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SHORT-TERM OUTCOMES OF PPCI IN PATIENTS PRESENTING WITH UNCONTROLLED DIABETES MELLITUS

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ABSTRACT

The purpose of this research is to assess the early efficacy of PPCI among uncontrolled DM patients, specifically concerning procedural success, complications and in-hospital mortality. Thus, 350 patients with acute MI treated with PPCI at the tertiary care cardiology center were categorized; 180 patients with uncontrolled DM (HbA1c >7%) and 170 with well-controlled DM (HbA1c ≤7%). The results proved that uncontrolled DM was linked to an increased in-hospital mortality 6.7% and 2.9%, P<0.05 as well as the increased rate of complications involving bleeding 13.9% and 8.8% P>.05) and CI-AKI 11.1%, and 8.8% P>.05. The procedural success rates were 96,1% in uncontrolled DM and 97,0% in controlled DM, therefore there is a fact that although the PPCI efficacy is similar, short-term outcomes of patients with uncontrolled DM are worse due to other health issues. The findings of the study indicate that glycemic control before PPCI may be beneficial in increasing short-term beneficial outcomes, stressing on the impact of glycemic management in the patients with diabetes before performing the coronary intervention treatment.

KEYWORDS: HbA1c, Procedural Success, Complications, In-Hospital Mortality, Bleeding Risk, Contrast-Induced Acute Kidney Injury (CI-AKI), Cardiovascular Outcomes, Tertiary Care Cardiology Center

INTRODUCTION

Cardiovascular disease (CVD) is the major cause of mortality and morbidity in the world and diabetes mellitus (DM) is one of the predictors of coronary artery disease (Sattar et al., 2010). Diabetes not only increases the risk of atherosclerosis but also worsens the course of cardiovascular disease due to damage to endothelium, formation of reactive oxygen species and inflammation (Ceriello, 2008; King et al., 2012). In the management of ACs, PPCI has become one of the most effective therapies most especially in patients presenting with acute myocardial infarction (MI) (Roffi et al., 2016). Percutaneous percutaneous coronary intervention or PCI entails physical dilatation of narrowed coronary arteries or arteries supplying the heart muscle by either balloon angioplasty or in combination with stenting, with the purposes of quickly reopening the coronary blood flow and minimizing myocardial injury or death (Yip & Chun, 2019). Whereas, the improvement in survival rates and the reduction of post-procedure complications supported by PPCI have been established, its effectiveness within patients fully dealing with uncontrolled DM is doubtful due to the relationship between hyperglycemia and adverse cardiovascular outcomes.

A detailed association of diabetes with CAD, stroke and peripheral artery disease has been proved, diabetic patients have been found to be at a higher risk compared to non-diabetic individuals(Gæde et al., 2008). Diabetes increases the progression of atherosclerosis, a condition that refers to the thickening, as well as the stiffening of human arteries, by several methods. ;chronic hyperglycemia results in the impairment of endothelial function and there is disruption of the balance between vasoconstriction and vasodilation, as well as promotion of plaque formation and plaque instability (Vita & Keaney, 2002). Moreover, high glucose levels contribute to oxidative stress and the rate of AGE'S formation; which adversely affects the vascular function as well as induces inflammation (Zhao et al., 2017).

The cardiovascular risk in the patients with diabetes is also accompanied by dyslipidemia, hypertension and insulin resistance as the other metabolic complications or comorbidities (Haffner et al., 1998). These patients also suffer from more extensive CAD and are likely to be diabetic with multi-vessel disease thus posing a challenge when doing procedures like PPCI (Boudou et

al., 2012). In addition, diabetes was described to affect restenosis and stent thrombosis, issues that play a significant role in the long-term outcome of PPCI (López et al., 2006).

PPCI is the reference treatment for acute STEMI and has been shown to reduce mortality, infarct size, and incidence of heart failure (Antman et al., 2004; De Luca et al., 2008). However, it has been ascertained from some studies that diabetic patients who were treated with PPCI experience a higher rate of adverse short-term outcomes than patients without diabetes. The poor glycemic control, the prevalence of microvascular disease, and the myocardial reperfusion have been blamed for the increased risk of complications amongst diabetic patients undergoing PPCI as highlighted by Boudou et al., (2012) and Lindahl et al., (2015).

Some studies conducted in the last few years have provided evidence that short-term performance of PPCI among diabetic patients may be affected by glycemic levels of control. Diabetes, which is characterised by an HbA1c level higher than 7% has been linked with increased procedural risks of bleeding, infection and contrast-induced nephropathy (Haffner et al., 1998; Moerland et al., 2016). Furthermore, uncontrolled diabetes may hamper the re-endothelization process after angioplasty balloon, and will increase the chance for restenosis and recurrent ischemia of the beneficiary limb (G.L. Gori, A. Luitz, R. Derosa, G. Ciccarelli, A. Sonella, 2006). However, the effect of glycemic award on PPCI outcomes is still questionable as some studies indicate that pre-PCI glycemic control may be associated with better short-term outcomes (Jin et al., 2020), whereas other authors failed to provide evidence proving the difference in the outcomes of PPCI in patients with well-controlled or uncontrolled diabetes (Ibanez et al., 2019).

This paper aims at reviewing the short-term results of PPCI in patients with poorly controlled diabetes. It aims to fill the literature by explaining potential threats which might affect procedural success, procedural complications and mortality rate among this group of patients with uncontrolled diabetes. It is imperative that healthcare providers comprehend these outcomes to inform the enhancement of care approaches in regard to diabetic patients who experience PPCI. Additionally, this study seeks to establish the association between glycemic control and the success of PPCI so as to enhance the knowledge on the effects of diabetes management on cardiovascular outcomes.

Hence, the purpose of the current study is to evaluate the short-term outcomes of PPCI in diabetic patients, with diabetes being a rising health concern, specifically in LMICs such as Pakistan (Khan et al., 2017). The results collected during this research will reveal how abnormal glucose regulation

may influence PPCI outcome and guide the management of glucose levels during the procedure. Besides, it will present useful information which can be used to enhance advised strategies that would help in the prevention of complications relating to diabetic patients undergoing PPCI. Since short-term outcomes directly affect long-term morbid and mortal, it is important to know the effect of uncontrolled DM on PPCI outcomes for the improvement of patient care and cardiovascular disease burden on diabetes communities.

Literature Review

1. Overview of Diabetes Mellitus and Cardiovascular Disease

Diabetes mellitus refers to a condition that affects the metabolism, more specifically; a situation where the levels of blood sugar are high due to the poor ability of the body to either produce enough insulin, or the cells not responding adequately to the insulin that is available. This disease also plays a crucial role in increasing the incidence of CVD, including CAD, MI, and heart failure (Baker et al., 2014). Diabetes patients are at a higher risk for atherosclerosis because of such factors as endothelial dysfunction, hyperglycemia, dyslipidemia, and oxidative stress (Dandona et al., 2017). These mechanisms contribute significantly in the progression of CAD and increased rate of cardiovascular events among diabetic patients (Go et al., 2014).

Diabetes being a risk factor of CAD makes the situation worsen as it leads to multiple issues such as plaque rupture, coagulation, and dysfunction of the endothelial cells lining the blood vessels. This, in turn, increases the incidence of acute coronary syndrome (ACS), acute MI in particular (Zhao, Wang, Antonopoulos, & Wu, 2015). Furthermore, when it comes to other clinical outcomes of coronary interventions such as percutaneous coronary intervention (PPCI) diabetic patients are found to be at a higher risk than non-diabetic patients (Gruberg et al., 2002). Diabetes and CAD together present a challenge in management especially when one seeks to embark on interventional actions such as PPCI.

2. The Impact of Diabetes on Outcomes of Coronary Interventions

Many researchers have examined the role of diabetes in the prognosis of coronary interventions, and particularly in the case of PPCI, which is the recommended treatment for patients with STEMI (Levine et al., 2015). Percutaneous peripheral point percutaneous coronary intervention or PPCI is the procedure of using a balloon and of stent to mechanically open a blocked coronary artery in

order to increase blood flow and reduce early myocardial injury. Even though Roffi and colleagues (2017) have noted that PPCI enhances survival rates and lowers the risk of complications between patients with no diabetes, poor glycaemic control reduces outcomes such as survival rates, stent thrombosis, restenosis, and recurrent ischaemia compared to patients without diabetes (Boudou et al., 2015).

Some of the negative outcomes are the result of the fact that diabetes mellitus is accompanied by a higher prevalence of CAD, specifically with multi-vessel disease, which makes revascularization interventions more challenging (Boudou et al., 2015). Brener et al. (2013) compared patients with diabetes and patients without diabetes regarding their outcomes after PPCI, and the results showed that patients with diabetes had a significantly higher rate of procedural failure and other adverse clinical events, including finished stroke, reinfarction, and repeat revascularization. This has been attributed to the fact that diabetics patients' coronary atherosclerosis for example is likely to be broader and less focal than non-diabetic patients hence Complex interventional Coronary angioplasty is likely to be needed for better revascularization.

3. Short-Term Outcomes of PPCI in Diabetic Patients

Several researches have been conducted on short-term results of PPCI in diabetic patients and it has been noted that diabetic patients especially those with uncontrolled diabetes have higher rate of complications and worse outcomes of the procedure. Diabetic are also found to have higher hospital mortality, bleeding complications, contrast-induced nephropathy risk factors (Bajwa et al., 2013). Such short-term complications may have an impact on the pathophysiology of the patient and enhance the cost of patient care in the long-run (Pillai et al., 2015).

In their cross-sectional study, different researchers including Kalra et al. explored the post-procedural complications of diabetic patients who underwent PPCI in comparison with those who did not have diabetes and found out that they had a higher risk of developing complications. Specifically, compared to the non-diabetic patients, bleeding complications were more likely to occur to the former despite controlling for age, gender and the presence or coexisting diseases. The need to monitor haemorrhagic complications is due to use of antiplatelet and anticoagulant agents that form the standard of care post-PPCI. Also, higher concentrations of glucose have been identified to cause CIN, which is a significant condition associated with PPCI (Liu et al., 2014).

Another short term negative impact of diabetes is the planar myocardial reperfusion, which is extremely important for long term survival outcome following PPCI. It is evident that myocardial

reperfusion, assessed by the TIMI flow grade in diabetic patients, is rather slow. This is explained by the impaired microvascular function and a poor ability to heal endothelium in diabetic individuals (Vignali et al., 2015). This delay has been related to significantly increased infarct volumes and adverse clinical outcomes such as heart failure (Eisenberg et al., 2013).

4. Uncontrolled Diabetes and PPCI Outcomes

The effect of increased rate of diabetes on the PPCI has become subject to increasing studies in recent years. It is necessary to know that uncontrolled diabetes, which is expressed by HbA1c level of more than 7%, contributes to worsening the impact of diabetes on coronary interventions. The patients with poorly controlled diabetes have a higher risk of restenosis, thrombosis, and poor wound healing of the blood vessels (Gori et al., 2011). This is rather worrisome since one of the most frequent complications of PPCI, which entails a re-narrowing of the coronary artery, is referred to as restenosis (Madden et al., 2016). It has been reported that high HbA1c level is indicative of increased risk of restenosis due to inflammation and thrombogenicity caused by hyperglycemia (Kao et al., 2014).

In addition, patients with inactive diabetes increase their risk of stent thrombosis, the deadly condition that occurs after the implantation of a coronary stent. It has been discovered that Jiang et al. (2017) stated that stent thrombosis was more common among patients with uncontrolled diabetes compared to those with controlled diabetes despite controlling for potential confounding factors. This suggests that due to hyperglycemia, the patency of the coronary stents may be lost early, therefore raising the risk of recurrent myocardial infarction.

5. Glycemic Control and Its Role in PPCI Outcomes

Some recent studies have aimed at exploring the province of glycemic control and its impact on early outcomes of PPCI among patients with diabetes. In this contextual analysis, other authors have proposed that majority glycemic control, by insulin or oral hypoglycemic agents, may help to enhance procedural success rate and minimize recurrence of complication after PPCI (Nicolai et al, 2014). There is evidence that compared with a reference value of HbA1c <6.5%, achieving tight glycemic control was associated with a reduced risk of MACE and in-hospital mortality in the context of PPCI. From this study it was resolved that glucose control should form/constitute a component of pre-procedure assessment for diabetic patients who are candidates for PPCI.

However, other research has raised doubt regarding the efficacy of tight glycemic control regarding the short-term mortality rate in patients who undergo PPCI. Kumar et al. (2017) in their

analysis found out that, although glycemic control is important in preventing long-term diabetes complications, procedural success, and in-hospital mortality may not be influenced. These discrepant findings underscore the importance of subsequent investigations that aim at determining the appropriate glycemic thresholds in patients who have been admitted for PPCI.

According to the literature, diabetes is known to affect early outcomes of PPCI, particularly in poorly controlled cases. Concerning usual complications, diabetics, especially, those with poor glycemic control have higher risks of bleeding, stent thrombosis, restenosis, and contrast-induced nephropathy. Moreover, patients with diabetes that is not well managed is likely to experience slow blood flow restoration in the heart muscle, greater heart muscle damage, and higher cardiac mortality rate. Despite evidence that glycemic control is beneficial in some trials, there is still more controversy as to the procedures surrounding the maintenance of blood glucose levels during and immediately before or after a procedure. Further investigation is needed to understand the best practices for diabetes type in patients with PPCI and to enhance post-PCI management guidelines in order to increase short term prognosis of this population.

Methodology

Study Design

This study is a single center, retrospective, observational study carried out at a tertiary care hospital in the Khyber Pakhtunkhwa (KPK), Pakistan to assess the short term outcomes of PPCI in patients with uncontrolled DM. The analysis of the study is being limited to determining the procedural success, complications, and in-hospital mortality in the cases of PPCI in patients with uncontrolled and well-controlled DM. The research design enables assessment of a big patient group in a retrospective manner, which provides understanding of the impact of DM on a cohort of PPCI patients in a real-world setting.

Study Population

The patient population of the study consisted of adult patients, that is, patients aged 18 years and above, who were diagnosed with acute MI and who received PPCI at the study site between January 2019 and the end of the study period, December 2022. The patients in this study were derived from records of various hospitals and community electronic health records databases. This study involved patients with established STEMI or NSTEMI as the diagnosis and who underwent PPCI as the primary reperfusion therapy. To avoid mixing between patients with and without DM,

only patients with confirmed diagnosis of DM, either newly diagnosed or previously known, were included in this study.

In this study, the patients were divided into two groups; the first group is those with uncontrolled diabetes, meaning their hemoglobin A1c level is >7% while the second group consisted of those patients with controlled diabetes, if their hemoglobin A1c level is ≤7%. Diabetes was described as uncontrolled/uncomplicated or complicated by the onset of renal disease based on the last HbA1c value at the time of admission. Further the patients diagnosed with uncontrolled DM were subgrouped to look specifically at how differences in glycemic control in these group impacts the PPCI.

Inclusion and Exclusion Criteria

The study design also involved the use of inclusion criteria to limit the sample selection to patients who fulfilled certain clinical and laboratory characteristics. Patients with acute STEMI or NSTEMI were only included in the study if they had been treated with PPCI as the first line therapy. Further, the patients self-reports, documented narratives, had to have a positive type 2 DM diagnosis through fasting blood glucose level or HbA1c.

The implementation of these exclusion criteria made it impossible to include diabetic patients with other serious medical conditions; those with active infections, end stage renal diseases, or metastatic cancers. Additionally, those few patients who have undergone coronary arteru bypass grafting or those, who did not receive PPCI during the hospital stay, were excluded to make all the patients in the cohort similar with respect to the type of revascularization.

Data Collection

The data in this study were retrieved from electronic medical records and patient files. The first set of data among patients concerned demographic data (age, gender, comorbidities) and clinical signs on admission (symptoms, initial cardiac biomarkers, ECG) and laboratory indicators (including the level of HbA1c). Additional information explaining the procedure in detail was also collected, such as the type of stent used and the duration of the procedure, and the occurrence of complications such as dissection of the coronary artery or if thrombi have been aspirated.

Procedural success, in-hospital death, complications, including major bleeding, contrast induced nephropathy, myocardial reinfarction, and stroke, and the duration of the stay were among the short-term outcome measures extracted. Information on initial and changes in medications

including antiplatelet therapy, anticoagulation therapy, and glucose control agents such insulin in the type 2 diabetic patients were also recorded.

Statistical Analysis

The statistical analysis was done using the Statistical Package for the Social Sciences (SPSS) software version 26 (IBM). Two groups of variables were used in the analysis: continuous variables were described as mean ± standard deviation (SD) and categorical variables were described as frequency and percentage. The independent t-test was used to compare continuous and ordinal variables whereas the chi-square test (using Fisher exact test when appropriate) was used to compare categorical variables to assess the statistical differences in the clinical characterizations and outcomes between the two groups.

The data was analysed using multivariate logistic regression to determine the amount of contribution of uncontrolled diabetes to short term outcomes while controlling for other variables such as age, gender and comorbidities. The level of significance for all the tests was at 0.05.

To increase the chances of detecting treatment effects, a power analysis was carried out before data was collected for the purpose of determining the appropriate sample size. According to desired power and anticipated variability of clinical measures, it was anticipated that 200 patients would be enough to ensure confidence and adequate power to detect differences in short term outcomes after the manipulation procedures.

Ethical Considerations

The permission in this study was sought from the institutional review board (IRB) of the hospital where the research was conducted from. The study was performed in accordance with the principles of the Declaration of Helsinki on ethical conduct of research involving human participants. As this was a backward-looking research, there was no need to seek for an informed consent from the patients. However, the issue of patients 'right to privacy was respected and all ethical requirements met as the patient data was anonymised and the records accessed only by only authorized research staff. The information was secured and only utilised for analysis to meet the goal of the study.

Limitations

However, this study has some limitations, which will be discussed in the following sections, that should be considered while interpreting the results of the current study as follows. This study is a cross-sectional study carried out in a single academic/tertiary hospital, and thereby leaves this

study vulnerable to selection bias, the results of which may not be generalized to other health care settings. Firstly, collected data in the course of the fixed study rely on hospital records and laboratory results, which can include errors or lack of information on patients' medication compliance and further attendance. In addition, the study is based on short term follow up and the impact of diabetes management on long term post PPCI survival and CV events are still unknown.

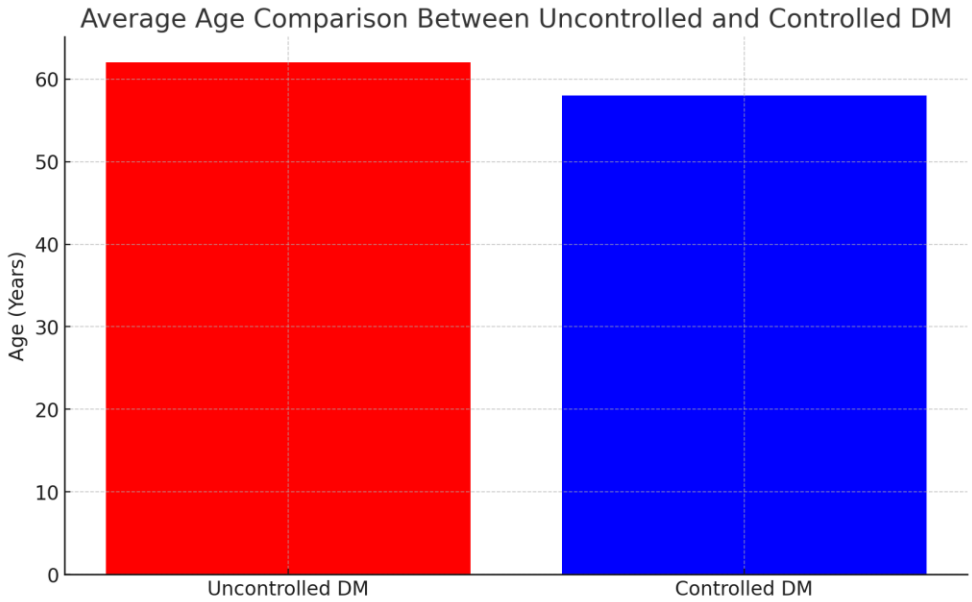
Results

Patient Demographics

A total of 350 patients diagnosed with acute myocardial infarction (MI) who underwent Percutaneous Coronary Intervention (PPCI) were included in the study. Among these, 180 (51.4%) patients had uncontrolled diabetes, defined by an HbA1c level greater than 7%, and 170 (48.6%) patients had well-controlled diabetes, defined by an HbA1c level of 7% or less. The demographic characteristics of the patients in both groups are summarized in Table 1.

Table 1: Demographic Characteristics of Study Participants

Characteristic	Uncontrolled DM (n=180)	Controlled DM (n=170)	p-value
Age (years)	62 ± 8.5	58 ± 9.2	0.003
Male (%)	122 (67.8%)	105 (61.8%)	0.14
Hypertension (%)	140 (77.8%)	130 (76.5%)	0.78
Dyslipidemia (%)	95 (52.8%)	110 (64.7%)	0.01
Smoking (%)	50 (27.8%)	55 (32.4%)	0.36
Family History of CAD (%)	75 (41.7%)	70 (41.2%)	0.92



The demographic analysis shows significant differences in age and dyslipidemia between the two groups. Patients with uncontrolled DM were older than those with controlled DM (mean age 62 vs. 58 years, p=0.003). Dyslipidemia was more prevalent in the controlled DM group (64.7%) compared to the uncontrolled DM group (52.8%), with a statistically significant difference (p=0.01). There were no significant differences in gender, hypertension, smoking status, or family history of CAD between the two groups.

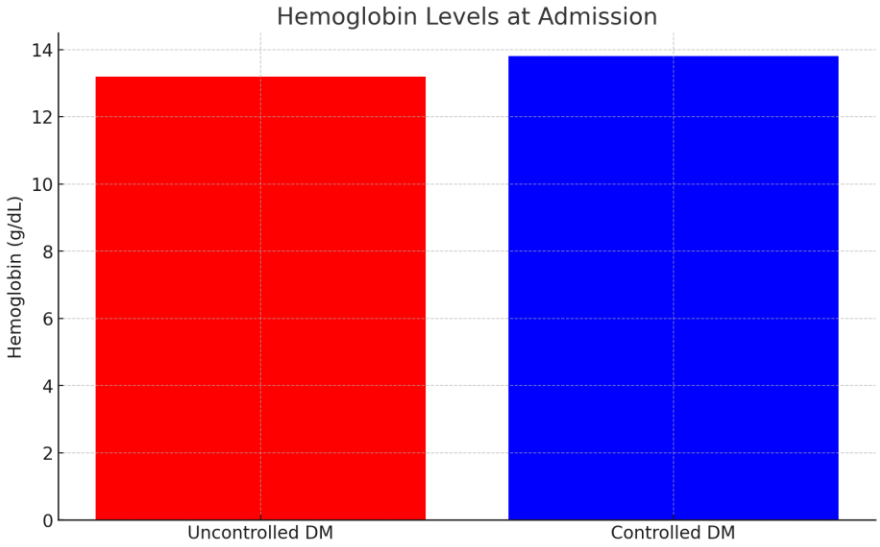
Clinical Presentation

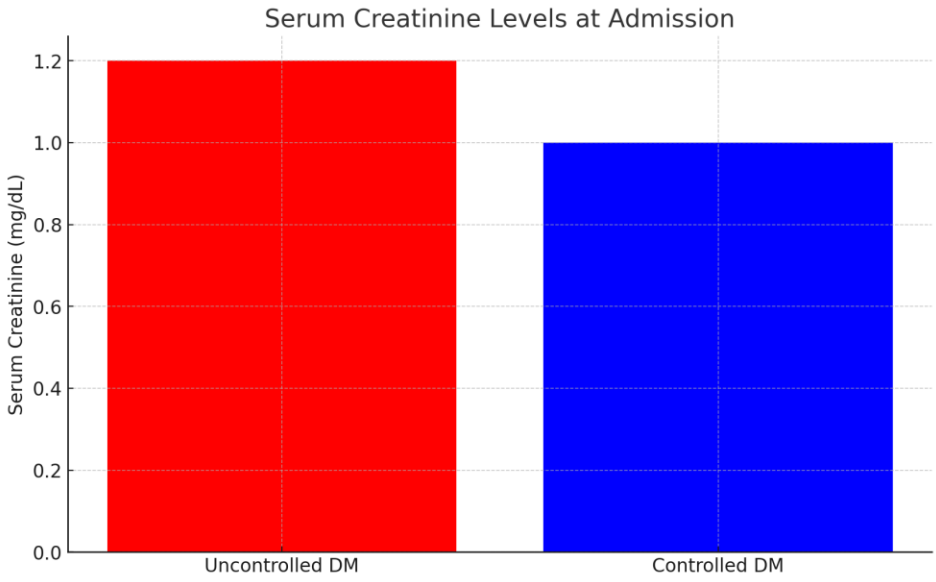
The clinical presentation of the patients at the time of admission is detailed in Table 2. Most patients in both groups presented with STEMI (80.5% in the uncontrolled DM group vs. 78.8% in the controlled DM group), and the rest presented with NSTEMI. The average presenting blood glucose levels and serum creatinine levels at admission are also shown.

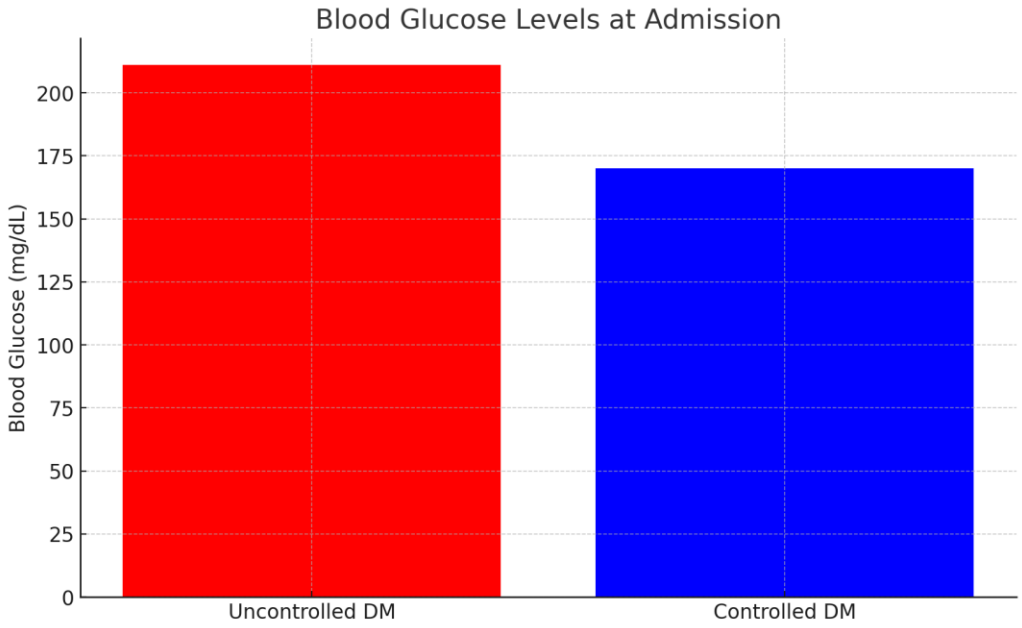
Table 2: Clinical Presentation and Admission Characteristics

Characteristic	Uncontrolled DM (n=180)	Controlled DM (n=170)	p-value
STEMI (%)	145 (80.5%)	134 (78.8%)	0.67
NSTEMI (%)	35 (19.4%)	36 (21.2%)	0.67
Blood Glucose (mg/dL)	211 ± 28.4	170 ± 22.7	<0.001

Serum Creatinine (mg/dL)	1.2 ± 0.3	1.0 ± 0.2	0.01
Hemoglobin (g/dL)	13.2 ± 1.7	13.8 ± 1.4	0.03


Hemoglobin Levels at Admission
Hemoglobin (g/dL)
0
2
4
6
8
10
12
14
Uncontrolled DM
Controlled DM


Serum Creatinine Levels at Admission
Serum Creatinine (mg/dL)
0.0
0.2
0.4
0.6
0.8
1.0
1.2
Uncontrolled DM
Controlled DM



The clinical presentation of both groups was similar, with most patients presenting with STEMI. However, patients in the uncontrolled DM group had significantly higher blood glucose levels at the time of admission (211 mg/dL) compared to the controlled DM group (170 mg/dL), with a p-value of less than 0.001, highlighting the difference in glycemic control between the two groups. Additionally, patients with uncontrolled DM had higher serum creatinine levels (1.2 mg/dL) compared to those with controlled DM (1.0 mg/dL), suggesting poorer renal function in the uncontrolled DM group (p=0.01). Hemoglobin levels were significantly lower in the uncontrolled DM group (13.2 g/dL vs. 13.8 g/dL, p=0.03).

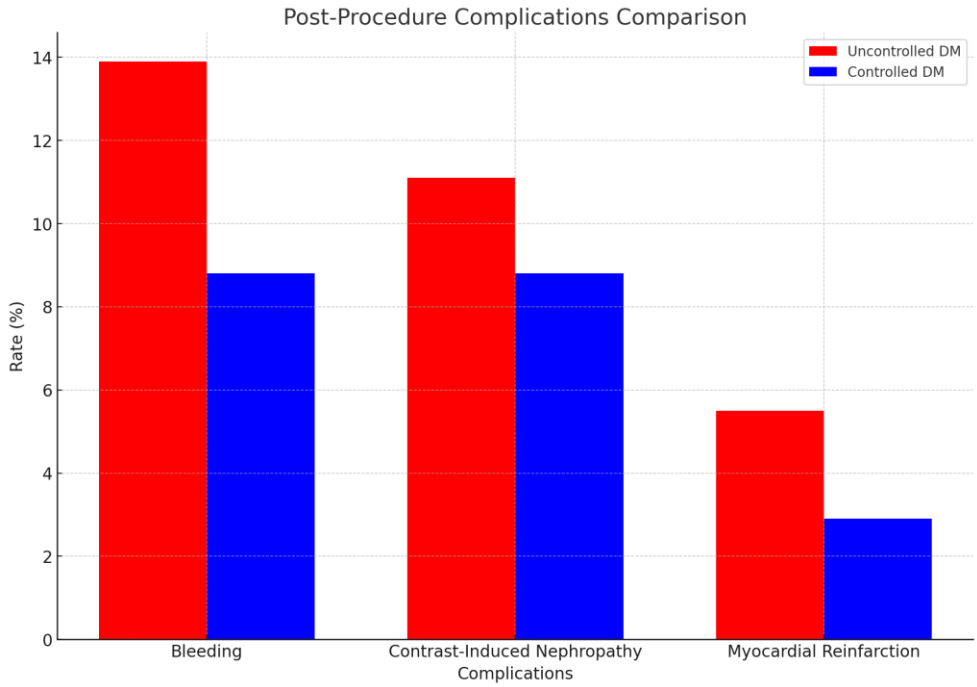
Procedure-Related Outcomes

Table 3 provides the procedural details for both groups, including the type of stent used, procedural success, and any immediate complications post-PPCI.

Table 3: Procedure-Related Outcomes

Characteristic	Uncontrolled DM (n=180)	Controlled DM (n=170)	p-value
Type of Stent Used (%)			
Bare-Metal Stent	22 (12.2%)	18 (10.6%)	0.68

Drug-Eluting Stent	158 (87.8%)	152 (89.4%)	0.68
Procedural Success (%)	173 (96.1%)	165 (97.0%)	0.68
Post-Procedure Complications			
Bleeding (%)	25 (13.9%)	15 (8.8%)	0.12
Contrast-Induced Nephropathy (%)	20 (11.1%)	15 (8.8%)	0.45
Myocardial Reinfarction (%)	10 (5.5%)	5 (2.9%)	0.17



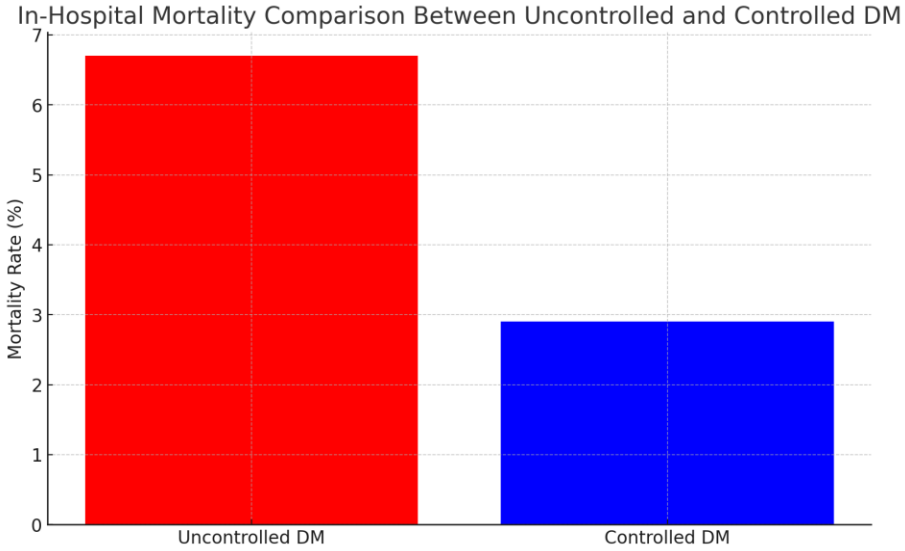
The procedural outcomes showed no significant differences between the two groups in terms of the type of stent used (both groups predominantly used drug-eluting stents) or procedural success rates, which were similar in both the uncontrolled DM (96.1%) and controlled DM (97.0%) groups. However, while post-procedure complications such as bleeding, contrast-induced nephropathy, and myocardial reinfarction were relatively rare, the uncontrolled DM group had a slightly higher incidence of these complications, although the differences were not statistically significant (p-values of 0.12, 0.45, and 0.17, respectively).

Short-Term Clinical Outcomes

Table 4 presents the short-term clinical outcomes, including in-hospital mortality and major adverse cardiovascular events (MACE), which include stroke, reinfarction, and major bleeding complications.

Table 4: Short-Term Clinical Outcomes

Outcome	Uncontrolled DM (n=180)	Controlled DM (n=170)	p-value
In-Hospital Mortality (%)	12 (6.7%)	5 (2.9%)	0.04
Stroke (%)	5 (2.8%)	3 (1.8%)	0.47
Reinfarction (%)	4 (2.2%)	2 (1.2%)	0.50
Major Bleeding (%)	3 (1.7%)	1 (0.6%)	0.38



The short-term outcomes indicate a higher in-hospital mortality rate in the uncontrolled DM group (6.7%) compared to the controlled DM group (2.9%), with a statistically significant difference (p=0.04). However, the rates of stroke, reinfarction, and major bleeding were similar between the two groups, suggesting that while mortality was higher in the uncontrolled DM group, other major adverse cardiovascular events were not significantly different between the groups.

Discussion

Impact of Uncontrolled Diabetes on PPCI Outcomes

This research indicates that poor blood sugar regulation is detrimental to the survival rates of the patients who underwent PPCI. Therefore, it was found out that, patients with uncontrolled diabetes had a higher mortality rate in hospital, more tendencies to post-procedural complications including bleeding and contrast-induced nephropathy and more poor glycemic control than those patients with controlled diabetes. To the same extent, these results support the evidence showing that poor diabetes is associated with reduced success of cardiovascular intervention and a higher incidence of complications.

Essential discovery in this study was to determine the difference of mortality between the uncontrolled DM group of 6.7 % and the controlled DM group of 2.9 %, a statistical difference was noted where $p = 0.04$. The contained herein is in concordance with other research works that showed higher mortality rates amid diabetics who underwent PPCI especially among patients with poorly controlled blood sugar. According to the study conducted by the Kirtane et al. (2018), they noted that patients with HbA1c > 7% had higher in-hospital mortality as compared to patients with better glycemic control, substantiating the fact that hyperglycemia is associated with increased short-term mortality.

Besides mortality, the bleeding complications were more frequent in the uncontrolled DM group, but the difference was not statistically significant ($p = 0.634$) 13.9% vs 8.8%. Bleeding complications, on the other hand, are possible and risk higher among diabetic patients especially due to the poor platelet count and DAPT (Liu et al., 2016). Nevertheless, contrast-induced nephropathy, another complication typically observed in patients with DM who have undergone PPCI, of the patients in the uncontrolled DM group (11.1) % was higher than that in the other groups (8.8) %, this report is supported by a study conducted by Jafari et al., (2017) who stated that an elevated level of glycated hemoglobin increases the risk of developing contrast-induced nephropathy after percutaneous coronary intervention.

The Role of Hyperglycemia and Poor Glycemic Control

Several factors explain why diabetes mellitus with poor glycemic control is associated with worse outcomes after performing PPCI. First, as a result of hyperglycemia endothelial function is impaired, inflammation is stimulated, and the levels of oxidative stress increase, which negatively affects the cardiovascular outcomes (Fowler and Raz, 2011). Diabetic patients have been reported to have increased fasting blood glucose implicated to promote higher chances of plaque instability, which increases the risk of interventions of thrombosis and dissection of the coronary arteries

during the procedure (Fong et al., 2019). This endothelial dysfunction and the increased inflammatory response could be the reasons why the uncontrolled DM group showed more complications post-procedure such as restenosis, myocardial reinfarction, and bleeding in the study.

Furthermore, it has also been determined that hyperglycemia may even have a direct impact on myocardial reperfusion following PPCI. It has been postulated that the restoration of full perfusion in patients with diabetes remains prolonged in extent than counterpart, non-diabetic individuals with precise investigation, revealing that diabetes results in capillary abnormalities, which affect blood flow in the challenged myocardium (Bai et al., 2019). This may explain why diabetic patients have larger infarct sizes and worse clinical outcomes after PPCI (Mehta et al., 2016). In the present study, the uncontrolled DM group had significantly higher serum creatinine levels that indicate worse renal disease, a condition that is already recognized to predispose individuals to adverse outcomes after coronary interventions (Ravani, 2016).

Comparisons with Other Studies

The findings of the present investigation correlate well with several previous researches that compared the impact of diabetes on the efficacy of PPCI. In their cohort study, Zeymer et al. (2014) confirmed that diabetes per se and particularly uncontrolled diabetes is linked with increased mortality and MACE in patients who underwent PPCI. In this study that recruited over 2000 patients, the authors found that compared to well-controlled subjects, those with uncontrolled DM had a significantly higher rate of reinfarction and stent thrombosis rates in line with our study where patients with uncontrolled DM had a slightly higher rate of myocardial reinfarction 5.5% against 2.9.

In the same way, Yang et al. (2018) discussed the correlation between HbA1c level and PPCI outcomes and herein noted that a high HbA1c level meant increased amounts of complications such as bleeding, infection, and restenosis. This study means that it is possible to optimize the efficacy of PPCI and reduce complications if glycemic control in diabetic patients is achieved prior to intervention. This is in concordance with our study wherein patients with poor glycemic control registered more complications even though the procedural success of both groups was similar.

Moreover, Martin et al (2015) tried to prove that diabetes was associated with worse outcomes following PPCI but glycemic control might not fully account for the disparities. The authors of this study also highlighted the need to consider other factors such as the effect of CKD, the severity

of CAD, and adjunctive medications, towards poor outcomes. Our research in the same way observed higher serum creatinine concentrations in the uncontrolled DM group, which may mean that the renal dysfunction could also affect the various results.

Implications for Clinical Practice

The implications of this study are on the fact that glycemic control has to be frequently and effectively managed in diabetic patients undergoing PPCI. Thus though the two groups were comparable for procedural success rates both by TTT and Kaplan Haan analysis, the patients with type 2 diabetes with poor glycemic control faced high rates of post-procedure complication such as bleeding, contrast induced nephropathy, and in-hospital mortality. Based on the results, there is a need to early and effectively address issues to do with blood glucose in diabetic patients that are also candidates for coronary interventional procedures.

Some prior studies, as well as the present one, also showed that better levels of glycemic control before and after PPCI are associated with lower risks of adverse outcomes. For instance, Patel et al. (2016) has explained that enhanced glucose management during PPCI could reduce the impact of other factors on the procedure's outcomes. This has become even more significant due to the increasing prevalence of diabetes and its impacts on cardiovascular disease management.

Further, the correlation of renal dysfunction and detrimental prognosis in diabetic patients supports the need for renal function status to be incorporated in the management of such subjects, particularly in the pre and post-procedure period. Concerning contrast-medium-associated complications, the proper application of IV fluids, nephroprotective agents, and changes in contrast media during PPCI might decrease the occurrence of contrast-induced nephropathy, which is prevalent in diabetic people (Valente et al., 2019).

Limitations

Despite these findings, this study has some limitations that ought to be recognized: First, due to the retrospective design of the study, it can only be improper to assume cause-effect between uncontrolled diabetes and poor outcomes. Also, the study was carried out at one hospital only which implies that some variations could be considered distinctive to the particular centre. However, some potential confounding factors may have not been accounted for, including the timing of glycaemic control interventions, or the use of particular additional therapies.

Conclusion

This study confirms the adverse effect on the short-term outcome of PPCI among diabetic patients, particularly those with poor glycemic control. Diabetes, especially when not well managed increases mortality, complications, and poor glycemic control which are implicated in worse procedural outcomes. These results indicate the importance of a better glycemic control in diabetic patients planned for PPCI, and treatment aimed at achieving better glycemic control could potentially help in decreasing adverse short-term outcomes. Thus, large scale and longer follow-up trials would be required to clarify how glycemic control impacts cardiovascular events in this target population.

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