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OUTCOME OF PRIMARY PERCUTANEOUS CORONARY INTERVENTION IN PATIENTS WITH ACUTE ST ELEVATION MYOCARDIAL INFARCTION

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Abstract

Background: A sudden onset ST-segment elevation myocardial infarction is a life-threatening presentation of coronary artery disease which requires prompt restoration of coronary blood flow. In cases where reperfusion is performed promptly, primary PCI is the preferred option. This study evaluated the outcomes of primary PCI for acute STEMI.
Methods: It was a cross sectional study in the Cardiology Department of Said Sharif Medical College and Teaching Hospital over a period of six months. Fifteen-nine patients aged between 18 and 75 were recruited using consecutive non-probability sampling method. Procedural success was considered when a residual coronary stenosis of 30% or less and final Thrombolysis in Myocardial Infarction grade III distal flow was achieved. A structured proforma was used to gather demographic, clinical and socioeconomic data. IBM SPSS Statistics version 21 was used for data analysis. Frequencies, percentages, means, standard deviations, medians and interquartile ranges were calculated. Chi square test or Fisher's exact test was used to assess association with outcome.
Results: The success rate of primary PCI was 96.2% (153/159), with six patients failing to have a successful procedure. Increased duration of illness for more than six hours, diabetes mellitus, post-infarction heart failure and cardiogenic shock were significantly associated with unsuccessful PCI. The greatest association with procedural failure was for cardiogenic shock. There were no significant associations with age, sex, BMI, hypertension, smoking history, or socioeconomic status, residence, education or occupation.
Conclusions: The rate of successful primary PCI was very high. Further improvement in reperfusion outcome in regional tertiary cardiac care systems may be achieved by reducing delay in treatment and prioritizing patients with diabetes, heart failure and cardiogenic shock.

Keywords: TIMI grade III flow, cardiogenic shock, diabetes mellitus, reperfusion, ST-segment elevation myocardial infarction, initial percutaneous coronary intervention, procedural success, and residual coronary stenosis.

1. Introduction

Cardiovascular diseases are still the leading cause of deaths in the world and strain health care system in various clinical and socioeconomic settings [1]. CAD is a leading cause of death and hospitalization [2]. It is a disease that is seen more commonly in the elderly, and many risk factors such as hypertension, diabetes mellitus, smoking, obesity, physical inactivity, unhealthy diet and dyslipidemia are associated with its prevalence [1,2]. Acute myocardial infarction is an important symptom and demands timely clinical management to prevent irreversible myocardial damage and mortality. Acute myocardial infarction (AMI) is defined as myocardial injury with clinical evidence of acute myocardial ischemia [3]. In ST-segment elevation myocardial infarction (STEMI), the mechanism involves rupture or erosion of the atherosclerotic plaque, and the formation of a thrombus, which leads to an epicardia coronary artery occlusion [3,4]. Interruption of coronary blood flow leads to necrosis of myocardium due to lack of oxygen. The extent of damage depends on infarct location, duration of occlusion and time to reperfusion. Delay in treatment can lead to left ventricular dysfunction, heart failure, arrhythmias, cardiogenic shock and death [3].

Quick restoration of blood flow through the infarct-related artery is the primary objective of STEMI management. Reperfusion can be accomplished with fibrinolytic therapy or primary PCI [4]. At present, the guidelines suggest that primary PCI should be the preferred approach if it can be performed with speed and efficiency by an experienced team at a PCI equipped center [4,5]. In primary PCI, the vascular access is gained by either the radial or the femoral artery, and the PCI catheter is introduced into the coronary circulation. The lesion responsible for the culprit is identified angiographic ally, and treated by balloon angioplasty, coronary stents, or other suitable means. Treatment delay has a significant impact on the benefit of primary PCI. The phrase time is muscle, is a reflection of the relationship between coronary occlusion and irreversible myocardial necrosis. Delay in the healthcare system has been shown to be associated with higher mortality in STEMI treated with primary PCI [6]. The Door to balloon time is thus an indicator of service performance but also any delay prior to arrival at hospital, transport, referral, diagnosis and catheterization-laboratory activation is included in total ischemic time [7]. Rapid recognition of early symptoms, immediate electrocardiography, speedy referral and efficient transfer are critical to myocardial salvage and survival. In patients who are eligible and do not have contraindications, fibrinolytic therapy can be used if timely primary PCI is not available [4]. Primary PCI, however, is not generally associated with increased risks for recurrent myocardial infarction, stroke or death if performed without undue delay [8]. It also decreases the number of failed pharmacological reperfusion and allows to treat the culprit lesion immediately. An effective primary PCI programmer, therefore, would need trained staff, catheterization facilities, a coordinated referral process and after PCI services. Objective angiographic parameters should be used to assess procedural outcome. Coronary flow is graded by the Thrombolysis in Myocardial Infarction (TIMI) system which ranges from grade 0 (no integrate flow beyond the obstruction) to grade III (complete perfusion of the distal coronary bed) [9]. The lower final TIMI grade flow is correlated with recurrent ischemia, heart failure and mortality, while higher grades are correlated with favorable outcomes [9]. Residual stenosis is also crucial since balloon dilatation or stents may not achieve adequate vessel patency. The present study considered the successful primary PCI as having a final TIMI grade III distal flow and no residual coronary narrowing more than 30%. The success of PCI has improved since the introduction of coronary stents. Drug-eluting stents lower the risk of restenosis and of needing another revascularization than bare-metal stents [10]. The use of first generation drug-eluting stents was associated with the risk of late stent thrombosis, but newer stents have thinner stents, better polymers and biocompatibility [10]. But there is still a risk of complications, like no reflow, stent thrombosis, coronary dissection, bleeding, kidney damage, recurrent ischemia, heart failure and cardiogenic shock. There may be factors related to the patient that can affect the success of the procedure. Poor outcomes have been associated with older age, diabetes mellitus, hypertension, smoking, obesity, late presentation, extensive coronary disease, heart failure and cardiogenic shock. The rate of primary PCI success was 96.4% in a tertiary care study from North India [11]. Several studies have also shown good procedural and in-hospital results at cardiac centers specializing in the treatment of cardiac patients in Pakistan [12] delays in presentation and prolonged ischemic time continue to be problems [13]. However, there may be variations in outcome due to patient factors, referral patterns, institutional factors, and the experience level of the operator.

Although primary PCI has increased in Pakistan, evidence from the regional institutions is limited. Results of large cities may not be representative of hospitals with access to populations with different socioeconomic status, geographic barriers, and access to health care. So the main aim of this study was to find the result of primary percutaneous coronary intervention for patients having acute ST-segment elevation myocardial infarction at the Cardiology Department of Said Sharif Medical College and Teaching Hospital. Successful procedure was defined as final TIMI grade III distal flow, and no residual stenosis >30%. The study also sought to find out if there was any difference in outcomes by age, sex, BMI, length of time ill, diabetes mellitus, hypertension, smoking history, post-infarction HF, cardiogenic shock, socioeconomic status, residential address, education and occupation.

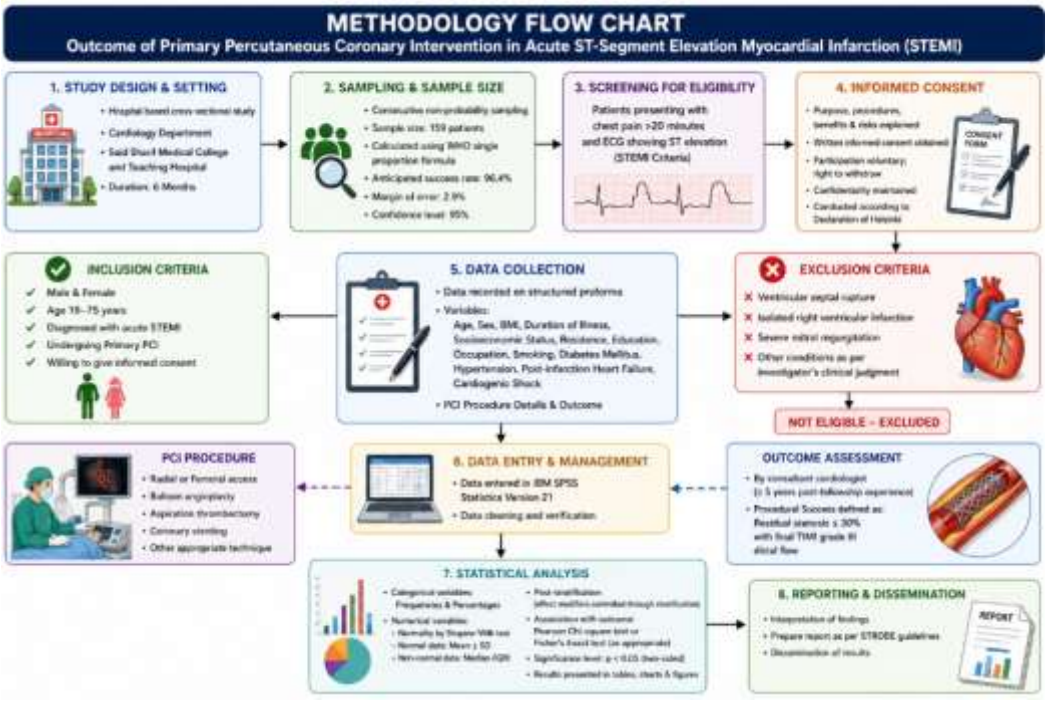
2. Methodology

The general methodological approach of the study to assess primary percutaneous coronary intervention (PCI) outcome in acute ST-segment elevation myocardial infarction (STEMI) is shown in Figure 1. The study was a hospital based cross sectional study carried out in the Cardiology Department, Saidu Sharif Medical College and Teaching Hospital during the study period of six months. The study was conducted using a non-probability consecutive sampling technique and the WHO sample size formula was used to determine the sample size of 159 patients based on the following assumptions: a 96.4% success rate of the procedure, a 95% confidence level, and a 2.9% margin of error. Patients with acute ST-segment elevation myocardial infarction (STEMI) with typical chest pain of more than 20 minutes duration were included in the study. All the subjects were given informed consent before their participation in the study, which outlined the aims of the study, the potential benefits, the risks involved and that participation would be voluntary and that confidentiality would be observed in line with the Declaration of Helsinki.

Patients undergoing the primary PCI procedure who gave informed written consent were included in the study, irrespective of sex and age of 18-75 years. Ventricular septal rupture, isolated right ventricular infarction, severe mitral regurgitation, and others considered unsuitable by the treating physician were not included in the analysis. Data was collected by means of a structured proforma which included details of the clinical risk factors (smoking, hypertension, diabetes mellitus, post-infarction heart failure, and cardiogenic shock), details of the procedure, and PCI outcome. The PCI procedure was conducted via either radial or femoral arterial access and was assisted by balloon angioplasty, aspiration thrombectomy, coronary stenting, and/or other suitable intervention techniques depending on the clinical situation.

All data collected were entered into the computer program IBM SPSS Statistics version 21 for data cleaning and verification before statistical analysis. Descriptive data were summarized as frequencies and percentages for categorical variables and as mean standard deviation (STD) or median (MZ) and interquartile range (IQR) for numerical variables, depending on the distribution of the data. The Shapiro–Wilk test was used to check normality and the Chi-square test or Fisher's exact test was used to analyze associations between independent variables and procedural outcomes with a two-sided p value < 0.05 being considered statistically significant. The primary outcome was "procedural success", defined as "residual coronary stenosis of 30% or less with final TIMI grade III distal coronary blood flow", assessed by an experienced consultant cardiologist of at least 5 years of post-fellowship experience. Finally, the findings of the study were analyzed, published following the guidelines of the STROBE and prepared for dissemination in science publication.

Figure 1: A methodological flowchart of the study on outcomes of Primary Percutaneous Coronary Intervention (PPCI) in patients with Acute ST-Segment Elevation Myocardial Infarction (STEMI)



The study was carried out as a cross-sectional study in Cardiology Department of Said Sharif Medical College and Teaching Hospital for 6-months. This study compared the angiographic results of primary percutaneous coronary intervention (PCI) in patients presenting with acute ST-segment elevation myocardial infarction (STEMI). Design and reporting method followed the recommendations for cross-sectional study in the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) [14]. A sample of 159 patients was used. Sample size was determined by the World Health Organization (WHO) formula for sample size estimation using a single population proportion, with an anticipated primary PCI success rate of 96.4%, a 95% confidence level and a 2.9% margin of error [15]. Non-probability sampling methods, consecutive sampling methods were used until the required sample was obtained. The study's inclusion criteria were: male and female patients aged 18–75 years with acute STEMI treated with primary PCI. Patients with ventricular septal rupture, isolated right ventricular infarction or severe mitral regurgitation were excluded. Acute STEMI was confirmed in those patients who had chest pain lasting longer than 20

minutes with electrocardiographic ST-segment elevation in more than one lateral or inferior lead or more than 2 anteroseptal precordial lead more than 0.2 mV. Considering the criteria used were consistent with those accepted as diagnostic for acute myocardial infarction [16] it is reasonable to view them as appropriate. Primary PCI was defined as emergency mechanical coronary revascularization via radial or femoral arterial access with the use of coronary stents, balloon angioplasty, and aspiration thrombectomy and or any other clinically appropriate method.

The major endpoint was procedural success, which was defined as a residual coronary stenosis of 30% or less and final Thrombolysis in Myocardial Infarction grade III distal flow. Ante grade perfusion of the distal coronary bed was considered successful reperfusion based on the TIMI grade III angiographic reperfusion parameter [17]. PCI outcome assessment was done by a consultant cardiologist of at least 5 years post-fellowship experience. Prior to data collection, ethical approval was secured. Eligible patients received an explanation of the study purpose, procedures, benefits and possible risks. All participants gave informed consent, and informed consent forms were obtained. As in the Declaration of Helsinki (18), participation was voluntary and confidentiality was ensured, without any implications for the clinical care of patients. The data was collected on a structured proforma including age, sex, BMI, duration of illness, socioeconomic status, residence, education, occupation, smoking, diabetes, hypertension, post-infarction heart failure, cardiogenic shock and outcome of PCI.

All proformas were checked for completeness and consistency prior to coding, entry, cleaning and statistical analysis procedures. The data was inputted and analyzed in IBM SPSS Statistics 21. A description of categorical variables was provided as frequencies and percentages. Normality of numerical variables was checked with Shapiro–Wilk test [19] and they were reported as mean and standard deviation or median and interquartile range. Stratification was used to control for potential effect modifiers. Pearson's chi-square test or Fisher's exact test were used to perform post-stratification associations with procedural outcome where cell frequencies were small [20]. A p-value < 0.05 (two-sided) was considered statistically significant and results were displayed in tables and figures.

3. Results

Descriptive statistics and normality test of the numerical variables that were included in the study are presented in Table 1. The mean age of the participants was 56.08 ± 10.21 years, the median age was 55.00 years and the interquartile range (IQR) was 49.00–63.50 years. The Shapiro–Wilk test was used to determine the normality of the data for age and was found to be approximately normally distributed with $W = 0.986$ and $p = 0.0999$. Thus, the age was summarized by means and standard deviations. The mean body mass index (BMI) was 27.03 ± 3.99 kg/m², with a median of 26.90 kg/m² and an IQR of 24.15–29.40 kg/m². The Shapiro–Wilk test indicated that BMI also was normally distributed ($W = 0.987$ and $p = 0.1500$). Thus, BMI is presented as mean ± SD. The median duration of illness before presentation was 6.70 hours (IQR 3.30 – 9.50 hours), and the mean was 6.80 ± 4.28 hours. The Shapiro–Wilk test showed that the data was significantly abnormal ($W = 0.954$, $p < 0.001$). Therefore, duration of illness was summarized by the use of median and interquartile ranges which were more appropriate for data that were not normally distributed.

Table 1. Descriptive statistics and Normality assessment of continuous variables.

Table 1. Numerical characteristics and normality assessment								
Age (years)	159.00	56.08	10.21	55.00	49.00–63.50	0.986	0.0999	56.08 ± 10.21
Body mass index (kg/m²)	159.00	27.03	3.99	26.90	24.15–29.40	0.987	0.1500	27.03 ± 3.99
Duration of illness (hours)	159.00	6.80	4.28	6.70	3.30–9.50	0.954	0.0000	6.70 (3.30–9.50)

This is the best as both demographic variables (gender, residence, education, occupation, socioeconomic status) and clinical variables (diabetes, hypertension, heart failure, cardiogenic shock, smoking history) are available on this table. Demographic and clinical parameters of 159 participants included in the study are summarized in Table 2. Most patients were male (78.0%) and 22.0% were female. The majority of the participants were from the middle socioeconomic class (47.8%), while 42.1% were from the lower socioeconomic status, and 10.1% were from the upper socioeconomic status. As for place of residence, 61.0% of the respondents came from rural areas while 39.0% came from urban areas. The education status was similar (61.0% educated and 39.0% are uneducated). The majority of participants were employed (71.1%) while 28.9% were unemployed. Diabetes mellitus was the most common clinical characteristic with a prevalence of 27.0% and hypertension was 42.8%. The percentage of participants with post-infarction heart failure was 14.5%, and 6.9% had cardiogenic shock. 40.9% of the patients reported a history of

smoking while 59.1% were non-smokers. In general, this study population was middle-aged and predominantly rural with a high prevalence of cardiovascular risk factors, including hypertension, smoking and diabetes mellitus.

Table 2. Demographic and Clinical data of the study subjects

Variables	**Category**	**Frequency**	Percentage
Gender	Male	124	78.0%
Gender	Female	35	22.0%
Socioeconomic status	Upper	16	10.1%
Socioeconomic status	Middle	76	47.8%
Socioeconomic status	Lower	67	42.1%
Residence area	Rural	97	61.0%
Residence area	Urban	62	39.0%
Education status	Educated	97	61.0%
Education status	Uneducated	62	39.0%
Occupation status	Employed	113	71.1%
Occupation status	Unemployed	46	28.9%
Diabetes	Yes	43	27.0%
Diabetes	No	116	73.0%
Hypertension	Yes	68	42.8%
Hypertension	No	91	57.2%
Post-infarction heart failure	Yes	23	14.5%
Post-infarction heart failure	No	136	85.5%
Cardiogenic shock	Yes	11	6.9%
Cardiogenic shock	No	148	93.1%
Smoking history	Yes	65	40.9%
Smoking history	No	94	59.1%

The relation between the success of primary percutaneous coronary intervention (PCI) and the patients' demographic and clinical features is shown in Table 3. In total, 153 patients (96.2%) had successful PCI and 6 patients (3.8%) had unsuccessful PCI. There were no significant associations between age group and procedural success ($p = 0.244$); success rates were slightly lower with age, at 100.0% for 18-45 years age group and 92.9% for age group 61-75 years. Gender ($p = 1.000$) and body mass index (BMI) ($p = 0.140$) also had no statistically significant relationship with PCI outcome. There was a significant association between the length of the illness and procedural success ($p = 0.030$). Patients presenting within 6 hours of symptom onset had successful PCI (100.0%) compared to those presenting after 6 hours (92.9%), which showed that delayed presentation was associated with poorer procedural outcomes. Diabetes mellitus was significantly associated with PCI outcome among clinical risk factors ($p = 0.006$). Patients with diabetes were less successful (88.4%) and more likely to fail the procedure (11.6%) than those without diabetes who were more successful with a success rate of 99.1%. Similarly, a significant association was also found between procedural outcome and post-infarction heart failure ($p = 0.004$). Patients without heart failure achieved a success rate of 98.5% while patients with heart failure achieved a success rate of only 82.6%. With regard to individual shock categories, the strongest association was found for cardiogenic shock (only 54.5% of patients with shock had successful PCI v. 99.3% of patients without shock). In contrast, hypertension ($p = 1.000$), smoking history ($p = 0.227$), socioeconomic status ($p = 0.149$), residence area ($p = 1.000$), education status ($p = 0.405$), and occupation status ($p = 1.000$) were not significantly associated with procedural success. In summary, delayed hospital presentation, diabetes mellitus, post-infarction heart failure and cardiogenic shock were found to be important predictors of unsuccessful primary PCI, while most of the demographic characteristics and baseline cardiovascular risk factors were not statistically associated with the outcome of PCI.

Table 3: Association of Baseline Characteristics with Procedural Success after Primary Percutaneous Coronary Intervention (PCI) (n = 159).

Variables	Category	Total n	Successful n (%)	Unsuccessful n (%)	p-value
Age group (years)	18–45	23	23 (100.0%)	0 (0.0%)	0.244
	46–60	80	78 (97.5%)	2 (2.5%)	
	61–75	56	52 (92.9%)	4 (7.1%)	
Gender	Male	124	119 (96.0%)	5 (4.0%)	1.000
	Female	35	34 (97.1%)	1 (2.9%)	
BMI category (kg/m²)	<25.0	51	47 (92.2%)	4 (7.8%)	0.140
	25.0–29.9	71	69 (97.2%)	2 (2.8%)	
	≥30.0	37	37 (100.0%)	0 (0.0%)	
Illness duration	≤6 hours	75	75 (100.0%)	0 (0.0%)	**0.030**
	>6 hours	84	78 (92.9%)	6 (7.1%)	
Diabetes	Yes	43	38 (88.4%)	5 (11.6%)	**0.006**
	No	116	115 (99.1%)	1 (0.9%)	
Hypertension	Yes	68	65 (95.6%)	3 (4.4%)	1.000
	No	91	88 (96.7%)	3 (3.3%)	
Post-infarction heart failure	Yes	23	19 (82.6%)	4 (17.4%)	**0.004**
	No	136	134 (98.5%)	2 (1.5%)	
Cardiogenic shock	Yes	11	6 (54.5%)	5 (45.5%)	**0.000**
	No	148	147 (99.3%)	1 (0.7%)	
Smoking history	Yes	65	61 (93.8%)	4 (6.2%)	0.227
	No	94	92 (97.9%)	2 (2.1%)	
Socioeconomic status	Upper	16	16 (100.0%)	0 (0.0%)	0.149
	Middle	76	75 (98.7%)	1 (1.3%)	
	Lower	67	62 (92.5%)	5 (7.5%)	
Residence area	Rural	97	93 (95.9%)	4 (4.1%)	1.000
	Urban	62	60 (96.8%)	2 (3.2%)	
Education status	Educated	97	92 (94.8%)	5 (5.2%)	0.405
	Uneducated	62	61 (98.4%)	1 (1.6%)	
Occupation status	Employed	113	109 (96.5%)	4 (3.5%)	1.000
	Unemployed	46	44 (95.7%)	2 (4.3%)	

The distribution of demographics and clinical parameters of the study population is shown in figure 2. Patients undergoing primary percutaneous coronary intervention (PCI) for ST-segment elevation myocardial infarction (STEMI) were mainly male (78.0%). Also, most of the participants were the same as the patient population served by the study center, which were rural residents (61.0%). Hypertension (42.8%) was the most prevalent cardiovascular risk factor followed by a smoking history (40.9%). Nearly one-quarter (27.0%) of participants presented with diabetes mellitus. As for acute clinical complications, acute cardiac failure was seen in 14.5% of cases and cardiogenic shock was seen in 6.9% of cases. While relatively uncommon, these complications are serious clinical problems which can affect procedural and clinical outcomes after primary PCI. In general, the study population had a high prevalence of cardiovascular risk factors, especially hypertension, smoking, and diabetes mellitus, and were predominantly male and rural. On the contrary, serious complications like heart failure and cardiovascular shock were rather rare but clinically significant due to their potential effect on the prognosis and treatment of the patient.

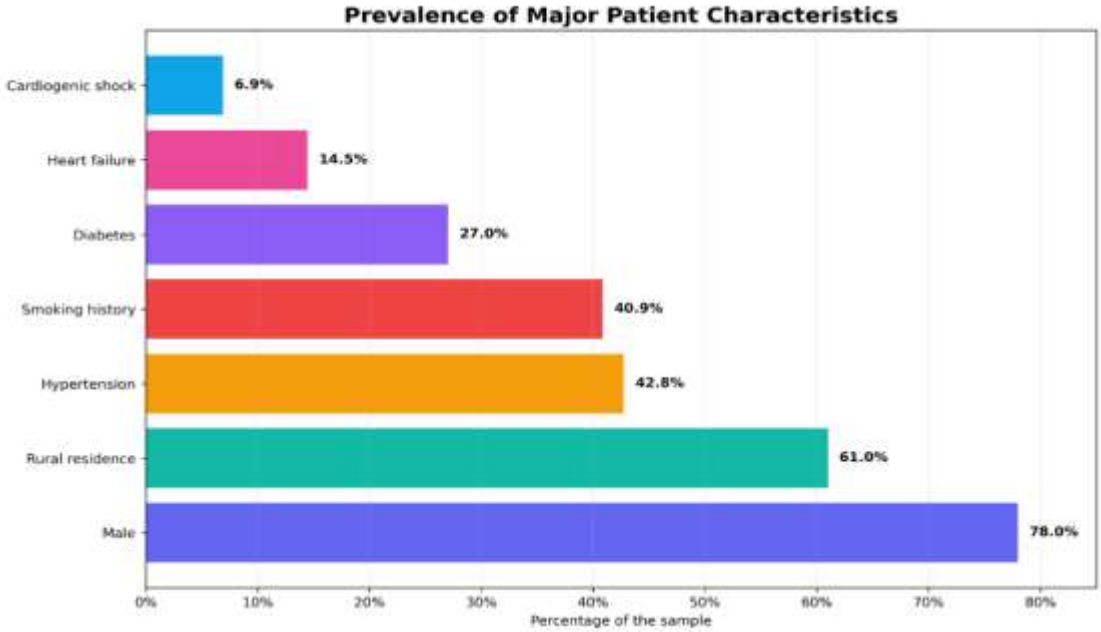


Figure 2: The major demographic and clinical characteristics of the study participants (n = 159)

The success rate of primary percutaneous coronary intervention (PCI) by age and body mass index (BMI) is shown in figure 3. Among the age groups, patients aged 18–45 years achieved a 100.0% procedural success rate (23/23), while those aged 46–60 years had a success rate of 97.5% (78/80). The success rate was slightly lower for those aged 61-75 years (92.9% (52/56)), indicating a possible decrease in procedural success with age. This difference was however not statistically significant ($p = 0.244$). Regarding BMI, patients with a BMI <25.0 kg/m² had a procedural success rate of 92.2% (47/51), whereas success increased to 97.2% (69/71) among those with a BMI of 25.0–29.9 kg/m². All patients with a BMI ≥30.0 kg/m² achieved successful PCI (100.0%, 37/37). However, the relations between BMI category and the success of the procedures was not statistically significant ($p = 0.140$). Overall, the figure shows consistently high rates of procedural success for all age and BMI groups. Primary PCI outcomes in the older patient population and in patients with lower BMI were less successful, although these differences were not statistically significant in this study.

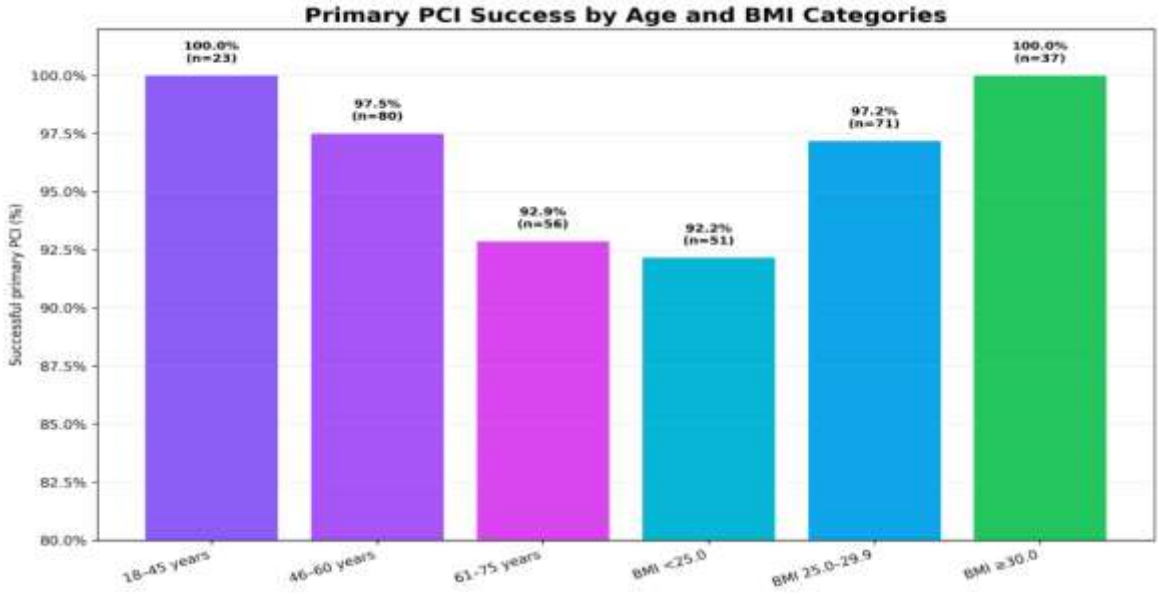


Figure 3: Primary Percutaneous Coronary Intervention (PCI) Success by age and BMI categories.

Figure 4 shows the rates of successful and unsuccessful primary percutaneous coronary intervention (PCI) by the key clinical factors found in this study. Patients who presented within 6 hours of symptom onset had a procedural success rate of 100.0%, while those who presented after 6 hours had a success rate of 92.9% and 7.1% who underwent PCI with unsuccessful result. This discovery underscores the detrimental impact of late presentation to hospital on the procedure. The same trend was seen in the case of diabetes mellitus. Overall, the success rate was very high (99.1% for non-diabetic patients, 88.4% for diabetic patients). Patients with diabetes had poorer procedural outcomes with unsuccessful PCI experiments (11.6%) compared with those without diabetes (0.9%). The presence of P-IHF was also related to lower procedural success. Success was 98.5% for patients without heart failure, significantly lower at 82.6% for heart failure patients. Thus, the percentage of failure rose from 1.5% in those without heart failure to 17.4% in those who did have heart failure. The biggest variation was seen in patients with cardiogenic shock. Patients without cardiogenic shock had a procedural success rate of 99.3%, with just 54.5% of patients with cardiogenic shock having successful PCI. Cardiogenic shock was the only clinical factor that was associated with lower procedural success (almost half of the patients with cardiogenic shock had unsuccessful procedures, 45.5%). Overall, the figure shows that delayed presentation (>6 hours), diabetes mellitus, post-infarction heart failure and cardiogenic shock were all associated with lower primary PCI success rates, with the lowest being observed in those with cardiogenic shock. These results highlight the critical need for timely admission and early recognition and treatment of the high-risk clinical situations associated with STEMI to achieve better procedural results.

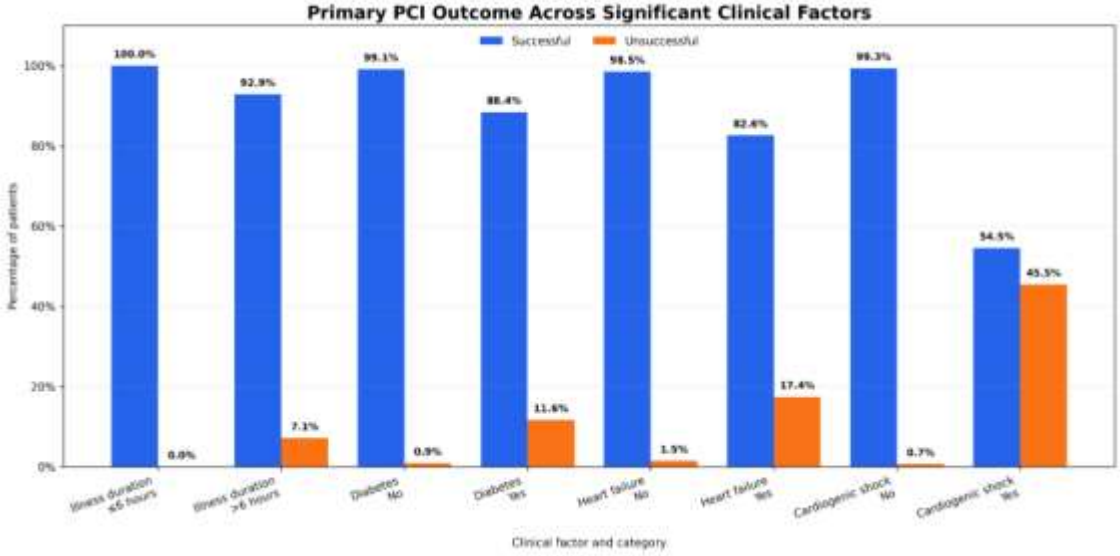


Figure 4: Primary Percutaneous Coronary Intervention (PCI) Outcomes by Significant Clinical Factors

4. Discussion

The present study showed that the primary percutaneous coronary intervention (PCI) success rate was very high (96.2%) with a residual stenosis of ≤30% and final TIMI grade III flow. This finding indicates that effective coronary reperfusion was accomplished in the overwhelming majority of patients. Other regional and international studies reported similar rates of procedural success (over 90%), but caution should be exercised when comparing these results directly, because procedural success varies according to patient characteristics, operator experience, complexity of the lesion, and institutional resources [21,22]. In Pakistan, Akhtar et al. found that final TIMI III flow was achieved in 80% of STEMI patients who underwent primary PCI, which is comparable to the present study [23]. Patients arriving after 6 hours of onset of symptoms had significantly reduced procedural success. This discovery is in line with the tried and tested principle of early reperfusion in STEMI treatment. Mechanical reperfusion is less effective if it is delayed, because the progressive maturation of the thrombus, the duration of myocardial ischemia, the development of microvascular obstruction, and the myocardial necrosis caused by the thrombus may occur. De Luca et al. found that each additional minute of delay from onset of chest pain to primary angioplasty resulted in an increased mortality rate, so that minimizing total ischemic time is important [24]. These results highlight the importance of better public awareness of the symptoms of myocardial infarction, timely electrocardiographic diagnosis, effective EMS and timely transfer to PCI facilities.

Another important predictor of unsuccessful PCI was diabetes mellitus. Diabetes could contribute to a reduced coronary blood flow supply to the myocardium even though epicardia coronary blood flow may be restored, through effects on diffuse coronary atherosclerosis, endothelial dysfunction, platelet activation and microvascular impairment. A recent systematic review also found that STEMI patients with abnormal glycemic status who received PCI had poor outcomes [25]. These results validate the need for a holistic evaluation of glycaemia and more frequent peril-procedural monitoring in diabetic patients with PCI.A lower procedural success was also seen in patients with heart failure after myocardial infarction. The patients that present with heart failure often have larger infarct size, left ventricular function deficits, and more extensive myocardial injury that are deleterious to coronary perfusion and clinical recovery. Heart failure (HF) at presentation has been consistently shown to be associated with prolonged hospital stay, major adverse cardiovascular event (MACE) and higher mortality after primary PCI in previous studies [23]. Thus, prompt detection and rapid treatment of ventricular dysfunction remains crucial in the treatment of STEMI. The strongest correlation with procedural outcome was with cardiogenic shock. A significantly lower PCI success rate was seen in nearly half of patients with shock compared to an excellent PCI success rate in patients without shock. This is biologically possible since cardiogenic shock is a reflection of severe myocardial damage, a decrease in cardiac output, systemic hypo perfusion, and impaired coronary microcirculation. According to recent evidence, despite the development of revascularization and critical care, myocardial infarction with cardiogenic shock has a death rate of around 40% in the short term [25]. Revascularization within a few minutes along with intensive hemodynamic support continues to be crucial for survival in these high risk patients.

There was no significant correlation between age, sex, BMI, hypertension, smoking status, socioeconomic status, education, residence or occupation. These results should be taken with a grain of salt since the number of procedures that failed was small, creating a low statistical power. Acute clinical presentation (delayed arrival to hospital) is more likely to affect procedural success than baseline demographic characteristics overall, the study shows. Improving regional STEMI systems, optimizing prehospital delays, encouraging early identification of high-risk presentations, and expedite access to primary PCI could enhance clinical results, especially in low-resource health systems.

5. Conclusion

This study revealed that primary percutaneous coronary intervention (PPCI) had high procedural success rate in patients with acute ST-segment elevation myocardial infarction (STEMI) at Said Sharif Medical College and Teaching Hospital. The final TIMI grade III distal flow was reached in most patients with residual coronary stenosis of 30% or less demonstrating good restoration of epicardia coronary perfusion. The results confirm that primary PCI is the preferred reperfusion strategy in eligible patients with STEMI if it can be timely performed by an experienced interventional cardiology team.

Failure of the procedure was significantly associated with illness duration >6 hours, diabetes mellitus, post-infarction heart failure and cardiogenic shock. Of these, cardiogenic shock had the highest correlation with failure, highlighting the importance of early hemodynamic stabilization, the prompt activation of the catheterization-laboratory and coordinated intensive care. Delayed presentation with worse outcome continues to support the importance of limiting total ischemic time through public education, prompt awareness of myocardial infarction symptoms, early electrocardiographic diagnosis, effective referral mechanisms and rapid transport to PCI equipped centers. There were no statistically significant relationships between procedural outcome and age, sex, body mass index, hypertension, smoking, social class, living area, educational or occupational status. But these results should be taken with a pinch of salt as there were relatively few failed procedures, and the statistical power of the subgroup comparisons may have been limited.

In general, the study shows the positive angiographic results of primary PCI in a tertiary-care center in a region of the country. Enhancing STEMI networks, optimizing prehospital pathways and prioritizing high-risk diabetes patients with heart failure and cardiogenic shock could further increase procedural success and decrease morbidity and mortality. The results of the current study can only be confirmed by larger multicenter prospective study and should assess short term and long term clinical outcomes of successful reperfusion and also look into other factors involved in a successful reperfusion in Pakistanis with STEMI in different regional health care settings.

References

1. Di Cesare M, McGhie DV, Perel P, Mwangi J, Taylor S, Pervan B, et al. The heart of the world. Glob Heart. 2024;19(1):11.
2. Roth GA, Johnson C, Abajobir A, Abd-Allah F, Abera SF, Abyu G, et al. Global, regional, and national burden of cardiovascular diseases for 10 causes, 1990 to 2015. J Am Coll Cardiol. 2017;70(1):1-25.
3. Thygesen K, Alpert JS, Jaffe AS, Chaitman BR, Bax JJ, Morrow DA, et al. Fourth universal definition of myocardial infarction. J Am Coll Cardiol. 2018;72(18):2231-64.

4. Byrne RA, Rossello X, Coughlan JJ, Barbato E, Berry C, Chieffo A, et al. 2023 ESC guidelines for the management of acute coronary syndromes. Eur Heart J. 2023;44(38):3720-826.
5. Rao SV, O'Donoghue ML, Ruel M, Rab T, Tamis-Holland JE, Alexander JH, et al. Guideline for the management of patients with acute coronary syndromes. Circulation. 2025;151(13):e771-e862.
6. Terkelsen CJ, Sørensen JT, Maeng M, Jensen LO, Tilsted HH, Trautner S, et al. System delay and mortality among patients with STEMI treated with primary percutaneous coronary intervention. JAMA. 2010;304(7):763-71.
7. Menees DS, Peterson ED, Wang Y, Curtis JP, Messenger JC, Rumsfeld JS, et al. Door-to-balloon time and mortality among patients undergoing primary PCI. N Engl J Med. 2013;369(10):901-9.
8. Yanamala CM, Bundhun PK, Ahmed A. Comparing mortality between fibrinolysis and primary percutaneous coronary intervention in patients with acute myocardial infarction: a systematic review and meta-analysis. Coron Artery Dis. 2017;28(4):315-25.
9. Kammler J, Kypta A, Hofmann R, Kerschner K, Grund M, Sihorsch K, et al. TIMI 3 flow after primary angioplasty is an important predictor for outcome in patients with acute myocardial infarction. Clin Res Cardiol. 2009;98(3):165-70.
10. Varenhorst C, Lindholm M, Sarno G, Olivecrona G, Jensen U, Nilsson J, et al. Stent thrombosis rates with new- and old-generation drug-eluting stents compared with bare-metal stents. Clin Res Cardiol. 2018;107(9):816-23.
11. Dubey G, Verma SK, Bahl VK. Primary percutaneous coronary intervention for acute ST elevation myocardial infarction: outcomes and determinants of outcomes. Indian Heart J. 2017;69(3):294-8.
12. Samore NA, Khalil H, Aziz S, Hussain F, Abbas S, Fazal I. Procedural outcomes of primary percutaneous coronary interventions in patients with ST-segment elevation myocardial infarction. Pak Armed Forces Med J. 2022;66(Suppl 1):S80-5.
13. Akhtar A, Saleemi MS, Zarlish QM, Arshad MB, Hashmi KA, Ghafoor H. Experience and outcomes of primary percutaneous coronary intervention in a tertiary care hospital in South Punjab, Pakistan. Cureus. 2023;15(12):e50024.
14. von Elm E, Altman DG, Egger M, Pocock SJ, Gøtzsche PC, Vandenbroucke JP; STROBE Initiative. The Strengthening the Reporting of Observational Studies in Epidemiology statement: guidelines for reporting observational studies. Ann Intern Med. 2007;147(8):573-7.
15. Lwanga SK, Lemeshow S. Sample size determination in health studies: a practical manual. Geneva: World Health Organization; 1991.
16. Gibson CM, Cannon CP, Murphy SA, Marble SJ, Barron HV, Braunwald E. Relationship of the TIMI myocardial perfusion grades, flow grades, frame count, and percutaneous coronary intervention to long-term outcomes after thrombolytic administration in acute myocardial infarction. Circulation. 2002;105(16):1909-13.
17. World Medical Association. World Medical Association Declaration of Helsinki: ethical principles for medical research involving human participants. JAMA. 2025;333(1):71-4.
18. Shapiro SS, Wilk MB. An analysis of variance test for normality: complete samples. Biometrika. 1965;52(3-4):591-611.
19. Fisher RA. On the interpretation of χ^2 from contingency tables, and the calculation of P. J R Stat Soc. 1922;85(1):87-94.
20. Shah SM, Ali J, Khan KA, Rahim T, Shah T, Shah HA, et al. Procedural success and in-hospital outcomes of primary percutaneous coronary intervention in ST-elevation myocardial infarction: a retrospective cohort study. Pak J Cardiovasc Interv. 2025;5(2):55-64.
21. Beig JR, Shah TR, Hafeez I, Dar MI, Rather HA, Tramboo NA, et al. Clinico-angiographic profile and procedural outcomes in patients undergoing percutaneous coronary interventions: the Srinagar registry. Indian Heart J. 2017;69(5):589-96.
22. De Luca G, Suryapranata H, Ottervanger JP, Antman EM. Time delay to treatment and mortality in primary angioplasty for acute myocardial infarction: every minute of delay counts. Circulation. 2004;109(10):1223-5.
23. Yan F, Zhang Y, Pan Y, Li S, Yang M, Wang Y, et al. Prevalence and associated factors of mortality after percutaneous coronary intervention for adult patients with ST-elevation myocardial infarction: a systematic review and meta-analysis. J Res Med Sci. 2023;28:17.
24. Elkammash A, Abdelhamid M, Sobhy M, Zaki A, Sadaka M, Alsinan M, et al. The association between admission heart failure and in-hospital outcomes in ST-elevation myocardial infarction patients undergoing primary percutaneous coronary intervention. Cardiol Res. 2022;13(4):236-41.
25. Samsky MD, Morrow DA, Proudfoot AG, Hochman JS, Thiele H, Rao SV. Cardiogenic shock after acute myocardial infarction: a review. JAMA. 2021;326(18):1840-50.