Arab American University
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Prevalence of Contrast-induced Acute Kidney Injury post Percutaneous Coronary Intervention in Al-Makassed Hospital-Jerusalem

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Thesis Approval

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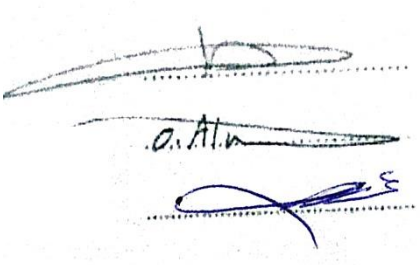
1. Dr. Mu’taz Dreidi :Supervisor	
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Declaration

I confirm that the master's thesis I have submitted, unless otherwise noted, is the result of my research and that neither it nor any of its parts have ever been applied for a higher degree at any other university or organization.

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Dedication

To the one whom I held my head high with pride..... My father, may God protect him

And to the one who lit the way for me with her prayers..... my mother, may God protect her

To my dear wife, my companion, and my constant support in life

To my little and dear daughter, Jaffa

To those who are my pride and support in life... my brothers

To those whom we walked together as we paved the way together towards success and creativity... my sisters

To my professors and colleagues in the College of Graduate Studies at the Arab American University

To those who think and research to advance science everywhere

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Abstract

Background: Contrast-induced acute kidney injury (CI-AKI) is still a feared consequence for patients receiving intravascular contrast media. Within a few days of the contrast medium being administered, kidney function gradually declines, which is the hallmark of contrast-induced acute kidney injury.

Objectives: The purpose of the study was to determine the prevalence and risk factors of developing contrast-induced nephropathy after injection of contrast media in percutaneous coronary intervention patients.

Methods: In this retrospective study, the prevalence of contrast induced acute kidney injury in one hospital in East Jerusalem Al-Makassed was examined using data collected in October and November 2023, by reviewing the data on the electronic system in the hospital AV-Ceina. 300 patients were included in the analysis that underwent percutaneous coronary intervention and baseline and post intervention data were recorded.

Results: The result of this study showed that about 30% of the sample developed acute kidney injury after exposure to contrast post percutaneous coronary intervention. It was found that female patients, patients with comorbidities, the amount of contrast infused into patients and older patients were at the highest risk for contrast-induced acute kidney injury ($P < 0.01$).

Conclusion: The incidence of acute kidney injury caused by contrast was moderate following initial PCI for acute myocardial infarction in this study. The frequency of contrast-induced acute kidney injury in patients who undergo PCI procedure still need to be highlighted and improved and needs to be implanted in more precise way by

healthcare providers, as contrast-induced kidney injury causes a burden on the health care system, patients and their caregivers.

Key words: contrast, acute kidney injury, percutaneous coronary intervention, nephropathy, Palestine.

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List of Abbreviations

Abbreviation	Meaning
CVD	Cardiovascular disease
IHD	Ischemic heart disease
STEMI	ST- elevation myocardial infarction
Non-STEMI	Non-ST-elevation myocardial infarction
PCI	Percutaneous coronary intervention
CIN	Contrast induced nephropathy
SCr	Serum creatinine
CM	Contrast media
BUN	Blood Urea Nitrogen
GFR	Glomerular filtration rate
CI-AKI	Contrast induced acute kidney injury
Hgb	Hemoglobin
LDL	Low Density Lipoprotein
HDL	High Density Lipoprotein
BP	Blood Pressure
HTN	Hypertension

HR	Heart Rate
IOCM	Iso-isomar contrast media
IRB	Institutional review board
EHD	Electronic health records
SPSS	Statistical Package for the Social Science
SA	Stable Angina
UA	Unstable Angina

Chapter One

Introduction

1.1 Introduction

One of the most significant health issues and the primary cause of mortality worldwide is cardiovascular disease (CVD) (Amini et al., 2021). Despite developing countries having a higher prevalence and incidence of CVD over the past few decades, CVD related deaths are higher in developed countries (Tefera et al., 2017).

CVD encompass many disorders. The most important and serious of them are ischemic heart disease (IHD) and coronary artery disease (CAD). IHD affects 244.1 million people worldwide in 2020. IHD was more common in men than in women (141.0 and 103.1 million, respectively) (Tsao et al., 2022). Coronary artery disease (CAD) which also called ischemic heart disease or coronary heart disease (Centers for Disease Control and Prevention, 2021) includes ST- elevation myocardial infarction (STEMI), non ST-elevation myocardial infarction (Non STEMI) and unstable angina pectoris are the disorders that fall under the umbrella of the acute coronary syndrome (Nakahara et al., 2017).

(CAD) is defined as a condition in which the arterial blood supply to the heart is obstructed by thrombosis, atheroma, or coronary artery spasm. This might decrease the flow of oxygenated blood to the heart tissue to the point where myocardial ischemia takes place. If this happens severely or for an extended period, this could cause cardiac muscle cell death (Whittlesea & Hodson, 2018). An acute intraluminal coronary thrombus development within a pericardial coronary artery, which results in complete or almost total acute coronary blockage, is the underlying pathophysiology of coronary

artery disease (Ambrose & Singh, 2015). The term "atherosclerosis" refers to a low-grade inflammatory condition that affects the intima (inner lining) of medium-sized arteries and is hastened by established risk factors such as high blood pressure, high cholesterol, diabetes, heredity and cigarette use. This progressive thickening of the inner layer of the coronary arteries, which occurs in the case of coronary atherosclerosis, results in a steady development that may eventually cause the arterial lumen to narrow to varying degrees (Ambrose & Singh, 2015). The location of the blockage, its intensity and the length of the myocardial ischemia affect the clinical presentation and prognosis (Rezende et al., 2019).

To confirm the presence of coronary artery disease, there are noninvasive investigations which include: electrocardiography, exercise electrocardiography, cardiac magnetic resonance imaging and stress echocardiography. There is also an invasive procedure such as coronary angiography (i.e., invasive testing for coronary artery disease). This procedure could be diagnostic or interventional and include percutaneous coronary intervention (PCI). During this procedure a contrast media is used to visualize intravascular structures (Klein et al., 2009).

In 1971 the first clinical application of using contrast media in computed tomography (Krause, 1996). But this contrast media has side effects when it is used during PCI. It may cause contrast induced nephropathy (CIN) which is defined as an increase of serum creatinine (SCr) level by 25% above the baseline level within 48-72 hours after the injection of contrast (Hong et al., 2020). The greatest incidence of CIN is linked to coronary angiography and percutaneous coronary procedures (Chillo et al., 2021). Nephropathy due to the injection of contrast has become a common cause of hospital-acquired kidney damage (Sang et al., 2019). It is widely known that

radiocontrast materials can lead to an acute renal damage. In vitro testing has demonstrated that all contrast media substances are cytotoxic. When exposed to contrast medium, endothelial cells suffer severe cell damage and/or apoptosis (Sendeski, 2011). CIN may result in long period of hospital stays and higher mortality (Bottinor et al., 2020). It also increases the hospitalization cost (Chen et al., 2023). These findings revealed the importance of studying the prevalence and risk factors of CIN in Palestine.

1.2 Problem Statement

Contrast-induced nephropathy is considered the third most common cause for acute kidney failure in hospitalized patients (Perrin et al., 2012). Following PCI, patients development of CIN increases both short- and long-term mortality, prolonged hospital stays, the requirement for short-term hemodialysis, and irreversible renal impairment (Mandal et al., 2018). The incidence of CIN during coronary angiography or percutaneous coronary intervention (PCI) has been reported to range from 2% to 25%, depending on the patient's baseline parameters and the studies definition of CIN (Firouzi et al., 2020).

Patients with CIN had a significantly higher incidence of procedural cardiac complications than those without CIN, such as stroke, myocardial infarction, hematoma formation, coma, death, access-site bleeding, adult respiratory distress, pseudoaneurysms, gastrointestinal hemorrhage and pulmonary embolus (Firouzi et al., 2020).

There are many risk factors that may lead to CIN. Cardiovascular disease alone or in addition to comorbidities such as diabetes and renal insufficiency, as the presence of

diabetes and previous renal insufficiency are the two main patient-related risk factors for postprocedural chronic kidney injury (QiaoPing et al., 2011).

Recently there is an increase in the frequency of procedures involving contrast media. Make it is a crucial point to comprehend the clinical and financial costs of CIN (Subramanian et al., 2007).

Nijssen et al. (2017) mentioned that contrast-induced nephropathy has no known cure, hence, prevention is the main goal. As there are no studies demonstrating the prevalence of CIN and its risk factors in Palestinian hospitals, this study helps to provide statistics about CIN and its risk factors that may demonstrate the importance of implementing a prevention strategy in Palestinian hospitals as this will play an important role in reducing the number of CIN cases, which will reflect on the health care facility burden.

1.3 Study Significance

Patients who undergo percutaneous coronary intervention and cardiac catheterization represent half of contrast-induced nephropathy cases (Azzalini et al., 2016). The incidence of CIN in patients who have a normal kidney function is considered low, it is less than 3%, as mentioned in the literature (Klima et al., 2012), but it is significantly increased in patients with chronic renal disease to more than 40% (Klima et al., 2012). In another study, it was shown that up to 56% of people with diabetes mellitus who also have concomitant renal insufficiency go on to develop irreversible renal failure, making diabetes mellitus with associated renal insufficiency an independent risk factor for contrast nephropathy (Perrin et al., 2012).

Furthermore, literature showed that CIN increased the financial burdens as it increased the length of stay in hospitals (Jo et al., 2006). A study conducted about in-hospital morbidity showed that patients who underwent PCI and developed CIN have a higher tendency to develop bleeding in comparison with patients who underwent PCI but did not develop a CIN (McCullough, 2006). The development of CIN post PCI increases the patient's mortality rate five times compared with other patients (McCullough, 2006). These findings highlight the importance of assessing and identifying the prevalence and risk factors of CIN in Palestinian hospitals, which may lead to more systematized prevention strategies for such patients and decrease the prevalence of CIN. Moreover, this study has not been conducted in Palestine so far. The findings of the current study may also aid in improving the patient's outcomes, decreasing complications, length of stay and costs.

1.4 Purpose of the Study

The purpose of this study was to determine the prevalence and risk factors of developing contrast-induced nephropathy after injection of contrast media in percutaneous coronary intervention patients.

1.5 Objectives of the Research

The objectives of the current study were to:

1. Determine the prevalence of developing CIN after injection of contrast media during cardiac PCI.
2. Identify the effect of anemia on CIN occurrence.

3. Identify the difference between males and females in the occurrence of CIN after PCI.
4. Identify the difference between STEMI and Non-STEMI patients in CIN occurrence.
5. Assess the difference between patients with a free medical history and patients with comorbidities in developing CIN.

1.6 Research Questions

1. What is the prevalence of developing CIN after injection of contrast during cardiac PCI?
2. Does anemia have a detrimental effect on CIN occurrence after PCI?
3. Is there a significant difference between males and females of CIN occurrence after PCI?
4. Is there a significant difference between STEMI and Non-STEMI patients in CIN occurrence?
5. Is there a significant difference between patients with comorbidities and patients with free medical history in developing CIN.

1.7 Research Hypothesis:

1. There is a high prevalence of developing CIN post PCI.
2. Anemia considers a factor of developing CIN post PCI.
3. There is a statistically significant difference between males and females in developing CIN post PCI.
4. There is a statistically significant difference between patients with STEMI and patients with Non- STEMI.

There is a statistically significant difference between patients with chronic diseases and those with free past medical history.

Chapter Two

Literature Review

Percutaneous coronary intervention is defined as an invasive method performed to open a blocked coronary artery (Abubakar et al., 2023). The temporary insertion and inflation of a balloon into the stenosed artery in order to widen a metallic scaffold either bare metal or drug-eluting is frequently implanted to preserve the patency of the artery and reduce the risk of restenosis (Sasidharan et al., 2019). The first successful balloon angioplasty was first performed by Andreas Gruntzig in 1977 (Abubakar et al., 2023). During percutaneous coronary intervention, a contrast media was used to provide a guide and good vascular visualization during the procedure (McCullough, 2006), but using this contrast media has a range of complications including minor symptoms like itching or pain to potentially fatal events including allergy, hypotension, cardiovascular events, and renal failure. Even though the majority of these side effects are temporary, contrast-induced nephropathy (CIN) can have detrimental long-term effects (Andreucci et al., 2014).

Contrast-induced nephropathy is defined as a decline in renal function due to injection of a contrast media (Andreucci et al., 2014). Contrast induced nephropathy is an elevation in serum creatinine level of more than 25% from the baseline (McCullough, 2008). Typically, CIN begins to show clinical signs 3 days after contrast media (CM) injection, peaks 3 to 5 days later, and then recovers to normal between 10 to 21 days. However, in some cases, a sustained or permanent nephropathy occurs (Gleeson & Bulugahapitiya, 2004).

2.1 Pathophysiology of CIN

The exact pathway of contrast-induced acute kidney failure is not clearly understood yet. Intravenous contrast affects kidneys by a complex interaction between oxidative stress, hemodynamic alterations, and direct renal tubular cell damage (Scharnweber et al., 2017).

Sustained or permanent nephropathy occurs as the renal vasculature is first dilated after contrast is administered, followed by a protracted constriction (Calvin et al., 2010). On the other hand, the extra renal vasculature contracts before slowly relaxing. Increased renal vascular resistance, reduced renal blood flow, and lower glomerular filtration rate (GFR) are the results of these conflicting effects (Murphy & Jones, 2010). Time progression of hemodynamic changes after contrast, blood flow in the kidneys may continue to be 30% to 45% below baseline for up to 4 hours. The medulla is where the hemodynamic effects are most noticeable (Scharnweber et al., 2017).

Contrast administration also leads to change the viscosity. Blood's and tubular fluid's viscosity are both increased by contrast injection which lead to increase interstitial pressures, lower medullary blood flow, and decreased filtration rate are the results of higher viscosities (Persson et al., 2005). Both adenosine and endothelin have vasodilatory effects that are mediated by nitric oxide. Contrast can hinder the production of nitric oxide directly. The endothelium's vascular deterioration brought on by metabolic variables may be the cause of this impact (Andrade et al., 1998; Prabhakar, 2001).

Another pathway that contrast can lead to kidney injury is through oxidative stress that increases the oxygen requirement in kidney medulla, which leads to ischemic injury

(Heyman et al., 2008). In addition, tubular cells immediately absorb contrast media, and then renal tubular cells expand and undergo apoptosis as a result. This high concentration of contrast causes continual toxicity to neighboring tubular cells (McCullough, 2006; Tervahartiala et al., 1997).

2.2 Risk Factors for Contrast Induced Kidney Injury

Hypertension, diabetes mellitus, old age, heart failure, nephrotoxic medication and volume depletion are major risk factors for contrast-induced kidney failure. Another group who at risk of developing CIN includes female gender multiple myeloma, liver cirrhosis, kidney transplantation and using of medication like: angiotensin receptor blockers or angiotensin-converting enzyme inhibitors (Toprak, 2007;Scharnweber et al., 2017).

When diabetic patient received iodinated radiocontrast medium, their renal parenchymal oxygenation is sharply decreased; this loss is most pronounced in the renal medulla (Mogher Khamaisi et al., 2008).

Concurrent use of nephrotoxic medications such as: amphotericin, cisplatin, cyclosporin A, aminoglycosides and nonsteroidal anti-inflammatory drugs poses a significant risk of developing contrast induce acute kidney failure due to their suppression of prostaglandins that dilate blood vessels (Andreucci et al., 2014).

The decrease in the intravascular volume can be due to the presence of chronic diseases such as congestive heart failure, liver cirrhosis or aberrant fluid losses from inadequate salt consumption that lead to salt depletion in addition to severe dehydration all of these factors increase the risk of CIN occurrence (Andreucci et al., 2014).

In multiple myeloma patients CIN has been linked to tubular epithelial cells that have been injured and desquamated by ischemia, as well as the precipitation of radiographic contrast medium molecules by the presence of Tamm-Horsfall proteins and other abnormal proteins (Gleeson, 2004).

The risk of CIN is dose-dependent and rises with the volume of contrast medium supplied during the operation. The route of contrast administration plays a role as intravenous administration of contrast has less risk than intrarterial contrast administration (Katzberg & Newhouse, 2010).

Anemia, due to its role in renal ischemia, poses a risk for CIN. A poor hematocrit has been shown to be a significant risk factor for CIN. Patients with the lowest baseline hematocrit and glomerular filtration rate have a greatest incidence of developing CIN (28.8%) (Andreucci et al., 2014).

Advance age considers another risk factor of developing CIN post PCI as a study showed that older adult exhibited a greater compromise of global hemodynamic status and basal EF when they exposed to contrast (Andò et al., 2013).

Regarding gender there is currently little data to support the theory that patients who identify as female are more susceptible to CIN, especially when receiving initial PCI (Lucreziotti et al., 2014).

2.3 Clinical Findings of CIN

The most frequent clinical sign of contrast-induced acute kidney injury (CI-AKI) is a brief rise in serum creatinine (SCr) that is not accompanied by oliguria or other obvious clinical abnormalities. In general, the definition of an increased SCr of CI-AKI is a minimum of 0.5 mg/dL or a rise of 25% over 48 hours after the contrast delivery

(Khwaja, 2012). The diagnosis process firstly includes the exclusion of all other possible causes of acute kidney injury in the patients, then the performance of a topical workout which includes: urine analysis and ultrasound (Katzberg & Newhouse, 2010).

2.4 Diagnosis

It is necessary to rule out other causes of AKI in order to confirm the diagnosis of CI-AKI, regardless of the severity of it. Urinalysis and ultrasonography are routinely part of the workup, but they do not rule out other etiologic variables, thus until a clear alternative reason is identified, the change is frequently assigned to contrast without looking for a more detailed explanation (Scharnweber et al., 2017).

2.5 Prevention of CIN

When it comes to treat ST elevation myocardial infarction (STEMI) by using percutaneous coronary intervention (PCI), it has gained importance and popularity compared to pharmacologic reperfusion with fibrinolytic agents. Percutaneous coronary intervention results in fewer ischemic complications, more survival myocytes, preserved ventricular function, and improved patient survival (He et al., 2019). On the other hand, there is a serious complication of PCI which is the contrast induced nephropathy (Mandal et al., 2018).

A study showed that the incidence of developing post PCI contrast-induced nephropathy is approximately equal between complicated PCI and non-complex one which around 12% (Azzalini et al., 2019). Marenzi et al. (2004) stated that when receiving primary PCI for acute myocardial infarction, the risk of CIN is very significant (19%). Another study conducted at William Beaumont Hospital showed that

a 14.5% of the 1826 patients who received PCI had CIN (McCullough et al., 1996). The risk of developing CIN increases with the presence of comorbidities; for example, CIN in diabetic patients ranges from 5.7% to 29.4% (Nikolsky et al., 2004). Many studies have also shown that older age is considered an independent predictor of CIN (Sana et al., 2020). Moreover, the presence of anemia increases the risk of CIN (Mehran & Nikolsky, 2006). Hemodynamic instability before the procedure and the presence of health condition that affect the blood volume such as: heart failure, liver cirrhosis and fluids loss augmenting the contrast media's ischemic insult (Vachharajani et al., 2018). Another risk factor for developing contrast-induced nephropathy is the amount of contrast administered as high doses and several contrast administrations increase the risk (Vachharajani et al., 2018). So that the presence of these risk factors emphasizes the importance of prevention.

Prevention is still the best course of action since CIN has no particular therapy. Common general suggestions include minimizing contrast media (CM) volume that is considered the most essential measure, utilizing pre-heated iso-isomar contrast media (IOCM), and ceasing use of nephrotoxic medications 48 hours before CM exposure such as nonsteroidal anti-inflammatory medicines, aminoglycosides, and cyclosporine (Klima et al., 2012). Pre procedural hydration is considered one of the most preventive measures to reduce the risk of CIN (Albabtain et al., 2012). The mechanism that pre-hydration reduces the risk of CIN is through suppresses the renin-angiotensin cascade and as a result it reduces renal vasoconstriction and hypoperfusion. This also increases diuresis, which limits the amount of time that contrast material is in contact with renal tubules and, thus its toxicity on tubular epithelium (Solomon & Dauerman, 2010).

Another trial revealed that administration of lyophilized recombinant human brain natriuretic peptide 24 hours before the PCI decrease the CIN incidence (Liu et al., 2014). The use of N-acetylcysteine pretreatment for a brief period of time dramatically decreased contrast toxicity on human embryonic kidney cells and its use was effective with three distinct contrast media—ionic ioxitalamate, iso-osmolar iodixanol and nonionic low-osmolar iopromide (Lee et al., 2011). A study confirms that patients having contrast-media-requiring diagnostic and interventional procedures can benefit from a short-term, high-dose statin pretreatment that lowers their blood creatinine level and rate of CIN occurrence (Zhang et al., 2011).

Chapter Three

Methodology

This chapter described the study design, tools used for data collection, setting, sampling method, ethical aspect, procedure and plan of data analysis.

1.3 Designs and Settings

This study was a single center retrospective study. The target hospital is a referral hospital where many patients with acute coronary syndrome (ACS) receive their treatments including PCI. The hospital is Al- Makassed charity hospital- East Jerusalem. It has a high occupancy rate. It receives many patients from West Bank and Gaza Strip in Palestine. Nearly, 1500 patients underwent for PCI yearly in Al-Makassed hospital.

2.3 Population and Sample

Patients who underwent PCI surgery in Al-Makassed hospital since January 2020 until December 2021 were included in the study. All patients with ACS either STEMI or Non- STEMI were also included in the study. Patients who have any renal impairment before PCI were excluded. Around 1500 patient's files were approached for data extraction. Then G power used to calculate the sample size which was 300 file, sample randomization used to choose 300 files from 1500 files and random number generator used for randomization.

Setting

The data collected from Al-makassed hospital, which is a non-profit charitable hospital, located in East Jerusalem, this hospital established at 1968, It consists of 250 beds in 17 departments, more than 900 employee works on this hospital.

3.3 Sampling Technique

Randomize sampling used in this study, as a 300 patient's files collected randomly by using the random number generator to collect them.

3.4 Research Variables

The independent variables in this study are sociodemographic and clinical data, include the following: patient demographics (e.g., age, gender, place of living), medical history (e.g., hypertension, diabetes, heart failure, cancer, anemia not related to AKI), patient diagnosis (STEMI, Non-STEMI, Unstable angina), creatinine baseline, creatinine post PCI (after 48 hours), type of coronary angiography (diagnostic, PCI), used hydration strategies before procedure, medications (e.g., diuretics, ACE inhibitors, NSAIDs), amount of contrast media used during PCI, blood pressure and pulse rate (before procedure and after procedure), procedural factors (e.g., duration of the procedure, number of stents placed, diagnosis). The dependent variable is the occurrence of CIN post PCI. The patients were considered to have CIN when SCr increased by 25% above normal within 48 hours.

3.5 Ethical Considerations

Ethical approvals were obtained from the ethical committee at the Arab American University (AAUP). Institutional review board (IRB) approval was also

obtained from the ethical committee at Al-Makassed Hospital before approaching any patient's file.

The confidentiality and anonymity of the retrieved data were completely secured. The data was saved anonymously inside a laptop containing a strong password, and researchers have only access to this data for scientific purposes.

To maintain the accuracy of all laboratory tests conducted in Al-makassed hospital, the hospital quality department regularly checks the commitment of internal policies, also all machines used in the laboratory are checked every 3 months and when any impairment occurred by medical device engineers.

3.6 Data Collection

Data was collected from catheterization unit records in Al-makassed hospital by using the electronic health records (EHDs). Based on internal coding system, the principal investigator searched for ACS. Then, all results were screened for eligibility criteria to include only the target cases. Baseline, procedural, sociodemographic and clinical data were recorded.

The parts of the data collection sheet consist of demographical data (e.g., age, gender, place of living), a second part, related to patient health status (e.g., patient diagnosis, past medical history), a third part related to PCI procedure (e.g., type of PCI diagnostic or treatment, amount of contrast that was injected) and a fourth part related to care before and after PCI (e.g., intravenous fluid before administration of PCI, blood pressure and heart rate before and after PCI). The validity of this data sheet tested by reviewing it is content from 3 nurses worked in cardiac catheterization department and one cardiology specialist physician. All of these data were collected from archived

medical files; these files are saved on an electronic form in a system called AV-CENA by the assistance of IT department. All patients' files who conducted PCI in the required time frame were accessed but without the patients' names or any other private data. By using this way of approaching the files, the anonymity and confidentiality are further preserved.

3.7 Data Analysis

The statistical SPSS version 24 program was used to analyze the collected data. Descriptive statistics were used to summarize the data. The prevalence of CIN calculated as the proportion of patients who developed CIN following PCI. Bivariate analysis was used to identify the associated risk factors for developing CIN. Inferential statistics were used to assess the differences in the levels of CIN occurrence between males and females and, on the other side, to compare between STEMI and Non-STEMI.

Chapter Four

Results

The study's findings were divided into two sections in this chapter: the first one included illustrated demographic data statistics, while the second one included illustrated analytical statistics. The demographic characteristics include: age, gender, living place and the presence of comorbidities. Three hundred patients' files were included, all of them were in Al-Makassed hospital.

As shown in table 1, the number of female patients included in the PCI was 135 (45%), and the males were 165 (55%). The mean age of the patients was 52 years old. The area of residency was as follows: 31.3% from Gaza, 9.3% from Hebron, 32.7% from Jerusalem, 7.3% from Nablus, 2.7% from Tulkarem, 0.3% from Qalqilya, 12.3% from Ramallah and 4 % from Jenin. 78% of patients have comorbidities (i.e., diabetes mellitus, hypertension) while 22% have a free history of comorbidities.

Table 4.1 Descriptive Statistics for Socio-Demographic Characteristics of the Sample (n= 300).

Variables	**Mean**	**SD**	**Frequency (n)**	**Percentage %**
Age (years)	52.0	11.3	-	-
Gender				
Male	-	-	165	55%
Female			135	45%
Living Place				
Gaza			94	31.3%
Hebron			28	9.3%

Jerusalem	98	32.7%
Nablus	22	7.3%
Tulkarem	8	2.7%
Qalqilya	1	0.3%
Ramallah	37	12.3%
Jenin	12	4%
Comorbidities		
Yes	234	78%
No	66	22%

Acute coronary syndromes were as the following: STEMI (34.7%), UA (26.3%), Stable angina (21.7%) and Non STEMI (17.3%). The mean of baseline serum creatinine level for patients included in the sample was 1.61 mg/dl and the baseline blood urea nitrogen (BUN) mean was 25.2 mg/dl, the minimal amount of contrast used in PCI was 100 ml while the maximum amount of contrast was 150 ml. There were 118 patients taking a nephrotoxic medication while 182 patients did not take any nephrotoxic medications. Moreover, 65.7% of patients' hemoglobin was within the normal range, while 34.3% had anemia. The majority of patients (85%) have adequate hydration before PCI procedure, only 15% of patients do not have adequate hydration before the procedure. (Table 2)

Table 4.2 Descriptive Statistics for Clinical Characteristics of the Sample at Baseline (N = 300).

Variables		M	SD	Range	Min	Max	N	%
RBS		170	80.5	326	68	394		
Nephrotoxic medications		---	---	---	---	---		
	Yes						118	39.3
	No						182	60.7
Diagnosis		---	---	---	---	---		
	SA						65	21.7
	UA						79	26.3
	STEMI						104	34.7
	NonSTEMI						52	17.3
BUN		25.2	11.0	47	15	62	---	---
sCr		1.61	0.92	5.4	0.6	6	---	---
Hgb								
	Anemic						1.3	34.3
	Nonanemic						197	65.7
LDL		128.4	39.4	231	84	315	---	---
HDL		63.9	7.7	28	52	80	---	---
BP		---	---	---	---	---		
	Normal						155	51.6
	Mild HTN						23	7.7
	Severe HTN						122	40.7
Temperature		36.7	0.35	1.7	35.9	37.6	---	---
HR		79.7	11.1	41	62	1.3	---	---

Hydration		---	---	---	---	---		
	Yes						255	85
	No						45	15
Volume of Contrast		113.2	22.1	50	100	150	---	---
PCI Type		---	---	---	---	---		
	Diagnostic						65	21.7
	Balloon						19	6.3
	Stent						216	72

RBS: random Blood Sugar; SA: Stable Angina; UA: Unstable Angina; STEMI: ST-elevation Myocardial Infarction; NonSTEMI: Non-ST-elevation Myocardial Infarction; BUN: Blood Urea Nitrogen; sCr: Serum Creatinine; Hgb: Hemoglobin; LDL: Low Density Lipoprotein; HDL: High Density Lipoprotein; BP: Blood Pressure; HTN: Hypertension; HR: Heart Rate.

The changes post PCI on serum creatinine level, hemoglobin level, vital signs and hydration post the PCI procedure showed an elevation occurs in the mean serum creatinine level post PCI to 1.76 mg/dl, with a maximum value of 6 mg/dl and the lowest value of serum creatinine being 0.7 mg/dl. The percentage of patients post PCI who had a normal hemoglobin level was 66.3% and the percentage of patients who had lower than normal hemoglobin level was 33.7%. Patients who got hydration post the procedure were 82.3% while 17.7% of patients did not receive hydration post the procedure (Table3).

Table 4.3 Descriptive Statistics for Clinical Characteristics of the Sample Post Percutaneous Coronary Intervention in 48 hours (N = 300).

Variables		M	SD	Range	Min	Max	N	%
BUN		26.2	11.2	57	15	72		
SCr		1.76	0.92	5.3	0.7	6.0		
Hgb		---	---	---	---	---		
	Anemic						101	33.7
	Nonanemic						199	66.3
LDL		128.5	39.2	228	87	315		
HDL		64.3	8.0	31	53	84		
BP		---	---	---	---	---		
	Normal BP						165	55
	Mild HTN						11	3.7
	Severe HTN						124	41.3
Temperature		36.7	1.9	1.2	36.6	37.8	---	---
HR		80.3	11.2	52	58	110	---	---
Hydration		---	---	---	---	---		
	Yes						247	82.3
	No						53	17.7

BUN: Blood Urea Nitrogen; sCr: Serum Creatinine; Hgb: Hemoglobin; LDL: Low Density Lipoprotein; HDL: High Density Lipoprotein; BP: Blood Pressure; HTN: Hypertension; HR: Heart Rate.

Regarding the amount of CM, it was found that there was a statistically significant relationship between the quantity of contrast employed during the PCI procedure and serum creatinine level ($r = 0.310$, $p = 0.012$). On the other hand, BUN has also a

significant relationship with the amount of CM (r = 0.228, p = 0.017). The other variables do not have significant relationships with CM (p > 0.05). (Table 4.4)

Table 4.4: Correlation Between Amount of Contrast Media Used with Clinical Variables (N = 300).

Contrast Media		
Baseline BUN	"r"	0.055
	p	0.343
SCr Baseline	"r"	0.062
	p	0.283
LDL Baseline	"r"	0.121
	p	0.013*
HDL Baseline	"r"	0.160
	p	0.005**
Temp Baseline	"r"	0.038
	p	0.517
HR Baseline	"r"	0.113
	p	0.336
BUN Post	"r"	0.228
	p	0.017*
sCr Post	"r"	0.310
	p	0.012*
Contrast Media		
LDL	"r"	-0.048

Post	*p*	0.411
HDL	"r"	0.146
Post	*p*	0.011
Temp	"r"	-0.095
Post	*p*	0.100
HR	"r"	0.020
Post	*p*	0.733

(*) Correlation is significant at the 0.01 level (2-tailed)

An independent sample t-test was conducted to assess the differences between males and females across the clinical variables. The results showed that there were significant differences between male and female in Post PCI SCr (t = 3.267, p = 0.020). In relation to the other variables, there were no significant differences between male and female in all other variables (all ps > 0.05). (Table 5)

Table 4.5: Independent Sample T-Test to Assess the Differences Between Gender Across Clinical Variables (N = 300).

Variables	**T**	**P**
RBS	-0.326	0745
	Pre PCI	
BUN	0.298	0.766
SCr	0.502	0.616
LDL	-0.257	0.798
HDL	0.803	0.423
Temperature	0.537	0.591
HR	-0.301	0.764

Variables	T	P
	Post PCI	
BUN	0.449	0.654
SCr	3.267	0.020
LDL	-0.434	0.665
HDL	0.963	0.336
Temperature	-0.716	0.474
HR	-1.693	0.902

BUN: Blood Urea Nitrogen; sCr: Serum Creatinine; Hgb: Hemoglobin; LDL: Low Density Lipoprotein; HDL: High Density Lipoprotein; BP: Blood Pressure; HTN: Hypertension; HR: Heart Rate.

The information provided in table 6 indicates that there are variations in comorbidities, hemoglobin levels, and blood pressure between males and females. For blood pressure, 50 males and 114 females had normal blood pressure, while 88 males and 76 females had hypertension (HTN). The difference in the prevalence of hypertension between males and females was statistically significant ($p = 0.001$), indicating a difference in blood pressure levels between the genders. Hemoglobin levels, 53 males and 83 females were classified as anemic, while 67 males and 69 females were classified as non-anemic. The difference in anemia rates between males and females was statistically significant ($p = 0.006$). It appears that there is a difference in hemoglobin levels between males and females. For comorbidities, out of the 300 participants, 107 males and 127 females reported having comorbidities. The difference in the prevalence of comorbidities between males and females was statistically

significant (p = 0.034), suggesting that there was a difference in the occurrence of comorbidities between the genders.

Table 4.6: The Differences Between Male and Female Across Clinical Variables (N = 300).

Variables	**Comorbidities**				**Hemoglobin**				**BP**			
	Yes	**No**	**χ2**	**P**	**A**	**NA**	**χ2**	**P**	**N**	**HTN**	**χ2**	**P**
Male	107	29	2.889	0.034	53	83	2.143	0.006	67	69	3.45	0.001
Female	127	37			50	114			88	76		

- A: Anemic; NA: Non-anemic; BP: Blood Pressure; N: Normal; HTN: Hypertension.

All patients in this study were underwent for PCI. So, a paired samples t-test that contrasts the results of the variables before and after the intervention. The results have shown that the mean difference between the Scr pretest and Scr posttest was statistically significant (p < 0.001). There is a significant difference between BUN pretest and posttest (t = -5.86, p < 0.001). Regarding LDL, HDL, HR, and temperature, it was found that there were no significant differences between these variables at pretest and posttest (ps > 0.05). (Table 7)

Table 4.7. A paired Sample T-Test Between Serum Creatinine and Blood Urea Nitrogen Pretest and Posttest (N = 300).

Variables	Paired Differences					T	df	Sig. (2-tailed)
	Mean	SD	Std. Error Mean	95% Confidence Interval of the Difference				
				Lower	Upper			
Scr pretest – Scr posttest	-.14	.56	.03	-.21	-.08	-4.59	299	0.000

BUN pretest – BUN posttest	-0.94	2.78	0.16	-1.25	-0.62	-5.86	299	0.000

As shown in table 8, participants who experienced acute kidney injury (AKI) after PCI had significant relationships with comorbidities (p-value = 0.001), age (p-value = 0.000), volume of contrast used (p-value= 0.000) and gender (p-value = 0.000). These results indicated that the presence of comorbidities, higher age, female patients and the high amount of contrast media given were correlated with a higher incidence of acute kidney injury. It was found that 30.3% of patients developed acute kidney injury, while 69.7% did not develop AKI post PCI.(Table 9)

Table 4.8: The Interrelationships Between Occurrence of Acute Kidney Injury with Age, Gender, Comorbidities and Contrast Volume Used (N = 300).

Variables	**Categories**	**Acute kidney injury**		**P value**
		Yes	**No**	
Age	20-60	9 (3%)	209(69.6%)	0.000
	> 60	82 (27.3%)		
Gender	Male	29 (9.6%)	209 (69.6%)	0.000
	Female	62 (20.6%)		
Comorbidity	Yes	85 (28.3%)	209 (69.6%)	0.001
	No	6 (2%)		
Contrast volume used	100 ml	35 (11.6%)	209 (69.6%)	0.000
	150 ml	56 (18.6%)		

Table 4.9: Frequency and percent of Patients Developed an AKI Post PCI:

Variables	Frequency	Percent	Valid Percent	Cumulative Percent
AKI developed	91	30.3	30.3	30.3
AKI not developed	209	69.7	69.7	100.0
Total	300	100.0	100.0	

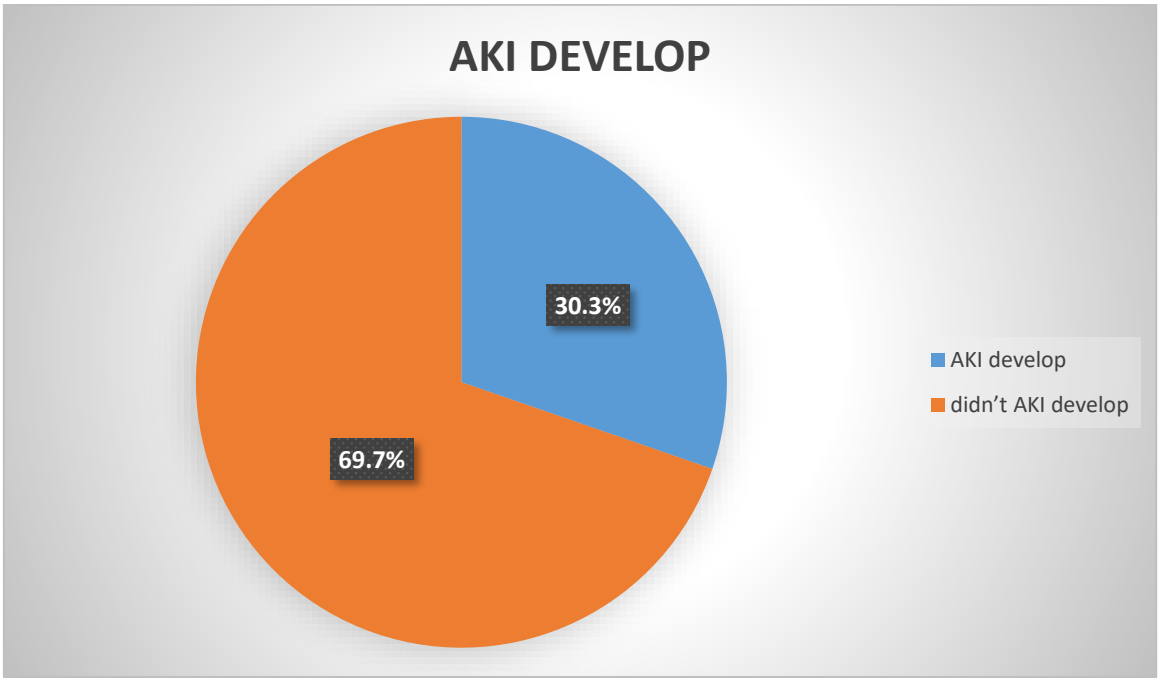

Figure 4.1: Percent of Patients Develop Acute Kidney Injury Post PCI.

Chapter Five

Discussion

This chapter discusses the results of this study. It comprises the traits of the research participants and the relationship between these variables and the increased risk of contrast-induced kidney injury post PCI and connecting these results with the results of previous researches conducted on the topic.

In this study, 90% of patients who developed AKI post PCI were above 60 years old. As shown in the literature, patients with acute myocardial infarction receive percutaneous coronary intervention, being 75 years of age or older has also been identified as an additional risk factor for acute renal failure (Kuboyama & Tokunaga, 2016). Also, it was found that patients with comorbidities (diabetes and hypertension) form 93% of patients who developed AKI post PCI procedure. These results are consistent with the results of previous studies as acute kidney injury occurred in 21.5% of type II diabetes patients following PCI (Sany et al., 2013). Pervious study also mentioned that hypertension increased the risk of post PCI acute kidney injury (Lun et al., 2021).

In this study, female patients who were advanced on age were more susceptible to developing contrast induced acute kidney injury post PCI, as 62 females' patients developed AKI while only 29 males developed it post PCI. Previous research conducted in Lebanon found that geriatric women are at higher risk of developing post PCI contrast induced AKI as 14.5% developed AKI while 11% of males developed it in the matched-age group of 65-79 years old (Sidhu et al., 2008).

This study's results also revealed that the volume of contrast used in the procedure is considered a risk factor of developing an AKI, as the risk increased by

increasing the volume of contrast used. 56 patients who developed AKI post the procedure were given 150 ml or more of contrast. This result coincides with the results of previous research which found that exposure to more than 4ml\kg is directly associated with increase the risk of contrast induced kidney injury within 72 hours of the exposure (Maioli et al., 2010). Overall, the infusion of contrast medium has the potential to cause acute kidney injury in 9.33% of patients, defined as a 25% increase in blood creatinine level above pre-PCI levels (Zhang et al., 2017).

We found in this study that anemia consider a risk factor of developing CIN post PCI, as anemic patient had higher percentage of developing CIN than non-anemic patients, these findings agree with (Rakowski et al., 2022) results, as the found that anemia aggravate the medullary ischemia induced by injected contrast media.

Based on the frequency of associated risk factors, the verified incidence of acute kidney injury following PCI ranges from 0 to 24%, with a larger prevalence following primary PCI in an emergency setting (Kaltsas et al., 2018, Zhang et al., 2017). In this study, 91 (30.3%) patients developed acute kidney injury while 209 (69.7%) patients had normal kidney functionOther studies found that the incidence of CIN occurrence post PCI range from 3.35 to 16.5% (Sadeghi et al., 2003; Iakovou I et al., 2003). This study results also incoherence with (Mandal et al., 2018) findings as they found that the incidence of CIN increased in diabetic patients. The increase of CIN occurrence in the study hospital may related to those complicated cases with comorbidities transferred to it for performing PCI.

5.1 Limitations

The difficulty of collecting data from all hospital in the West bank, Gaza and East Jerusalem. The electronic health records also represent a limitation since the documentation system is variable from hospital to another. As this study was a retrospective study, the results should be taken with precaution.

5.2 Recommendations

1. Further research is needed to investigate more associated risk factors that may lead to CIN post PCI procedure.
2. Conduct a similar study that includes all hospitals in the West Bank and Gaza to identify the incidence and prevalence of CIN post PCI.
3. Developing a local guideline of protective measures that reduces the risk of CIN occurrence that applied in all hospitals.
4. Conduct a prospective study design and / or longitudinal study to identify the results for Scr on a long-term period to identify the effect of CM on the renal functions.

5.3 Conclusion

The incidence of acute kidney injury caused by contrast was moderate following initial PCI for acute myocardial infarction in this study. As a result, the results of the current study provide a clue for the risk on the kidney function post PCI. However, the frequency of contrast-induced acute kidney injury in patients who undergo PCI procedure still needs to be highlighted and improved, and it needs to be implanted in more precise way by healthcare providers, as contrast-induced kidney injury causes a

burden on health care system, patients and their caregivers. It is clear that prevention of the contrast-induced acute kidney injury is better and priority over treating existence AKI after PCI.

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Appendices

Appendix A

The following questionnaire consists of sociodemographic data, co-existing factor, clinical data, and procedural-related factor to use of contrast among patients underwent for percutaneous coronary intervention.

Demographics	
Age	
Gender	
Place of living	
Co-existing factor	
Comorbidities	
Nephrotoxic medication	
Patient diagnosis	
Clinical data	
SCr. Level	
Blood pressure	
Pulse rate	
Hydration	
Hemoglobin level (Anemia)	
Procedural factors	
Contrast volume used	
PCI type	
SCr. Post PCI	

Blood pressure post PCI	
Pulse rate post PCI	
CKD; chronic kidney disease, D.M; diabetes mellitus, HTN; hypertension, ARBs; angiotensin receptor blockers, ACEIs; angiotensin converting enzyme inhibitors, NSAIDs; non-steroidal anti-inflammatory drugs, Non-STEMI; non-ST-segment elevation myocardial infarction, STEMI;ST-segment elevation myocardial infarction, Cr; creatinine.	

Appendix B

AAUP IRB Approval

Arab American University- Palestine
Deanship of Scientific Research
IRB committee
Tel: 04-241-8888, ext 1196
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الجامعة العربية الامريكية- فلسطين
عمادة البحث العلمي
لجنة أخلاقيات البحث العلمي
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IRB Approval Letter

Study Title: The Prevalence and Risk Factors of Developing Contrast Induced Nephropathy after Injection of Contrast in Percutaneous Coronary Intervention Patients. Descriptive Retrospective Study.

Submitted by: Mahmoud Basem Alzghari

Date received: 19th May 2023

Date reviewed: 14th June 2023

Date approved: 16th June 2023

Your Study titled "**The Prevalence and Risk Factors of Developing Contrast Induced Nephropathy after Injection of Contrast in Percutaneous Coronary Intervention Patients. Descriptive Retrospective Study**" with archived number 2023/A/120/N was reviewed by the Arab American University IRB committee and was approved on 16th June 2023.

Reham Khalaf-Nazzal, MD, PhD
IRB committee chairman
Arab American University of Palestine

IRB
ARAB AMERICAN UNIVERSITY

General Conditions:
1. Valid for 4 months from the date of approval.
2. It is important to inform the committee with any modification of the approved study protocol.
3. The committee appreciates a copy of the research when accomplished.

لجنة أخلاقيات البحث العلمي في الجامعة العربية الامريكية
IRB at Arab American University

ملخص

مقدمة: انَّ القصور الكلوي الحاد الناجم عن مادة الملونة التي يتم إعطاؤُها وحقنها في الأوعية الدموية لا تزال تحمل نتائج سيئة للمرضى الذين يتلقون المادة الملونة الوريدية. خلال أيام قليلة من استخدام المادة الملونة تنخفض وتتراجع وظائف الكلى تدريجياً وهي السِّمة المميزة لقصور الكلى الحاد.

الهدف: كان الغرض من هذه الدراسة هو تحديد مدى انتشار وعوامل الخطر لتطور اعتلال الكلى الناجم عن المادة الملونة بعد حقنها في مرضى التدخل التاجي.

منهجية البحث: تم جمع البيانات في هذه الدراسة بأثر رجعي في تشرين الأول/أكتوبر وتشرين الثاني/نوفمبر 2023، من خلال مراجعة البيانات الموجودة على النظام الإلكتروني AV-Ceina في مستشفى المقاصد. تم شمل 300 مريض في التحليل الذين خضعوا للتدخل التاجي وتم تسجيل البيانات قبل التدخل والبيانات ما بعد التدخل.

النتائج: أظهرت نتائج هذه الدراسة أن حوالي 30% من العينة أصيبوا بقصور كلوي حاد بعد التعرض للمادة الملونة بعد التدخل التاجي. وقد وجد أن المرضى الإناث، والمرضى الذين يعانون من أمراض أخرى، وكمية المادة الملونة التي تم حقنها في المرضى والمرضى الأكبر سناً كانوا الأكثر عرضة للإصابة بقصور الكلى الحاد الناجم عن المادة الملونة ($P < 0.01$).

الكلمات المفتاحية: التباين، إصابة الكلى الحادة، التدخل التاجي عن طريق الجلد، اعتلال الكلية، فلسطين.