BPH	1(1.3%)	0(0%)	1(0.7%)	1.007	0.316
CKD	1(1.3%)	0(0%)	1(0.7%)	1.007	0.316
Free	12(16%)	9(12%)	21(14%)	0.498	0.480
Allergy					
NKFDA	70(93.3%)	71(94.7%)	141(94%)		
Penicillin	4(5.3%)	4(5.3%)	8(5.3%)	1.007	0.604
Voltarin	1(1.3%)	0(0%)	1(0.7%)		
Ejection fraction pre operation	0.38±0.03	0.36±0.04	0.37±0.04	3.234	0.002
Ejection fraction intra operation	0.36±0.04	0.36±0.05	0.36±0.04	1.181	0.240

According to the results in the table above, the only difference between the Cold Blood Cardioplegia group and the Cold Crystalloid Cardioplegia group that is significant at the 0.05 level is the Ejection fraction prior to surgery, The CBC group's mean Ejection fraction before to surgery is (Mean=38%), which is considerably higher than the CCC group's mean (Mean=36%). The test's P-value is 0.002 in this case.

In contrast, the findings in the table above demonstrate that there are no differences between the Cold Blood Cardioplegia group and the Cold Crystalloid Cardioplegia group in any of the other Clinical Features examined in the table (the P-values are higher than 0.05).

Figure 2

The results of differences between the study groups in Ejection fraction results



Part Three: Operation Data

The following table shows the results of differences between the study groups in Operation Data:

Table 5

The results of differences between Cardioplegia Solution Types in Operation Data

Indicator or Variable	Cardioplegia Solution Type		Total N=150	Test Statistic	P-value
	Cold Blood Cardioplegia (CBC) N=75	Cold Crystalloid Cardioplegia (CCC) N=75			
Extracorporeal Time (min)	127.6±18.95	125.53±16.72	126.57±17.84	0.708	0.480
Aortic Cross Lamp Time (min)	73.47±14.02	77.67±13.64	75.57±13.95	-2.007	0.045
Pt. Temperature Through Operation	30.69±1.01	31.24±1.05	30.97±1.06	-3.244	0.001
Cardioplegia Volume	1222.67±154.72	1180±171.64	1201.33±164.25	1.599	0.112
Cardioplegia Frequency/20 min	190±31.84	180±56.35	185±45.89	1.338	0.183
Use Hemofiltration Through CPB Time	51(68%)	10(13.3%)	61(40.7%)	46.445	0.000
Use Hot Shout Before Declamping	30(40%)	0(0%)	30(20%)	37.500	0.000
Pt Take Blood Unit (PRBC) Through CPB Time	2(2.7%)	15(20%)	17(11.3%)	11.212	0.001
If Yes,How Many SnitsDid the Patient Take?	1.5±0.71	1.2±0.41	1.24±0.44	0.906	0.379
1 Unit	1(50%)	12(80%)	13(76.5%)	0.883	0.347
2 Units	1(50%)	3(20%)	4(23.5%)		

Aortic cross lamp time, Pt. temperature through operation, use of hemofiltration through CPB time, Pt Take Blood Unit (PRBC) through CPB time, and use of hot shout before declamping are the only variables that significantly differ between the Cold Blood Cardioplegia group and the Cold Crystalloid Cardioplegia group, according to the results in the table above.

Regarding the Aortic cross clamp time, the mean in the CBC group is (Mean=73.47) which is significantly lower than the mean in the CCC group (Mean=77.67), the P-value of the test is 0.045.

Regarding the Pt. temperature through operation,the mean in the CBC group is (Mean=30.69) which is significantly lower than the mean in the CCC group (Mean=31.24), the P-value of the test is 0.001.

Regarding the Use of hemofiltration through CPB time, the percentage of cases in the CBC group is (n=51, p=68%) which is significantly higher than the percentage of cases in the CCC group (n=10, p=13.3%), the P-value of the test is less than 0.001.

Regarding the Use of hot shout before declamping, the percentage of cases in the CBC group is (n=30, p=40%) which is significantly higher than the percentage of cases in the CCC group (n=0, p=0%), the P-value of the test is less than 0.001.

Regarding the Pt Take blood unit (PRBC) through CPB time, the percentage of cases in the CBC group is (n=2, p=2.7%) which is significantly lower than the percentage of cases in the CCC group (n=15, p=20%), the P-value of the test is 0.001.

On the other hand, the data in the table above indicate that there are no differences between the Cold Blood Cardioplegia group and the Cold Crystalloid Cardioplegia group in any of the other Operation Data examined in the table, at least not at the 0.05 level (the P-values are higher than 0.05).

Figure 3

The results of differences between the study groups in aortic cross clamp time (min)

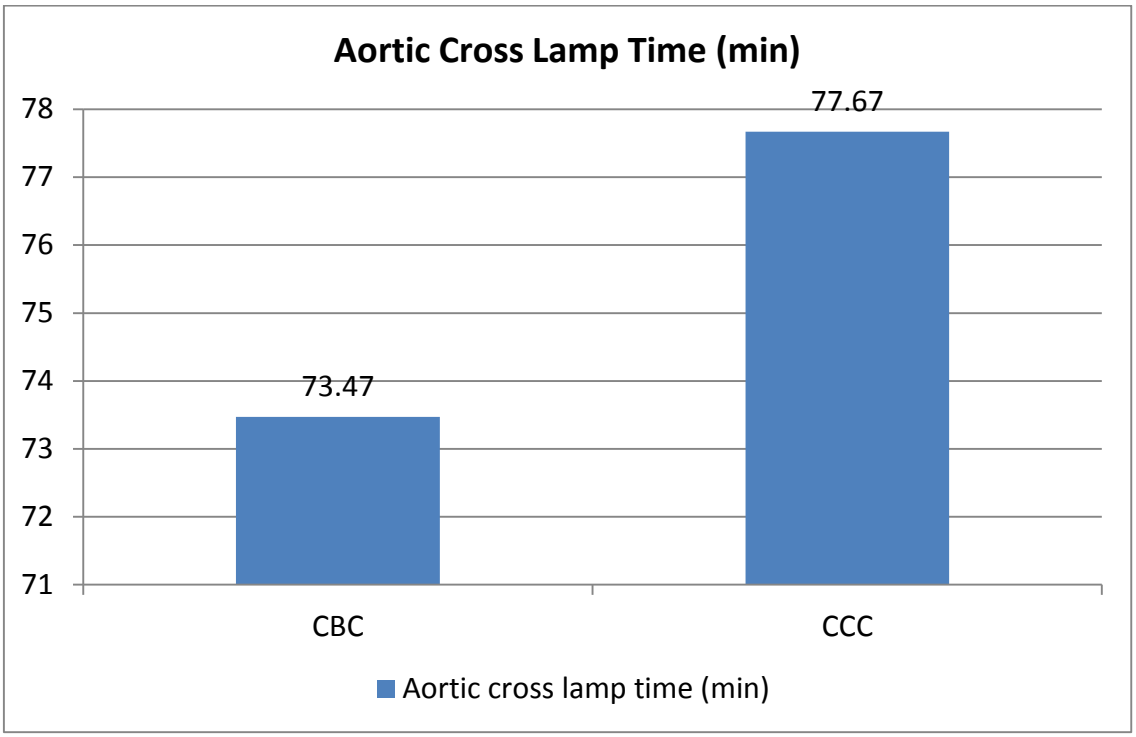
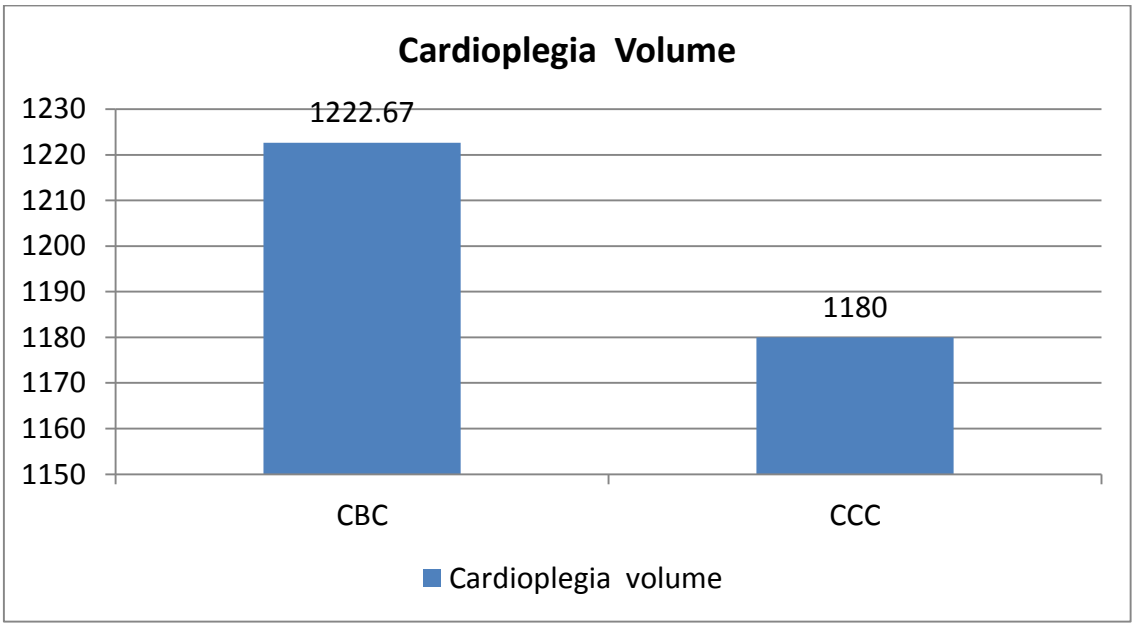


Figure 4

The results of differences between the study groups in cardioplegia volume



Part Four: Post-operation Data

The following table shows the results of differences between the study groups in Post-operation Data:

Table 6

The results of differences between Cardioplegia Solution Types in Post-operation Data

Indicator or Variable	Cardioplegia Solution Type		Total N=150	Test Statistic	P-value
	Cold Blood Cardioplegia (CBC) N=75	Cold Crystalloid Cardioplegia (CCC) N=75			
Post-op Time Staying on Mechanical Ventilator	8.88±8.22	9.67±9.3	9.27±8.76	-0.549	0.584
Post-op Time Staying on Cardiac support (Pharmacological)	21.79±22.95	16.99±16.48	19.39±20.06	1.471	0.143
Other Cardiac Support: IABP	2(2.7%)	3(4%)	5(3.3%)	0.207	0.649
Pt Need for Pacemaker	5(6.7%)	8(10.7%)	13(8.7%)	0.758	0.384
CVP Reading Post Operation	5.76±3.62	5.65±3.79	5.71±3.69	0.176	0.860
Amount of Blood Loss					
2 Hours	153.8±70.07	183.8±97.24	168.8±85.8	-2.168	0.032
4 Hours	239.07±94.38	255.6±122.09	247.33±109.07	-0.928	0.355
6 Hours	326.4±116.58	337±142.68	331.7±129.96	-0.498	0.619
Pt Take Blood Unit (PRBC) Post CPB Time	36(48%)	32(42.7%)	68(45%)	0.430	0.512
If Yes,How Many UnitsDid the Patient Take?	1.67±0.86	2.16±1.53	1.9±1.24	-1.652	0.103
1 Unit	20(55.6%)	14(43.8%)	34(50%)		
2 Units	9(25%)	9(28.1%)	18(26.5%)		
3 Units	6(16.7%)	3(9.4%)	9(13.2%)	5.509	0.239
4 Units	1(2.8%)	5(15.6%)	6(8.8%)		
8 Units	0(0%)	1(3.1%)	1(1.5%)		

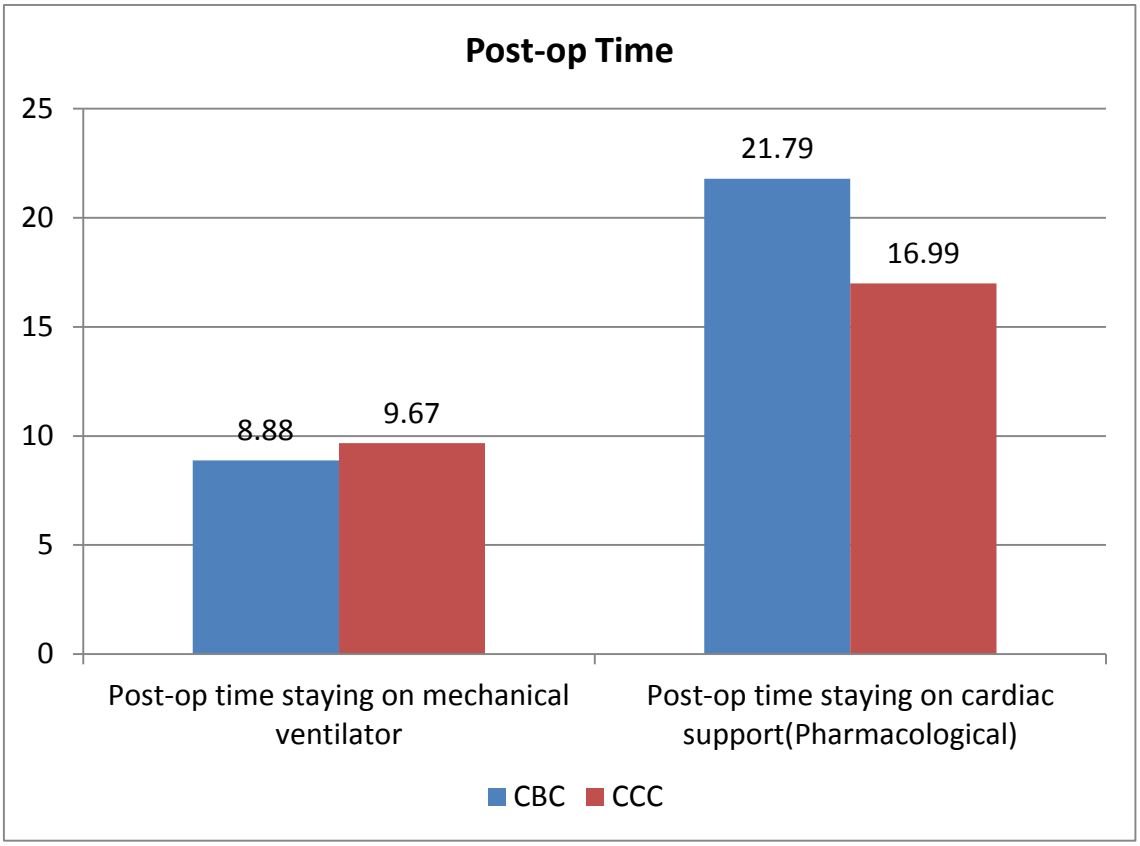
According to the data in the table above, only the amount of blood lost two hours after surgery differs significantly at the 0.05 level between the Cold Blood Cardioplegia group and the Cold Crystalloid Cardioplegia groupThe P-value for the test is 0.032

because the mean in the CBC group (Mean=153.8) is considerably lower than the mean in the CCC group (Mean=183.8).

On the other hand, the data in the table above indicate that there are no differences between the Cold Blood Cardioplegia group and the Cold Crystalloid Cardioplegia group in any of the other Post-Operation Data examined in the table, at least not significant ones at the 0.05 level (the P-values are higher than 0.05).

Figure 5

The results of differences between the study groups in Post-op Time Staying on Mechanical Ventilator and Post-op Time Staying on Cardiac support (Pharmacological)



Part Five: Post-operative Complication

The following table show the results of differences between the study groups in post-operative complication:

Table 7

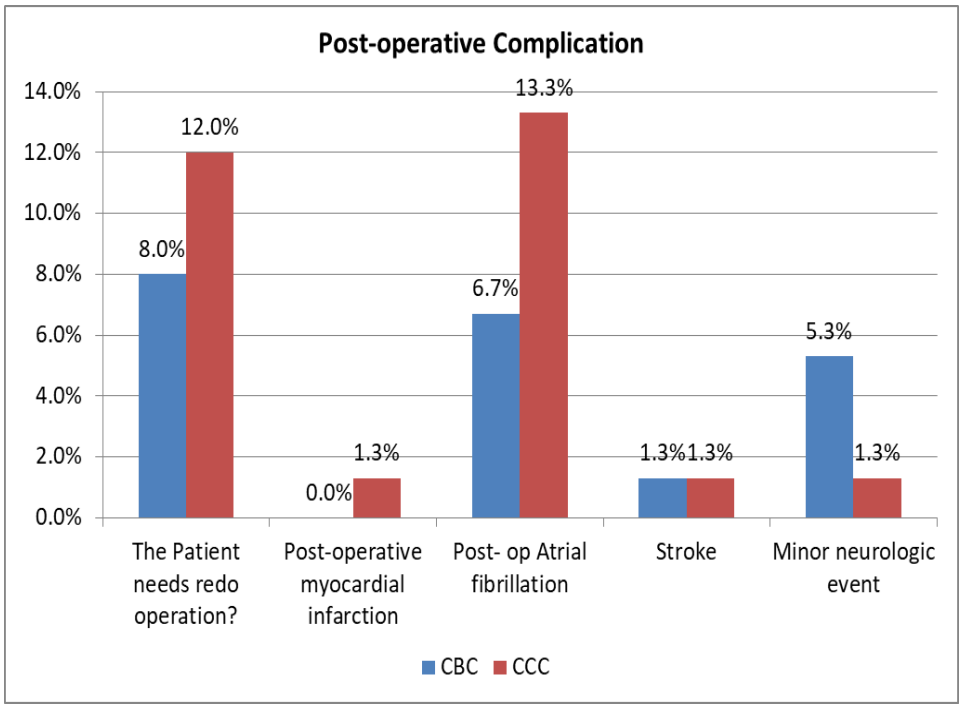
The results of differences between Cardioplegia Solution Types in Post-operative complication

Indicator or Variable	Cardioplegia Solution Type		Total N=150	Test Statistic	P-value
	Cold Blood Cardioplegia (CBC) N=75	Cold Crystalloid Cardioplegia (CCC) N=75			
The Patient Needs Redo Operation?	6(8%)	9(12%)	15(10%)	0.667	0.414
Post-operative Myocardial Infarction	0(0%)	1(1.3%)	1(0.7%)	1.007	0.316
Post- op Atrial Fibrillation	5(6.7%)	10(13.3%)	15(10%)	1.852	0.174
Stroke	1(1.3%)	1(1.3%)	2(1.3%)	0.000	1.000
Minor Neurologic Event	4(5.3%)	1(1.3%)	5(3.3%)	1.862	0.172

The findings in the table above demonstrate that there are no significant differences between the Cold Blood Cardioplegia group and the Cold Crystalloid Cardioplegia group at the 0.05 level for any of the post-operative problems examined (all the P-values are higher than 0.05).

Figure 6

The results of differences between the study groups in Post-operative complication



Part Six: Blood Test

The following table show the results of differences between the study groups in Blood Test:

Table 8

The results of differences between Cardioplegia Solution Types in Blood Test

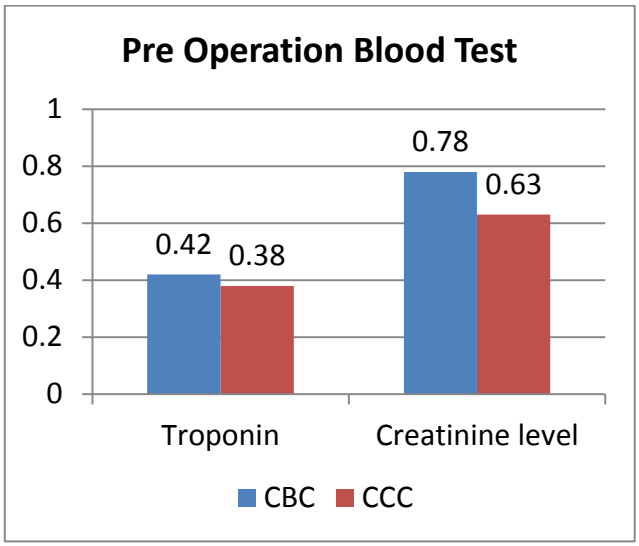
Indicator or Variable	Cardioplegia Solution Type		Total N=150	Test Statistic	P-value
	Cold Blood Cardioplegia (CBC) N=75	Cold Crystalloid Cardioplegia (CCC) N=75			
Pre Operation Results					
Troponin	0.42±1.76	0.38±1.74	0.4±1.74	0.111	0.912
Creatinine level	0.78±0.39	0.63±0.42	0.7±0.41	2.358	0.020
Blood Sugar level	151.47±60.69	137.6±47.03	144.53±54.55	1.564	0.120
HGB	14.35±1.46	14.4±1.17	14.37±1.32	-0.235	0.815
Post Operation Results					
Troponin	-----	-----	-----		
Creatinine level	0.94±0.52	0.87±0.68	0.91±0.61	0.759	0.449
Blood Sugar level	165.2±63.69	166.95±81.04	166.07±72.64	-0.147	0.884
HGB	9.74±1.57	9.93±1.83	9.84±1.7	-0.710	0.479

The results in the table above demonstrate that only Creatinine levels pre-operation are significantly different between the Cold Blood Cardioplegia group and the Cold Crystalloid Cardioplegia group at the 0.05 level; the mean in the CBC group is (Mean=0.78), which is significantly higher than the mean in the CCC group (Mean=0.63); the P-value for the test is 0.020.

On the other hand, the findings in the table above indicate that there are no differences at the 0.05 level between the Cold Blood Cardioplegia group and the Cold Crystalloid Cardioplegia group in any of the other Blood Tests performed prior to or during the surgery (the P-values are higher than 0.05).

Figure 7

The results of differences between the study groups in pre operation blood test results



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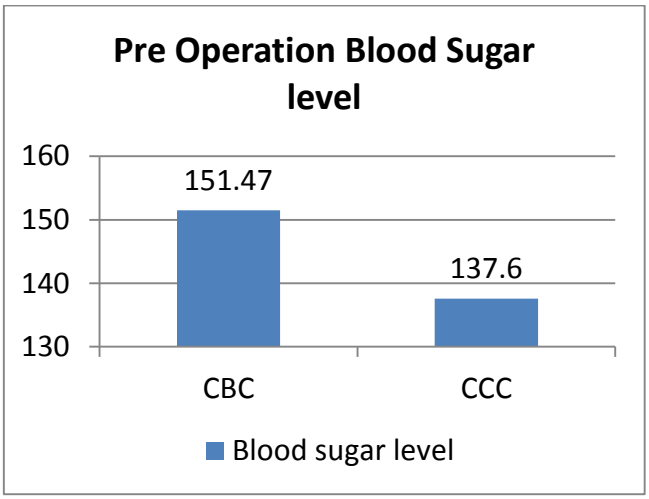


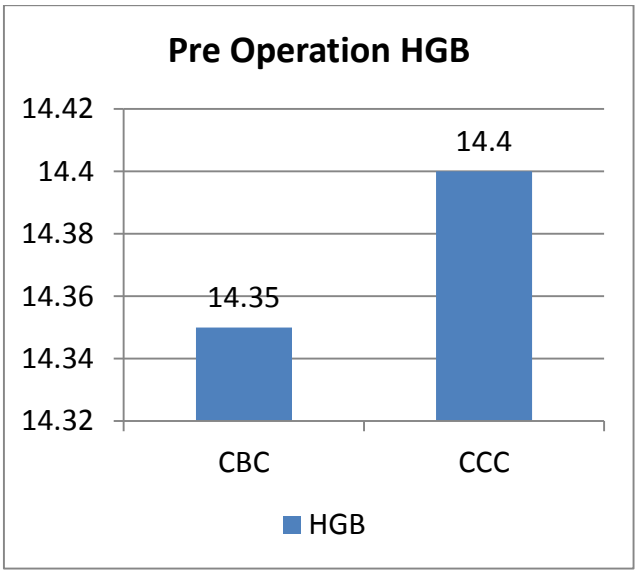
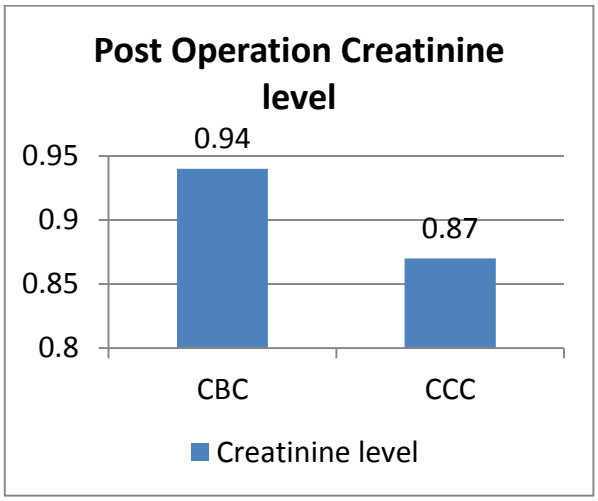
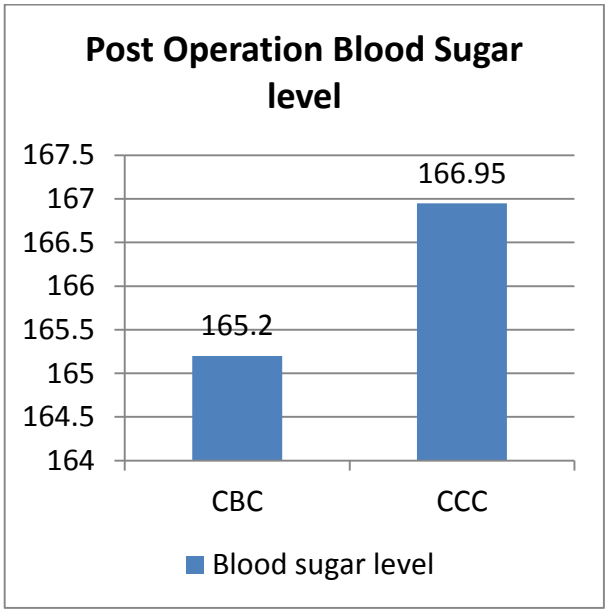
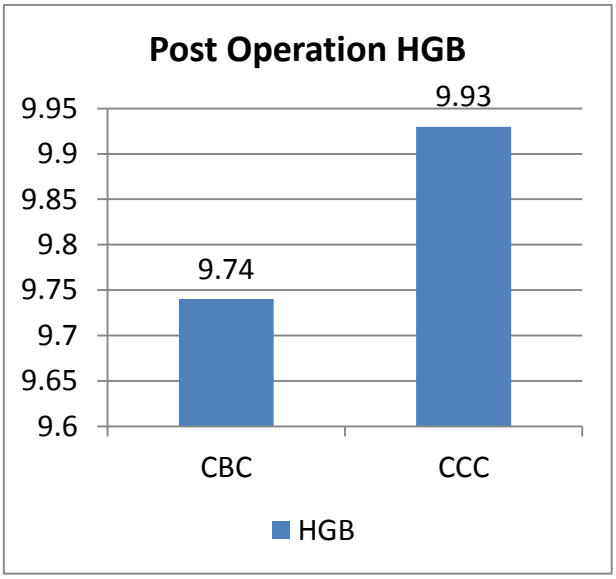


Figure 8

The results of differences between the study groups in post operative blood test results







Chapter Five

Discussion

5.1 Introduction

This chapter reviews the discussion of the present study's findings by comparing them to those of earlier studies and provides a critical overview from the researchers' perspective.

The primary study finding is discussed in this chapter. According to the study's findings, it is likely that myocardium preservation has a substantial relationship with the variables examined.

The aim of this this retrospective observational cohort study to compare the CBC versus CCC for coronary artery bypass grafting (CABG) in patients with low EF -in three large hospitals in Palestine to define which type is better to increase myocardium preservation through operation and reduce the complication after CABG operation.

To our knowledge, this study is the first performed in Palestine. This study compared between CBC and CCC.

This study contained the sample of 75Cases (50 %) in the cold blood cardioplegia group and 75 cases(50%) in the cold crystalloid cardioplegia group.

5.2 Socio-Demographic Data:

According to the study's findings, there are no significant differences between the CBC and CCC groups in any of the demographic information analyzed at the 0.05 level (all the P-values are higher than 0.05).

Above all, there are no differences between the CBC group and the CCC group in terms of age, gender, weight, or height at the (0.05) level (the P-values are larger than (0.05); this indicates that there are no differences between the CBC group and the CCC group in these categories.

5.3 Clinical Characteristics

The results demonstrate that only the Ejection Fraction Pre-Operation differs significantly between the CBC Group and the CCC Group at the 0.05 level; the CBC Group's mean Ejection Fraction Pre-Operation is (Mean=38%), which is significantly higher than the CCC Group's mean (Mean=36%), and the P-value for the test is 0.002.

On the other hand, the findings indicate that there are no differences between the CBC group and the CBC group in any of the other clinical characteristics examined (type of operation, history of medical or surgical disease, allergy, and ejection fraction intra-operatively), with P-values greater than 0.05.

All clinical characteristics are not affected by cardioplegia methods, except the Ejection fraction pre operation that increases in cold blood cardioplegia.

5.4 Operation Data

According to the results, the only variables that significantly differ between the CBC group and the CCC group at the 0.05 level are the Aortic cross lamp duration, Pt. temperature during operation, hemofiltration usage through CPB time, Pt Take blood unit (PRBC) usage through CPB time, and use of hot shout before declamping.

The P-value for the test is 0.045 because the mean for the Aortic Cross Lamp Time in the CBC group is (Mean=73.47), considerably lower than the mean in the CCC group (Mean=77.67).

The result refer to Aortic cross lamp time in cold blood carioplegia group is lower than the cold crystalloid cardioplegia group. This result may be due to the surgeon’s difference in the two methods.

In terms of the Pt. temperature during operation, the CBC group's mean (Mean=30.69) is considerably lower than the CCC group's mean (Mean=31.24), and the test's P-value is 0.001.

The result refers to pt. temperature through operation in cold blood cardioplegia group is lower than the cold crystalloid cardioplegia group.

Regarding the Use of hemofiltration through CPB time, the percentage of cases in the CBC group is (n=51, p=68%); which is significantly higher than the percentage of cases in the CCC group (n=10, p=13.3%), the P-value of the test is less than 0.001.

The result refer to the use of hemofiltration through CPB time in cold blood cardioplegia group is higher than in cold crystalloid cardioplegia.(his was affected by hospital protocol for use hemofiltration through CPB time). T

Regarding the use of hot shout before declamping, the percentage of cases in the CBC group is (n=30, p=40%) which is significantly higher than the percentage of cases in the CCC group (n=0, p=0%), the P-value of the test is less than 0.001.

The result refers to the use of hot shout before declamping in cold blood cardioplegia group is higher than in cold crystalloid cardioplegia.(This affected by cradiosurgerydoctors' preferences and hospital protocol).

Regarding the Pt take blood unit (PRBC) through CPB time, the percentage of cases in the CBC group is (n=2, p=2.7%); which is significantly lower than the percentage of cases in the CCC group (n=15, p=20%), the P-value of the test is 0.001.

The result refers to the pt. take blood unit (PRBC) through CPB time in cold blood cardioplegia group is lower than in cold crystalloid cardioplegia..(this was affected by hospital protocol for blood transfusion through CPB time). T

However, the results indicate that there are no differences between the CBC group and the CCC group in all other operation data (extracorporeal time, cardioplegia volume, and cardioplegia frequency/20 min) where the P-values are larger than 0.05.

5.5 Post-operation Data

The results indicate that only the amount of blood lost two hours after surgery differs substantially between the CBC group and the CCC group at the 0.05 level; the CBC group's mean is (Mean=153.8), which is significantly lower than the CCC group's mean (Mean=183.8), and the test's P-value is 0.032.

The results show that the cold blood cardioplegia group experienced less blood loss than the cold crystalloid cardioplegia group two hours after surgery.

On the other hand, the results indicate that there are no differences between the CBC group and the CCC group in all other post-operative data (post-op time spent on mechanical ventilator, post-op time spent on cardiac support (pharmacological), other cardiac support: IABP, patient need for pacemaker, post-operative CVP reading), where the P values are higher than 0.05.

5.6 Post-operative Complication

The findings demonstrate that there are no differences between the CBC group and the CCC group in any of the post-operative complications (Patient requires repeat surgery, post-operative myocardial infarction, post-operative atrial fibrillation, stroke, minor neurologic event), with all P-values being higher than 0.05.

5.7 Blood Test

The results indicate that only the pre-op creatinine levels between the CBC group and the CCC group differ substantially at the 0.05 level; the CBC group's mean is (Mean=0.78), which is significantly higher than the CCC group's mean (Mean=0.63); the P-value for the test is 0.020.

On the other hand, the findings reveal that there are no differences at the 0.05 level between the CBC group and the CCC group in any of the other blood tests performed before or after surgery that were examined in the table (the P-values are higher than 0.05).

5.8 Hypothesis One

H0: There is no significant difference between EF preoperative and intraoperative in two groups of the study (cold blood cardioplegia or cold crystalloid cardioplegia) at a significance level of P-value = 0.05.

According to the findings, the sole difference between the CBC group and the CCC group in terms of ejection fraction prior to surgery is significant at the 0.05 level, The CBC group's mean Ejection fraction before to surgery was 38 percent, which is considerably higher than the CCC group's mean of 36 percent. The test's P-value was 0.002 as a result.

On the other hand, the findings indicate that there are no significant variations in EF intraoperative between the CBC group and the CCC group at the 0.05 level (the P-values are higher than 0.05).

(Nardi et al., 2018)discovered that the postoperative left ventricular ejection fraction in the CCC group was likewise better than in the WBC group, but that this difference was probably caused by the higher preoperative mean value in the CCC group. (Nardi et al., 2018).

5.9 Hypothesis two

There is no significant difference in cardioplegia volume when use CBC or CCC at a significance level of P-value = 0.05.

The findings demonstrate that there are no significant variations in cardioplegia volume between the CBC group and the CCC group at the 0.05 level (the P-values are higher than 0.05).

Similar results were highlighted in cardioplegia volume (ml) in comparison between the CBC group and the CCC group by Øvrum et al in 2004 who found that no significant differences between the CBC and the CCC in cardioplegia volume (the P-values0.08) (Øvrum et al., 2004).

5.10 Hypothesis Three

There is no significant difference in extracorporeal time when use CBC or CCC at a significance level of P-value = 0.05.

From one side, the findings indicate that there are no differences between the CBC group and the CCC group in extracorporeal time at the 0.05 level (no significant correlation between extracorporeal time and different forms of cardioplegia), and the P-values are higher than 0.05.

Similar results were highlighted in cardiopulmonary bypass time (min) in a comparison between the Cold Blood Cardioplegia group and the Cold Crystalloid Cardioplegia group by Lerman, etal 2018, who found thatCardiopulmonary bypass time (min) 104.07 vs. 100.34 vs. 25.90. A total of 774 instances were examined; of those, 592 cases of

BCP and 182 cases of CCP were found, indicating no connection between extracorporeal time and various forms of cardioplegia (Lerman et al., 2018).

Øvrum etal,2004 also compared the CBC versus CCC: his prospective, randomized study of 1,440 patients undergoing CABG surgery found a small statistically significant difference in extracorporeal circulation time (Øvrum et al., 2004).

From this above-mentioned information, I concluded that different type of cardioplegia (CBC and CCC) have the same effects on cardiopulmonary bypass time.

In the opposite direction when Nardi etal.2018 At the heart surgical division of the University Hospital Tor Vergata in Rome, 330 consecutive patients had isolated CABG via cardiopulmonary bypass between January 2015 and October 2016 which compared the WBC group and CCC group .They discovered that the WBC group had a longer cardiopulmonary bypass time (P=0.017).(Nardi et al., 2018).

5.11 Hypothesis Four

H0: There is no significant difference in cross-clamp time when use CBC or cold CCC at a significance level of P-value = 0.05.

The findings reveal that the Aortic cross lamp duration is significantly different between the CBC group and the CCC group at the 0.05 level between the two groups.The P-value for the test is 0.045 because the mean Aortic cross lamp duration in the CBC group is considerably lower than the mean in the CCC group (Mean=77.67).

In a study in 2004 by Øvrum,etal, his prospective randomized trial of 1440 patients having CABG surgery, reported that there were no statistically significant changes in the Aortic cross lamp duration between CBC and CCC (Øvrum et al., 2004).

Additionally, Lerman et al. conducted a retrospective analysis of adult consecutive isolated AVR done between April 2006 and February 2011 at the Royal Infirmary Hospital of Edinburgh. It discovered no difference in cross-clamp duration (min) across the groups: 75.7818.78 in the CCP and 77.0114.47 in the BCP (Lerman et al., 2018).

Additionally, Nardi et al. reviewed early outcomes of coronary artery bypass grafting (CABG) procedures that used either antegrade intermittent warm blood cardioplegia or

cold crystalloid cardioplegia to preserve the myocardium. 330 consecutive patients underwent isolated on-pump CABG from January 2015 to October 2016, and it was discovered that both groups' aortic cross-clamp periods were comparable (Nardi et al., 2018).

5.12 Hypothesis Five

H0: There is no significant difference in postoperative time staying on mechanical ventilator when use CBC or CCC. at a significance level of P-value = 0.05.

The findings indicate that there are no differences in postoperative time spent on mechanical ventilation between the CBC group and the CCC group at the 0.05 level. Talwar et al., in contrast, conducted a prospective randomized trial in 2017 to compare del Nido (DN) cardioplegia with conventional cold blood cardioplegia. The primary outcome was the use of long-acting cardioplegia solution was associated with decrease duration of mechanical ventilation (P = 0.01) than conventional cold blood cardioplegia(Talwar et al., 2017).

5.13 Hypothesis Six

H0: There is no significant difference in blood loss volume on 2,4,6 hrs. postoperative when use CBC or CCC at a significance level of P-value = 0.05

The findings reveal that only the amount of blood lost two hours after surgery differs significantly between the Cold Blood Cardioplegia group and the Cold Crystalloid Cardioplegia group at the 0.05 level.The CBC group's mean (Mean=153.8) is substantially lower than the CCC group's mean (Mean=183.8), as indicated by the test's P-value of 0.032.

We found no previous studies examining postoperative CABG blood loss. Comparison of cold crystalloid and cold-blooded cardioplegia.

5.14 Hypothesis Seven

H0: There is no significant difference in incidence of complication postoperative when using CBC or CCC. at a significance level of P-value = 0.05.

The findings reveal no statistically significant differences between the CBC group and the CCC group in any of the post-operative problems examined (The Patient needs a repeat operation?). All of the P-values for post-operative myocardial infarction, post-operative atrial fibrillation, stroke, and minor neurologic incident are higher than 0.05.

No statistically significant difference between the two forms of cardioplegia is shown by Paolo Nardi et al in 2018. stroke and postoperative atrial fibrillation rates, with the exception of lower postoperative cardiac troponin and CK-MB concentrations with blood cardioplegia than with crystalloid cardioplegia. (Nardi et al., 2018).

Additionally, Fan et al. discovered in 2010 that there was no statistically significant difference in the occurrences of clinical events between patients receiving crystalloid cardioplegia versus blood cardioplegia. and a post-surgical complication (Fan et al., 2010).

5.15 Hypothesis Eight

H0: There is no significant difference in increase in Creatinine level when use CBC or CCC at a significance level of P-value = 0.05.

The findings demonstrate that only the pre-operation Creatinine levels of the CBC group and the CCC group differ significantly at the 0.05 level. The CCC group's mean (Mean=0.63) is considerably lower than the CBC group's mean (Mean=0.78), which is why the test's P-value is 0.020.

The data, however, reveal that there are no differences between the CBC group and the CCC group in post-operative creatinine levels that are significant at the 0.05 level (the P-values are higher than 0.05).

Lerman etal found that no significant differences in pre-operative creatinine level between cold blood cardioplegia and cold crystalloid cardioplegia(Lerman et al., 2018).

Chapter Six

Conclusion and Recommendations

6.1 Conclusion

The study concluded that using cold blood cardioplegia has the same myocardium preservation and complication from cold crystalloid cardioplegia.

Acceptance for hypothesis that indicates there is no significant difference between the result of intra -operative ejection fraction, cardioplegia volume, cardiopulmonary bypass time, blood loss post- operative on 4 and 6 hr. post operatively, time staying on mechanical ventilation post operatively, time staying on pharmacological cardiac support post-operatively, creatinine level post-operatively and post- operative complication when using CBC compared with use CCC at a significant level of P value (0.05).

The ejection fraction prior to surgery is the factor where there are significant variations between the CBC group and the CCC group at the 0.05 level, according to partial acceptance for hypothesis. The CBC group's mean ejection fraction prior to surgery was 38 percent, which is considerably higher than the CCC group's mean of 36 percent; the test's P-value was 0.002 as a result.Two hours after surgery, there are differences in the amount of blood lost that are significant at the 0.05 level. The CCC group's mean (Mean=183.8) is considerably higher than the CBC group's mean (Mean=153.8), and the test's P-value is 0.032.and the pre-operation creatinine levels differ significantly at the 0.05 threshold. By utilizing CBC in comparison to CCC at a significant level of P value, the test's P-value is 0.020 because the mean in the CBC group is (Mean=0.78), significantly higher than the mean in the CCC group's (Mean=0.63) (0.05). These factors alone do not support the conclusion that cold blood cardioplegia is preferable to cold crystalloid cardioplegia.

Finally, the study concluded that ejection fraction pre-operative,blood loss 2 hrs. post-operative and creatinine level pre-operative was significant only and another variable was not significant(ejection fraction intraoperative,cardioplegia volume, cardiopulmonary bypass time, blood loss post- operative on 4 and 6 hr. post operatively, time staying on mechanical ventilation post operatively, time staying on

pharmacological cardiac support post-operatively, creatinine level post-operatively and post- operative complication).However, according to mentioned above, we conclude that there is no preference for us: any type of cardioplegia at the expense of the other type, but cold blood cardioplegia need more cost than cold crystalloid cardioplegia when use the traditional method.and CCC give more visible for field.

6.2 Recommendations

For clinical practice, it is recommended to use cold crystalloid cardioplegia; to decrease the cost of cold blood cardioplegia use, and give more visible for surgical field.

1.Give instruction to perfusionist and cardio surgery team in AN-Najah University Hospital and Palestinian Medical Complex Hospital to continuo with same method of administration cardioplegia (cold crystalloid cardioplegia) and instruct Al- Makased Hospital to follow cold crystalloid cardioplegia to decrease cost.

2.Present the results of this study to the Palestinian Ministry of Health to make a comprehensive protocol and guidelines for all hospitals to follow cold crystalloid cardioplegia.

3.To further elucidate these findings, we recommend studies in large patient populations with complex diagnostics and invasive cardiac monitoring.

4.doing the study in experimental method to control of all variable.

5. Our recommendation to health-care facilities is to create a health-information system that includes all records and encourages documentation.

6.3 Limitations

1. This study was limited to three hospitals in the West Bank of Palestine, limiting generalizability to all Palestinian health systems.
2. There was no follow-up after discharge, thus the researcher would not know whether a patient was with another complication post-discharge.
3. Due to the fact that this is a retrospective study, there is some missing data such as pot- operative ejection fraction and post–operative troponin level.

4. There are numerous challenges in gathering data, such as the lack of a standard method for recording data, which forces researchers to interpret perfusionist' notes in order to extract the information they require.

List of Abbreviations

Abbreviation	Meaning
ACS	Acute Coronary Syndrome
AKI	Acute Kidney Injury
BPH	Benign prostatic hyperplasia
CABG	Coronary Artery Bypass Grapht
CAD	Coronary Artery Disease
CBC	Cold Blood Cardioplegia
CCC	Cold Crystalloid Cardioplegia
CHF	Congestive Heart Failure
CKD	Chronic Kidney disease
COPD	Chronic Obstructive Pulmonary Disease
CPB	Cardiopulmonary bypass
CVA	Cerebrovascular Accident
DM	Diabetes Mellitus
ECMO	Extra Corporeal Membrane Oxygenation
EDV	End- Diastolic Volume
EF	Ejection Fraction
FFF	Fresh Frozen Plasma
HGB	Hemoglobin
HTN	Hypertension
IABP	Intraaortic Balloon Pump
MVD	Multi Vessel Disease
NKFDA	No known Food and Drug Allergies
PT	Patient
PRBC	Packed Red Blood Cell
SV	Stroke Volume

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WASAY, A., HAFEEZULLAH, D., MEMON, R. A., AHMED, S., KUMAR, J., ACHAKZAI, A., & KUMAR, V. COMPARISON OF ANTEGRADE WITH ANTEGRADE/RETROGRADE CARDIOPLEGIA FOR MYOCARDIAL REVASCULARIZATION IN CORONARY ARTERY BYPASS GRAFTING.

Appendices

Appendix A

Data Sheet

Basic Information's	
Date of Admission to Hospital	
Date of Operation	
Date of ExudationAfter Operation	
Date of Discharge fromCCU or Death	

Data check list consists of six parts:

Part One:Demographic Data: which will include the patient`s information:

Variables	**Options**
Age (in complete years)	
Gender	**Male: Female:**
Weight (in kilograms)	
Height (in centimeters)	

Part Two: Clinical Characteristics

Variable	**Options**
Medical Diagnosis	
Operation type	
Type of Anesthesia	
History of Medical or Surgical Disease	
Allergy	
Ejection Fraction	**Pre operation:** **Intra operation:**

Part Three: Operation Data

Cardioplegia Solution Type	**Cold Blood Cardioplegia …….** **Cold Crystalloid Cardioplegia …….**
Cardioplegia Method	**Antegrade Cardioplegia……** **Retrograde Cardioplegia ……**
Extracorporeal Time (min)	
Aortic Cross Lamp Time (min)	
Pt. Temperature Through Operation	
Cardioplegia Temperature	
Cardioplegia Volume (ml)	
Cardioplegia Frequency	
Use Hemofiltration Through CPB Time?	**Yes: No:**
Use Hot Shout Before Declamping?	**Yes: No:**
Pt Take Blood Unit (PRBC) Through CPB Time?	**Yes: No:**
If Yes how many unit did the patient take?	

Part Four: Post-operation Data

Post-op Time Staying on Mechanical Ventilator	
Post-op Time Staying on Cardiac Support(Pharmacological)	
Other Cardiac Support: If yes,How Many TimesStay onIt?	**IABP** **ECHMO:**

	LVAD:
Pt. Need forPacemaker?	**Yes: No:**
CVP Reading Post Operation	
Amount of Blood Loss	**2 hours PO** **4 hours PO** **6 hours PO**
Pt Take blood unit (PRBC) Post CPB Time?	**Yes: No:**
If Yes,How Many UnitsDid the Patient Take?	

Part Five: Post-operative Complication

If pt has any of this post-operative complication

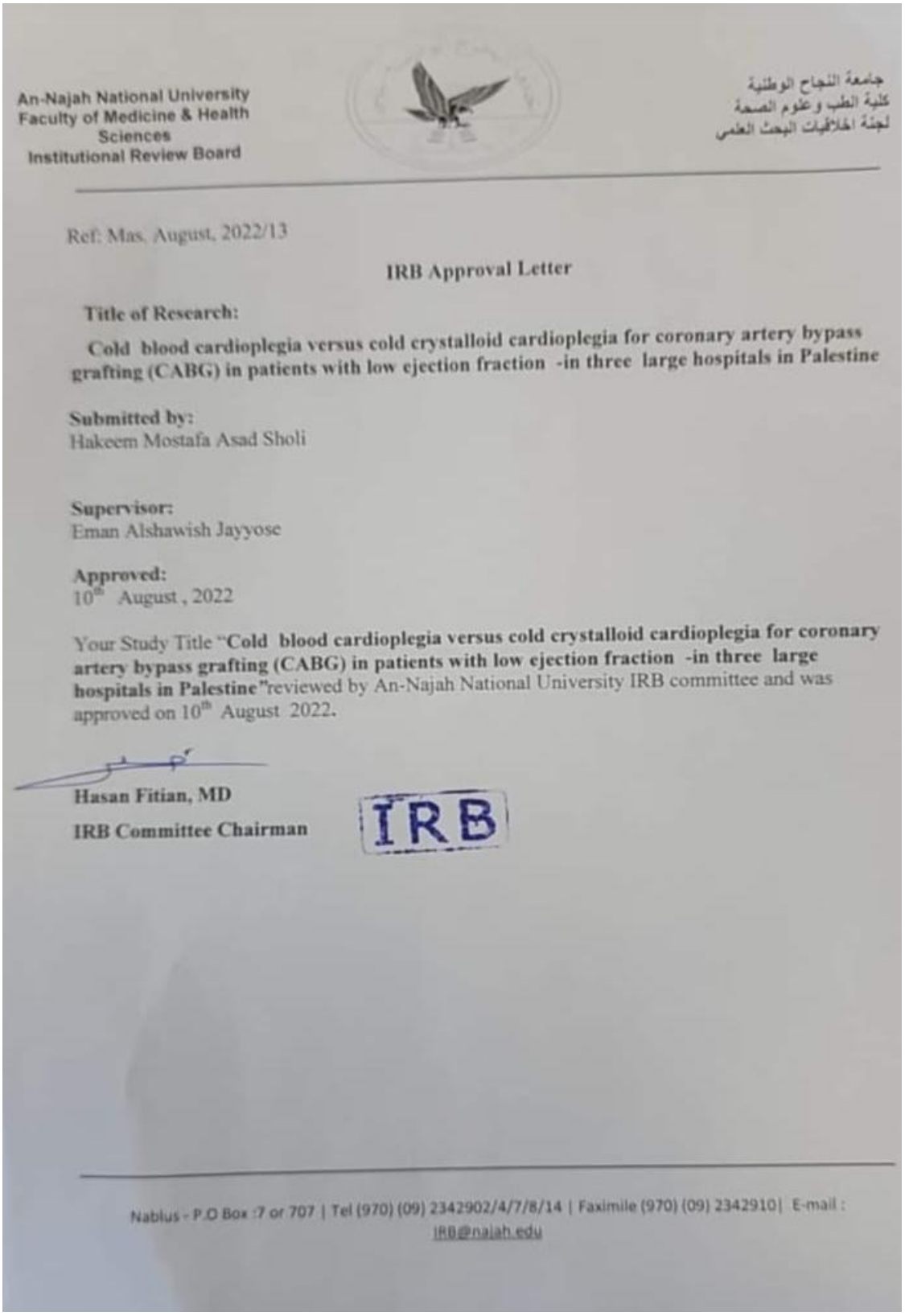
The Patient Needs Redo Operation?	**Yes: No:**
Post-operative Myocardial Infarction	**Yes: No:**
Post- op Atrial Fibrillation	**Yes: No:**
Stroke	**Yes: No:**
Minor Neurologic Event	**Yes: No:**

Part Six: Blood Test

Blood test	**Pre-Operation Result**	**Post Operation Result**
Troponin		
Creatinine Level		
Blood Sugar Level		
HGB		

Appendix B

IRB Approval



An-Najah National University
Faculty of Medicine & Health Sciences
Institutional Review Board

جامعة النجاح الوطنية
كلية الطب وعلوم الصحة
لجنة اخلاقيات البحث العلمي

Ref: Mas. August, 2022/13

IRB Approval Letter

Title of Research:

Cold blood cardioplegia versus cold crystalloid cardioplegia for coronary artery bypass grafting (CABG) in patients with low ejection fraction -in three large hospitals in Palestine

Submitted by:
Hakeem Mostafa Asad Sholi

Supervisor:
Eman Alshawish Jayyose

Approved:
10th August , 2022

Your Study Title "**Cold blood cardioplegia versus cold crystalloid cardioplegia for coronary artery bypass grafting (CABG) in patients with low ejection fraction -in three large hospitals in Palestine**"reviewed by An-Najah National University IRB committee and was approved on 10th August 2022.

Hasan Fitian, MD

IRB Committee Chairman

IRB

Nablus - P.O Box :7 or 707 | Tel (970) (09) 2342902/4/7/8/14 | Faximile (970) (09) 2342910| E-mail : IRB@najah.edu

Appendix C

Facilitation Papers

State of Palestine
Ministry of Health
Education in Health and Scientific
Research Unit

دولة فلسطين
وزارة الصحة
وحدة التعليم الصحي
والبحث العلمي

Ref.: .....
Date:.....

الرقم: ...ع.ص.ب/١٩٩٧/١٣٤...
التاريخ: ٢٠٢٠/٩/١٩

عطوفة الوكيل المساعد لمجمع فلسطين الطبي المحترم،،،

تحية واحترام،،

الموضـــوع: تسهيل مهمة بحث

يرجى التكرم بتسهيل مهمة الطالب: **حكيم مصطفى اسعد شولي** – ماجستير تمريض عناية مكثفة – جامعة النجاح، لعمل بحث بعنوان:

"Cold blood cardioplegia versus cold crystalloid cardioplegia for coronary artery bypass grafting (CABG) in patients with low ejection fraction-in three large hospitals in Palestine "

حيث سيقوم الطلبة بجمع معلومات من خلال مراجعة ملفات المرضى في الفترة (من 2018/1/1– 2021/12/30) لتعبئة استبانة (دون التعرض للمعلومات التعريفية للمرضى)، وذلك بعد موافقة المدير التنفيذي للمجمع الطبي وذلك في:

- **مجمع فلسطين الطبي**

مع العلم أن مشرف الدراسة: د. ايمان شاويش.

على ان يتم الالتزام بالمحافظة على اخلاقيات البحث العلمي وسرية المعلومات.
على ان يتم الالتزام بجميع تعليمات واجراءات الوقاية والسلامة الصادرة عن وزارة الصحة بخصوص جائحة كورونا، وتحت طائلة المسؤولية. وابراز شهادة التطعيم قبل دخول مرافق وزارة الصحة.
على ان يتم تزويد الوزارة بنسخة PDF من نتائج البحث، التعهد بعدم النشر لحين الحصول على موافقة وزارة الصحة. وتحديد دور وزارة الصحة.

مع الاحترام،،

د. عبد الله القواسمي
رئيس وحدة التعليم الصحي والبحث العلمي

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بسم الله الرحمن الرحيم

جامعة النجاح
الوطنية
كلية الطب وعلوم الصحة
دائرة التمريض

التاريخ:2022/09/12

حضرة أ.لؤي الزين المحترم ،، مدير دائرة التمريض في مستشفى النجاح الوطني الجامعي ،

الموضوع: تسهيل ، مهمة طالب الماجستير حكيم مصطفى اسعد شوله / ماجستير تمريض العناية المكثفه

تحية طيبة وبعد،

تهديكم دائرة التمريض وإلى عمله في كلية الطب وعلوم الصحه / جامعة النجاح الوطنية أطيب التحيات وبالشكر لحضرتكم حسن تعاونكم معنا ونرجو التكرم بالموافقه ، لي تسهيل مهمة الطالبة المذكورة أعلاه في المستشفى لديكم ، وهي دراسه بالرغم رجعي عن شلل القلب بالدم البارد مقابل شلل القلب البلوري بارد لتطعيم مجازة الشريان التاجي (CABG) في المرضى الذين يعانون من انخفاض الكسر القذفي – في ثلاثة مستشفيات كبيرة في فلسطين في الفترة الواقعه بين 1-1-2018 الى 30-12-2021.

وأن المعلومات سوف تستخدم لأغراض البحث العلمي ولاستكمال رسالة الماجستير تحت عنوان:

cold blood cardioplegia versus cold crystalloid cardioplegia for coronary artery bypass grafting (CABG) in patients with low ejection fraction –in three large hospital in Palestine

تحت اشراف: – د. ايمان احمد محمد شاويش

- مرفق IRB
- ملخص الدراسة

وتفضلوا بقبول الطلب ولكم فائق الاحترام ،،

منسقة برنامج ماجستير تمريض العناية المكثفه
مديرة دائرة التمريض والقبالة

جامعة النجاح الوطنية
كلية الطب وعلوم الصحة
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جامعة النَّجاح الوطنيَّة
كليَّة الدّراسات العليا

شلل القلب بالدم البارد مقابل شلل القلب البلوري البارد لتطعيم مجازة الشريان التاجي (CABG) في المرضى الذين يعانون من انخفاض الكسر القذفي – في ثلاثة مستشفيات كبيرة في فلسطين

إعداد
حكيم مصطفى اسعد شوله

إشراف
د. ايمان الشاويش

قدمت هذه الرسالة استكمالاً لمتطلبات الحصول على درجة الماجستير في تمريض العناية المكثفة، من كلية الدراسات العليا، في جامعة النجاح الوطنية، نابلس–فلسطين.

2023

شلل القلب بالدم البارد مقابل شلل القلب البلوري البارد لتطعيم مجازة الشريان التاجي (CABG) في المرضى الذين يعانون من انخفاض الكسر القذفي – في ثلاثة مستشفيات كبيرة في فلسطين

إعداد

حكيم مصطفى اسعد شوله

إشراف

د. ايمان الشاويش

الملخص

خلفية الرسالة: حماية عضلة القلب أثناء استخدام المجازة القلبية الرئوية في عملية الكسب غير المشروع للشريان التاجي (OPCABG) هو موضوع لا يزال قيد المناقشة. إن أهم طريقة لحماية عضلة القلب أثناء جراحة القلب هي شلل القلب الذي يسهل أيضًا الإجراءات الجراحية من خلال توفير مجال جراحي هادئ وخالي من الدم. وتشمل بعض هذه الحلول: شلل القلب البلوري البارد وشلل القلب في الدم البارد، ومع ذلك، لا يزال هناك جدل حول الحل الأفضل لحماية عضلة القلب أثناء العمليات الجراحية القلبية.

أهداف الرسالة: لمقارنة شلل القلب في الدم البارد مقابل شلل القلب البلوري البارد لتطعيم مجازة الشريان التاجي (CABG) في المرضى الذين يعانون من كسر طرد منخفض – في ثلاثة مستشفيات كبيرة في فلسطين لتحدي أي نوع أفضل لزيادة الحفاظ على عضلة القلب من خلال العملية وتقليل المضاعفات بعد عملية تحويل مسار الشريان التاجي.

منهجية الرسالة: تم استخدام تصميم دراسة التعرض المبني على المراقبة بأثر رجعي في هذه الدراسة. تم تسجيل جميع مرضى CAD متعدد الأوعية الذين تم قبولهم في المستشفيات المستهدفة في الفترة من 2020/1/1 إلى 2021/12/30، والذين تزيد أعمارهم عن 40 عامًا وأقل من 80 عامًا والذين تم إجراء عملية OPCABG المطلوبة في هذه الدراسة. تم جمع البيانات من خلال مراجعة السجلات الطبية للمرضى من نظام معلومات المستشفى. تشمل الخصائص التي تمت ملاحظتها البيانات الديموغرافية، والخصائص السريرية، وبيانات العملية، وبيانات ما بعد الجراحة، ومضاعفات ما بعد الجراحة، ونتائج الاختبارات المعملية. ثم تم إجراء مقارنات بين مجموعتين فرعيتين مقسمتين باستخدام الواصفات المذكورة أعلاه باستخدام SPSS كبرنامج إحصائي.

نتائج الدراسة: أظهرت النتائج أنه لا يوجد فرق كبير بين نتيجة الكسر القذفي أثناء العملية وحجم شلل القلب ووقت المجازة القلبية الرئوية وفقدان الدم بعد الجراحة في 4 و 6 ساعات بعد الجراحة ووقت البقاء على التهوية الميكانيكية بعد الجراحة ووقت البقاء الدعم القلبي الدوائي بعد الجراحة، مستوى الكرياتينين بعد الجراحة ومضاعفات ما بعد الجراحة عند استخدام شلل القلب بالدم البارد مقارنة باستخدام شلل القلب البلوري البارد عند مستوى معنوي من قيمة (0.05) P. وأظهرت النتائج وجود فروق ذات دلالة إحصائية عند استخدام شلل القلب بالدم البارد. مستوى 0.05 بين مجموعة شلل القلب في الدم البارد ومجموعة شلل القلب البلوري البارد فقط في عملية الكسر القذفي قبل العملية، ومتوسط العملية السابقة لكسر القذف في مجموعة CBC هو (المتوسط = 38٪) وهو أعلى بكثير من المتوسطفي CCC المجموعة (المتوسط = 36٪) ،القيمة الاحتمالية للاختبار 0.002 ،توجد فروق ذات دلالة إحصائية عند مستوى 0.05 في مقدار فقد الدم بعد ساعتين من العملية، المتوسط في مجموعة CBC هو (المتوسط = 153.8) وهو أقل بكثير من المتوسط في مجموعة CCC (المتوسط = 183.8) ،وقيمة P للاختبار هي 0.032. عند مستوى 0.05 في مستويات الكرياتينين قبل العملية، يكون المتوسط في مجموعة CBC هو (المتوسط = 0.78) وهو أعلى بكثير من المتوسط في مجموعة CCC (المتوسط = 0.63)، وقيمة P للاختبار هي 0.020. عند استخدام شلل القلب في الدم البارد مقارنة باستخدام شلل القلب البلوري البارد عند مستوى كبير من قيمة 0.05) P.

الاستنتاجات: استخلصت الدراسة إلى أن استخدام شلل القلب في الدم البارد له نفس الحفاظ على عضلة القلب ومضاعفاته من شلل القلب البلوري البارد.

الكلمات المفتاحية: شلل قلبي دم بارد، شلل قلبي بلوري بارد، حماية عضلة القلب، جزء طرد، طعم مجازة للشريان التاجي.