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Original Article

Investigation of the clinical outcomes of primary angioplasty in hospitalized patients with ST-segment elevation acute myocardial infarction, Imam Reza Hospital, Mashhad, 1399-1401

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ABSTRACT

Introduction: Ischemic heart disease (IHD) continues to be a prominent global health issue, significantly affecting patient mortality and life expectancy. Vascular reconstruction techniques, including coronary artery bypass grafting (CABG) and percutaneous coronary intervention (PCI), are essential in the management of ischemic heart disease (IHD).

Method: In this study conducted at Imam Reza Hospital, 103 patients with MI-STE who underwent PCI were evaluated. The study cohort consisted of 84 men and 19 women, with varying age ranges. A subset of patients had a history of CABG, addiction, or a family history of heart disease. The overall population experienced a low mortality rate of 1.9%.

Result: The predominant stents utilized were Supraflex and Xience, with the majority measuring ≤20 mm in length and 2.75 mm in diameter. Post-PCI complications encompassed hematoma at the angiography site, rehospitalization, coronary artery revascularization, contrast-induced nephropathy (CIN), no reflow phenomenon, in-stent restenosis (ISR), coronary artery dissection, and cardiogenic shock. Cardiogenic shock was markedly correlated with death, presenting a 100-fold elevated risk.

Conclusion: This study highlights how crucial it is to carefully monitor and manage complications after PCI to improve patient recovery and reduce the chances of mortality in those with ischemic heart disease (IHD). More research is needed to find better prevention strategies and improve treatments for these patients.

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Introduction

The high number of individuals affected by IHD in today's societies indicates its importance. It is estimated that 15,400,000 Americans are affected by IHD, with 7,800,000 of them being male and 7,600,000 having a history of MI. According to data from the Framingham study, the lifetime risk of developing IHD in men without risk factors is 3.6%, and in women it is 1%. In individuals with two or more major risk factors, this risk increases to 37.5% in men and 18.3% in women. IHD accounts for 46% of all deaths due to cardiovascular diseases and is the leading cause of death in American men and women. Despite a decreasing trend in CAD mortality in recent decades, IHD remains the primary cause of death worldwide[1].

The risk factors for IHD can be broadly divided into two categories: modifiable (controllable) and non-modifiable (uncontrollable). Factors such as obesity, diabetes, high blood pressure, and high cholesterol levels are included in modifiable risk factors, while age, gender, race, and family history are categorized as non-modifiable risk factors. In a study, 85.6% of patients with myocardial infarction showed at least one of the 5 controllable CHD risk factors, while 14.4% had none of the 5 risk factors[2].

The World Health Organization (WHO) projects that the mortality rate from ischemic heart disease would rise from 7.2 million deaths in 2012 to 9.2 million by 2030. Despite progress in diagnosis and therapies, STEMI remains a significant global public health challenge. In the United States, more than one million individuals are hospitalized each year owing to STEMI. Although the incidence of myocardial infarction hospitalizations has diminished in those over 55, this pattern is not evident in younger demographics, particularly women[3]. The American Heart Association (AHA) indicates a short-term death rate for STEMI of 5-6% during hospitalization and 17-18% within the first year. The greatest risk of ischemia problems arises within the initial 180 days. The decline in STEMI mortality is mostly ascribed to therapies like reperfusion therapy, which encompasses coronary thrombolysis, intravenous thrombolysis, and percutaneous coronary intervention (PCI)[4].

The European Society of Cardiology has set a goal to reduce non-communicable diseases, particularly coronary artery disease, by 2025[5]. Coronary artery disease is the most common chronic disease in Iran, affecting 21% of the population[6]. The incidence in Iran is higher than in Western countries, with 35,000 to 50,000 cardiac procedures performed annually and over 90,000 deaths attributed to it each year[7]. This rate is rising, with coronary artery disease now accounting for 46% of all deaths in individuals over 35[8, 9].

The management of persons with coronary artery disease includes risk factor reduction, pharmacological therapy, and vascular repair. Vascular reconstruction encompasses coronary artery bypass grafting and percutaneous coronary intervention (PCI). Although pharmacological therapy is the principal treatment for patients with ischemic heart disease, numerous individuals may be managed via percutaneous coronary intervention. Coronary intervention technology, employing percutaneous angioplasty and stenting, is a significant medical innovation, offering an innovative treatment alternative for several individuals with coronary artery disease instead of coronary artery bypass surgery. The management of ST-segment elevation myocardial infarction (STEMI) has shifted from pharmacological reperfusion to catheter-based reperfusion, leading to enhanced short-term and long-term results, diminished recurrence, and decreased mortality[10].

Coronary angiography and balloon angioplasty were initially offered in the late 1970s. Initially, balloon angioplasty without stent insertion resulted in elevated rates of restenosis and arterial dissection. In 1986, the first coronary stent was inserted, providing a method to occlude diseased segments and prevent reocclusion, resulting in superior outcomes compared to balloon angioplasty alone. As a result, coronary stents have emerged as the predominant treatment for coronary artery disease. Nonetheless, balloon angioplasty continues to exhibit an elevated risk of in-stent restenosis (ISR) attributable to neointimal hyperplasia, migration, and smooth muscle proliferation. A study identified an ISR rate of 10-20% within six months, potentially leading to myocardial infarction and angina, frequently necessitating revascularization.[11].

Percutaneous coronary intervention (PCI) is the principal technique for enhancing myocardial perfusion. Numerous specialists anticipate that angioplasty will ultimately supplant open-heart surgery as the favored therapy modality[12]. A study revealed that patients who underwent angioplasty perceived it as a transformative experience, which enhanced their quality of life and enabled them to return to normal activities. Coronary angioplasty provides significant advantages, although it also entails dangers inherent to any invasive surgery[10]. Significant problems after coronary angioplasty included recurrent angina, myocardial infarction, coronary artery restenosis, repeat coronary bypass surgery, and mortality. The mortality rate following ST-segment elevation in patients with stable angina and myocardial infarction is

5%, escalating to 30-35% in those undergoing cardiogenic shock[13].

The increasing application of contrast media-dependent coronary angiography techniques has led to a higher incidence of contrast-induced nephropathy (CIN). CIN is a major contributor to acquired renal impairment in hospitals, presenting both immediate and prolonged hazards. CIN may arise during emergency PCI for multiple causes. A recent investigation has demonstrated that contrast-induced nephropathy (CIN) is a recurrent complication in emergency percutaneous coronary intervention (PCI) for acute myocardial infarction. The significance of contrast-induced nephropathy (CIN) following emergency percutaneous coronary intervention (PCI) in individuals with acute coronary syndrome (ACS) remains under-researched.[14, 15]. Despite significant advancements in detection and treatment, STEMI remains a major public health issue in numerous countries. Approximately one million individuals in the United States are admitted to the hospital each year due to STEMI. The hospitalization rate for myocardial infarction has decreased in persons over 55, although this trend is not observed in younger patients, especially women[16]. The substantial decrease in mortality among STEMI patients is chiefly ascribed to reperfusion therapy, encompassing intracoronary fibrinolysis, intravenous thrombolysis, and advancements in PCI procedures[17]. Seventeen Research indicates that reperfusion therapy administered within the first 6 hours following myocardial infarction significantly reduces mortality rates[18]. Consequently, problems that occur after angioplasty have a significant impact on patient mortality and life expectancy. Angioplasty is a minimally invasive and more economical intervention relative to coronary artery bypass surgery. Before 1977, bypass surgery was the exclusive treatment for coronary artery disease; however, angioplasty has subsequently emerged as the predominant method.[19]. Although metallic stents reduce the likelihood of restenosis compared to balloon angioplasty alone, restenosis still occurs in 20-30% of patients, and total blockage occurs in 10-15% of instances within the initial year of treatment. Restenosis with non-drug-eluting stents frequently occurs in individuals with narrow arteries, extensive lesions, and diabetes; interventions such as pharmacotherapy in conjunction with stent insertion can partially mitigate restenosis.[20].

One of the risks following stent implantation is stent thrombosis, which is categorized as acute (occurring within 24 hours), subacute (occurring between 24 hours and 30 days), and late (occurring after one year). Clinical factors such as diabetes, kidney failure, heart failure, acute myocardial infarction, and lesion-related factors (length, location, vessel diameter), as well as procedural factors (technique used, physician expertise, presence of residual dissection in the stent), play a significant role in the occurrence of stent thrombosis[21].

Factors associated with increased mortality risk encompass advanced age, diabetes mellitus, heart failure, renal failure, involvement of many coronary arteries, and concomitant conditions[22]. Strong evidence suggests that the early initiation of treatment within the first hour is associated with lower mortality rates. Patients undergoing primary angioplasty experience fewer clinical complications within 30 days and 6 months post-myocardial infarction compared to those treated with thrombolytic therapy[18, 23].

Research indicates that persons with preexisting conditions, such as diabetes, who undergo primary angioplasty after myocardial infarction are at increased risk of mortality, recurrent myocardial infarction, and stent thrombosis; however, this may not be associated with the kind of stent used. Patients using drug-eluting stents (DES) during angioplasty have a lower requirement for repeat revascularization compared to those treated with bare-metal stents (BMS). 40-60% of patients with ACS-NSTE have multivessel involvement on angiography, for which the ACC/AHA recommends PCI for multivessel treatment.[24]. The implementation of multivessel PCI has improved clinical outcomes for patients and reduced the need for emergency revascularization. Nonetheless, it is linked to heightened risks of periprocedural myocardial infarction, stent thrombosis, bleeding, and contrast-induced nephropathy. [25, 26]. Stroke is a major complication of revascularization. The occurrence of stroke in the first 30 days following PCI is reduced relative to CABG, and the overall risk of stroke after 5 years continues to be lower in patients undergoing PCI. However, there is no significant difference in stroke risk between PCI and CABG from 31 days to 5 years.[27].

Despite the application of numerous therapy modalities for patients with coronary artery abnormalities, an agreement on the optimal approach remains elusive. Some cardiologists favor coronary artery angioplasty as an invasive treatment method, taking into account risk variables that influence problems in patients to ascertain the optimal treatment strategy.

Materials and Methods

The study was conducted at the Cardiology Department of Imam Reza Hospital in Mashhad from 1399 to 1400.

The researcher-developed questionnaire was administered following the established admission and exit criteria, employing data obtained from the patients' records after securing informed consent. The data included age, gender, left ventricular ejection fraction (LVEF), comorbidities, vascular access (radial or femoral), involved vessel, lesion type, complications related to percutaneous coronary intervention (PCI) (hematoma, access site complications, stent thrombosis, cardiogenic shock, tamponade, coronary dissection, arrhythmia, contrast-induced nephropathy, stroke, and mortality during PCI), stent characteristics (type, length, diameter), reasons for unsuccessful PCI and no-reflow phenomena, and catheter engagement. This retrospective cohort study was conducted on patients with STEMI undergoing PPCI at Imam Reza Hospital in Mashhad from 2019 to 2021. All patients meeting the inclusion criteria were included in the experiment, and data were collected for analysis using SPSS software. Descriptive statistics were presented, with continuous variables represented as mean ± standard deviation. A significance level of $\alpha = 0.05$ was used. The study included all STEMI patients who had PPCI and met the inclusion criteria from 2019 to 2021. Patient data were available for a minimum period of 24 months. The exit criteria were refusal to participate in the experiment, inadequate patient documentation, and insufficient follow-up information. The study examined variables including demographic details, left ventricular ejection fraction (LVEF), history of coronary artery bypass grafting (CABG), type of vascular access (radial, ulnar, femoral), balloon angioplasty, number of affected vessels (one, two, or three), type of affected vessels (LAD, LCx, RCA, OM, PDA, SVG), type of stent employed (Xience, Firehawk, Biomatrix, etc.), stent length (≥20mm or <20mm), stent diameter (2.25mm, 2.5mm, etc.), and procedural details. A local anesthetic was provided during angiography and stent placement. All patients underwent antiplatelet treatment and dual antiplatelet therapy following PCI. Subsequent appointments were scheduled at regular intervals post-PCI for the monitoring and evaluation of any potential issues. Data about post-PCI complications, death, and cardiogenic shock were collected and analyzed using SPSS software over a two-year follow-up period. This research utilized a retrospective cohort design. All STEMI patients who received PPCI and met the inclusion criteria were included in the study from 2020 to 2022. The data were gathered and input into SPSS software for analysis. Descriptive statistics were provided, with continuous variables expressed as mean ± standard deviation. A significance level of $\alpha=0.05$ was employed.

Result

This study was conducted on 103 patients with MI-STEMI referred to Imam Reza Hospital for PCI. In total, there were 84 male patients (81.6%) and 19 female patients (18.4%), with 23 patients (22.3%) in the age range of 30 to 50 years, 64 patients (62.1%) in the age range of 51 to 70 years, and 16 patients (15.5%) equal to or older than 71 years. Additionally, 2 patients (1.9%) had a history of CABG, 33 patients (32%) had a history of addiction, and 9 patients (8.7%) had a family history of heart disease (see Table 1).

Table 1: Demographic information of patients with STE-MI

Property		Number	Percent
Sex	Male	84	81.6
	Female	19	18.4
Age	30-50	23	22.3
	51-70	64	62.1
	71≤	16	15.5
BMI	18.6-24.9	49	47.6
	25-29.9	44	42.7
	30≤	10	9.7
History	No history of illness	37	35.9
	(DM)	9	8.7
	(HTN)	22	21.4
	(DLP)	3	2.9
	DM+HTN+DLP	11	10.7
	HTN + lung disease	4	3.9
	HTN + DLP	3	2.9
	DM + HTN	11	10.7
	DM+HTN+DLP+Stroke	3	2.9
EF	40% ≤	38	36.9
	30-39 %	42	40.8
	30%≥	23	22.3

The results and attributes of angioplasty, stent placement, and balloon dilation conducted during angiographies are compiled and displayed in the table below (Table 2).

Table 2: Frequency of angiography findings and stents and coronary access location in patients with STE-MI

Percent	Number	property	
92.2	95	**Performing angioplasty with a balloon**	
45.6	47	Femoral	**Access artery**
54.4	56	Radial	
36.9	38	SVD	**Number of involved coronary arteries**
35.9	37	2VD	
27.2	28	3VD	
58.3	60	LAD	**Type of involved vein**
5.8	6	LCX	
25.2	26	RCA	
6.8	7	OM	
2.9	3	PDA	
1	1	SVG	
30.1	31	Xience	**Type of implanted stent**
12.6	13	Firehawk	
3.9	4	Biomime	
5.8	6	CRE8	
5.8	6	Angiolitte	
33	34	Supraflex	
3.9	4	Biomatrixi	
1.9	2	Evermime	
2.9	3	Onyx	
38.8	40	20 mm>	**Length of stent**
61.2	63	20 mm≤	
1.9	2	2.25mm	**Diameter of stent**
8.7	9	2.5mm	
64.1	66	2.75mm	
20.4	21	3.5mm	
4.9	5	4mm	

Table 3 displays the outcomes and complications of stent insertion and balloon dilation, as assessed both clinically and electrocardiographically, along with the associated mortality rates. A mortality rate of 1.9% was observed in the studied population.

Logistic regression analysis was performed to identify factors influencing mortality following angioplasty. The results indicated that only cardiogenic shock significantly increased the mortality rate by 100 times ($p = 0.008$). These four variables explained between 11% and 68% of the variation in the mortality rate. The model correctly classified 98% of all variables (Table 4).

Due to the non-normal distribution of the data, the Kolmogorov-Smirnov test was applied as a non-parametric method for comparison.

Table 3: Results and complications of angioplasty in patients with STE-MI

Percent	Number	Complications/results	
5.8	6	**Rehospitalization**	
5.8	6	**Revascularization**	
6.8	7	**Hematoma at the site of angiography**	
87.4	90	**ST Resolution>50%**	
97.1	100	without thrombosis	**Stent thrombosis**
1.9	2	Acute thrombosis	
1	1	Subacute thrombosis	

2.9	3	**In Stent Restenosis**
8.7	9	**Multi-vessel PCI**
0	0	**Stroke**
0	0	**Coronary perforation**
4.9	5	**No Reflow**
2.9	3	**Coronary artery dissection**
5.8	6	**Contrast-Induced Nephropathy (CIN)**
1.9	2	**Cardiogenic shock**
1.9	2	**Mortality**

Table 4: Factors affecting mortality after angioplasty in patients with STE-MI

p value	EXP(B)	Odds ratio (95% CI)	B	SE	Wald	variable
0.59	2.15	2.15(0.13-35.57)	0.76	1.43	0.28	Addiction
0.94	1.01	1.01(1.45-0.7)	0.013	0.18	0.005	History
0.2	5.12	5.12(64-0.41)	1.63	1.28	1.6	Age
0.008	100	100(2997-3.33)	4.6	1.73	7.04	Cardiogenic shock

Based on Table 5, there is no significant relationship ($p > 0.05$) between the type of arterial access, stent length, stent diameter, and PCI vessel multiple and CIN.

Table 5: Comparison of various parameters related to stent and CIN in patients with STE-MI

P VALUE	CIN	Property	
0.82	3(6.4%)	**Femoral**	**Access Artery**
	3(5.4%)	**Radial**	
0.77	2(5%)	**۲۰mm>**	**Length of stent**
	4(6.3%)	**20 mm≤**	
0.55	0(0%)	**2.25mm**	**Diameter of stent**
	1(11.1%)	**2.5mm**	
	4(6.1%)	**2.75mm**	
	1(4.8%)	**3.5mm**	
	0(0%)	**4mm**	
1	0(0%)		**Multi-vessel PCI**
1	0(0%)		**Hematoma**

The correlation between the variable Major Adverse Cardiac Events (MACE), encompassing death, stroke, and recurrent myocardial infarction, was assessed against numerous factors utilizing the Spearman test. Only Reflow did not show a significant correlation with MACE ($P = 0.01$). The correlation between stent diameter and length with angiographic problems was analyzed, and no association was identified in the whole population with coronary perforation. Additional variables, including Reflow No. Coronary dissection showed no significant correlation with stent diameter and length, as determined by the Spearman test ($P > 0.05$). Furthermore, the clinical response (Resolution ST >50%) exhibited no significant correlation with the type of affected artery or the multiplicity of PCI vessels ($p > 0.05$). Additional factors analyzed included the type of arterial access and its association with hematoma incidence, revealing a correlation coefficient of -0.062 and a p-value of 0.53, indicating no statistically significant relationship with hematoma occurrence (Table 6).

Table 6: Correlation of MACE with various stent variables and angiographic complications

P VALUE	The correlation	Property
0.53	-0.062	**Access Artery**
0.28	-0.106	**Length of stent**
0.12	0.152	**Diameter of stent**
0.33	-0.09	**Multi vessels PCI**
0.79	-0.025	**Age**

0.4	-0.084	**Hematoma**
0.01	0.25	**No Reflow**
0.12	0.151	**Coronary artery dissection**
0.48	0.07	**Contrast Induced Nephropathy (CIN)**

Discussion

This study assesses clinical outcomes and procedural problems in 103 patients with ST-segment elevation myocardial infarction (STEMI) who received primary percutaneous coronary intervention (PPCI) at a tertiary referral institution. Our data indicate a promising in-hospital mortality rate of merely 1.9%, which is favorable compared to previously reported short-term mortality rates of 5–7% for STEMI patients undergoing PPCI, as recorded by the American Heart Association (AHA) and other extensive registries[4, 16]. A notable observation was the significant predominance of male patients (81.6%), aligning with global STEMI epidemiology, which indicates a higher frequency in men, particularly within middle-aged demographics. [1, 3]. A majority of patients (62.1%) were aged between 51 and 70 years, with the left anterior descending (LAD) artery being the most frequently affected, corroborating existing research that identifies LAD as the predominant culprit in acute anterior infarctions. [13, 17].

A high rate of angiographic success was achieved, with ST resolution of more than 50% observed in 87.4% of patients, indicating effective myocardial reperfusion. This correlates with improved short-term outcomes and reduced myocardial damage, reinforcing prior evidence that early reperfusion is a key determinant in improving STEMI prognosis[18].

The low incidence of in-stent restenosis (2.9%), stent thrombosis (2.9%), and contrast-induced nephropathy (CIN) (5.8%) observed in our cohort is notable. These outcomes may be attributable to the predominance of drug-eluting stents (DES) such as Supraflex and Xience, known to reduce neointimal hyperplasia and restenosis compared to bare-metal stents[2, 11]. Interestingly, neither the stent diameter nor length was statistically associated with major adverse cardiac events (MACE), suggesting that procedural and patient-related factors likely play a larger role than stent morphology alone—a point echoed in trials like ZEST and DESERT[2, 24].

Despite the overall favorable outcomes, cardiogenic shock emerged as the only statistically significant predictor of mortality (p=0.008), increasing the odds of death by 100-fold. This stark association aligns with literature citing mortality rates exceeding 30–50% in STEMI patients complicated by cardiogenic shock, despite timely revascularization[13, 16].

No statistically significant correlation was observed between CIN and stent characteristics, access route, or the number of vessels treated. While this aligns with some recent findings, it is important to note that larger studies have identified pre-existing renal dysfunction and contrast volume as critical contributors to CIN[14, 15]. The radial access approach was utilized in more than half of the procedures (54.4%), a shift consistent with current trends favoring radial access due to its association with lower bleeding risks and vascular complications without compromising procedural efficacy[12]. However, in our cohort, access site did not significantly correlate with hematoma occurrence or MACE—possibly due to procedural standardization and operator expertise in both radial and femoral approaches.

Finally, the relatively low rate of multivessel PCI (8.7%) suggests a cautious, staged approach in hemodynamically stable patients, in line with guideline recommendations emphasizing complete revascularization in selected cases[25, 26]. However, multivessel PCI did not show a significant impact on MACE in our dataset, reaffirming the need for individualized decision-making in complex coronary anatomy.

Conclusion

In conclusion, our findings underscore the effectiveness and safety of PPCI in managing STEMI, particularly when complications like cardiogenic shock are promptly addressed. While the mortality rate was low, the data reiterate the critical importance of early shock recognition and intervention. These findings contribute to the growing body of regional and international data supporting PPCI as the cornerstone of STEMI management.

Limitations

The primary constraint of this study was its observational design. The effect of therapies such as IIIa/GPIIb inhibitors, aspirin, thrombolytic agents, and IABP on mortality prevention cannot be evaluated without randomization. Furthermore, as this study was conducted at a single major tertiary care institution, the findings may not apply to smaller facilities with lower patient volumes. Moreover, the study's long-term

results are uncertain, as no follow-up was conducted beyond a two-year period.

Notwithstanding efforts to account for confounding variables, residual confounding may still affect the results. Selective biases within the study population were inadequately addressed in patients receiving revascularization. Consequently, the findings are confined to hospital outcomes and do not provide insight into long-term impacts. Furthermore, we could not assess variables including stages of cardiogenic shock, balloon-to-door time for STEMI patients, and timing of revascularization, all of which may have influenced the observed outcomes.

Consent for Publication

Written informed consent was obtained from the patient to publish clinical data.

Ethics Approval and Consent to Participate

This thesis was conducted based on the research proposal number 4000176, approved on 11/12/1400, and the ethical committee approval number IR.MUMS.MEDICAL.REC.1400.808 dated 1400/12/04, entitled "Evaluation of Clinical Outcomes of Primary Angioplasty in Hospitalized Patients with Acute Myocardial Infarction with ST-Segment Elevation at Imam Reza Hospital, Mashhad, 1399-1401."

Authors' contributions

Data collection: O. Kh., M. M. Sh. Y., Data analysis and interpretation: O. Kh., M. M. Sh. Y., Manuscript writing: O. Kh., M. M. Sh. Y., Manuscript revision: O. Kh., M. M. Sh. Y. All authors approved the final version of the manuscript

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Data Availability Statement

Data on personnel requests can be accessed from the corresponding author.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

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