DOOR-TO-BALLOON TIME AND CARDIOVASCULAR OUTCOMES IN PATIENTS WITH ST-ELEVATION MYOCARDIAL INFARCTION TREATED WITH PRIMARY PERCUTANEOUS INTERVENTION

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ABSTRACT

Background

Primary percutaneous coronary intervention (PCI) is the preferred reperfusion strategy in patients with ST-elevation myocardial infarction (STEMI) within 12 hours of symptom onset, provided it can be performed expeditiously (i.e., 120 min from STEMI diagnosis) by an experienced team. A professional team includes not only interventional cardiologists but also skilled support staff. Lower mortality rates among patients undergoing primary PCI are observed in centres with a high volume of PCI procedures. In addition, door-to-balloon time became an indicator of the quality of care in STEMI patients treated with primary PCI.

Objectives

To evaluate the impact of door-to-balloon time delay on cardiovascular outcomes in patients with STEMI.

Methods

Prospective cohort study of door-to-balloon time (DTB) delay and adverse cardiovascular outcomes in patients with STEMI treated with primary PCI.

Results

About 65% (n=131) of patients were free from adverse outcomes with a Mean door-to-balloon time of 92 minutes vs adverse effects (left ventricular dysfunction or angina) happened in 26% (n=52) with a mean door-to-balloon time of 168 minutes and death in 8% (n=16) with a mean time of 114 minutes (P=0.001). Similar results were found with symptom onset-to-balloon time, no adverse outcomes with a mean symptom onset-to-balloon time of 11.98 hours compared to 22 hours with adverse effects and deaths;(p=0.004.)

Conclusion

Any delay in door-to-balloon time or symptom onset-to-balloon time in patients with ST-elevation myocardial infarction is associated with higher morbidity and mortality rate.

Keywords: *Door-to-balloon time, Primary percutaneous coronary intervention, ST-segment elevation, Myocardial infarction.*

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INTRODUCTION

Coronary reperfusion with primary percutaneous coronary intervention (PCI) improves outcomes in patients with acute ST-elevation myocardial infarction (STEMI) or an MI with a new or presumably new left bundle branch block or an accurate posterior MI if performed within 12 hours of symptom onset and those with later arrival who have ongoing ischemia, HF, or shock [1-3].

The main goals of treatment in acute myocardial infarction are to limit myocardial damage by restoring myocardial blood flow as quickly as possible and decreasing subsequent remodelling, which can have unfavourable effects on ventricular function and prognosis[4].

When STEMI diagnosis is made in the prehospital setting, immediate activation of the catheterization laboratory not only reduces treatment delays but may also reduce patient mortality [5-8]. In addition, primary PCI is superior to fibrinolysis in reducing mortality, reinfarction, or stroke [9].

Coronary stenting is the technique of choice during primary PCI; in primary PCI, drug-eluting stents (DES) reduce the risk of repeated target vessel revascularization compared with BMS [10].

METHODS

The study population consisted of 199 patients was taken from Slemani Cardiac Hospital (SCH) between September 1, 2020, and June 31, 2021, who diagnosed with STEMI of less than 12 hr duration, in addition to those with later arrival who had ongoing ischemia, and at least two contiguous electrocardiographic leads with ST-segment elevation > 2.5mm in men under 40years, > 2 mm in men over 40years, or > 1.5 mm in women in leads V 2 –V 3 and/or > 1 mm in the other leads or LBBB.

After initial medication with loading doses of dual antiplatelet therapy (DAPT), parenteral anticoagulation and analgesics with bedside transthoracic echocardiography, the catheterization laboratory immediately activated for Primary PCI.

Data were recorded on all patients, including symptom duration, time of arrival at the hospital (door time), comorbidities, echocardiographic findings and time of balloon inflation (balloon time). Then, each patient was followed up prospectively for 30 days and observed for complications or death.

The study was approved by the Kurdistan Board of Medical Specialties research protocol ethics committee.

Statistical analysis

Data entry was performed using an excel spreadsheet then the statistical analysis was performed by the SPSS program, version 24.0 (IBM SPSS Statistical Package for the Social Sciences).

Compliance of quantitative random variables with the Gaussian curve (normal distribution) was analyzed using the Kolmogorov-Simonov test. Chi-square tests were used to compare the categorical data between these two groups of patients concerning different study variables, especially the occurrence of complications. Quantitative continuous variables were described by mean and standard deviation. Independent tests were used to compare the mean between the two groups. For the non-normally distributed quantitative variable as the door to balloon time in addition to mean and SD, it was also described by median and mean rank. In addition to the t-test Mann- Whitney was used for comparison.

The relative risk for complication (with 95% confidence interval) for the presence of the previous morbidity and for delay time to find the amount of risk and its significance. P values of 0.05 were used as a cut-off point for the significance of statistical tests.

RESULTS

One hundred ninety-nine patients with STEMI or LBBB were transferred or directly admitted to Slemani Cardiac Hospital for primary PCI. For patients aged between 30 to 90 years, the mean age + SD was 60.36 + 12.29; the majority were males, 73.4% compared to females 26.6% (Table 1).

The most frequent risk factors were hypertension 46%, diabetes mellitus 29%, current smoking 26% and dyslipidemia 11% (Table 2), (Figure 1).

Overall adverse cardiovascular outcome and death happened in 26% (n=52) and 8% (n=16) respectively (Table 3) (Figure 2).

The mean and median of DTB time for those without adverse event were much shorter compared to the other two groups (cardiovascular adverse outcomes and death), as the mean (median) of those free from adverse events were 92 (62) minutes, while for other two groups were 168(146), 115(100) respectively this compare is highly significant statistically P<0.001 (Table 4).

During the follow-up of each patient over 30 days, we observed that outcomes of death left ventricular dysfunction or angina were significantly higher in patients with DTB time greater than 90 minutes (Table 4, Figures 3 A and B). Additionally, symptom duration had a significant impact on outcomes; the mean (median) of symptom onset- to- balloon (OTB) time was 11.9 (6) hours in those without adverse outcomes, which is statistically significant in comparison to 22 (9.7) hours and 22 (11) hours in those with left ventricular dysfunction or angina, and death respectively (Table 5).

We found that the risk for adverse outcomes or death in the study cases had increased with comorbidity by about two times. Risk among the delayed group was more than three times, and the combination of these two risk factors (delay and comorbidity) for these complications was three times. All these risk associations were significant statistically (Table 6).

Table 1. Baseline patient characteristics.

Characteristics	Frequency	Percentage
Age (Years)		
Mean ± SD	60.36 ± 12.29	
31 - 45	23	11.6
46 - 60	76	38.2
61 - 75	77	38.7
76 - 90	23	11.6
Sex		
Male	146	73.4
Female	53	26.6
Work hours		0.0
Yes	45	22.6
No	154	77.4

Table 2. Relevant Comorbidities.

Risk factors	Frequency	Percentage
Hypertension	92	46.2
DM	58	29.1
Dyslipidemia	22	11.1
Current smoker	52	26.1
CHF	2	1.0
CVA	2	1.0
Prior MI	11	5.5
Previous PCI	14	7.0
Previous CABG	1	0.5
Family History IHD	1	0.5

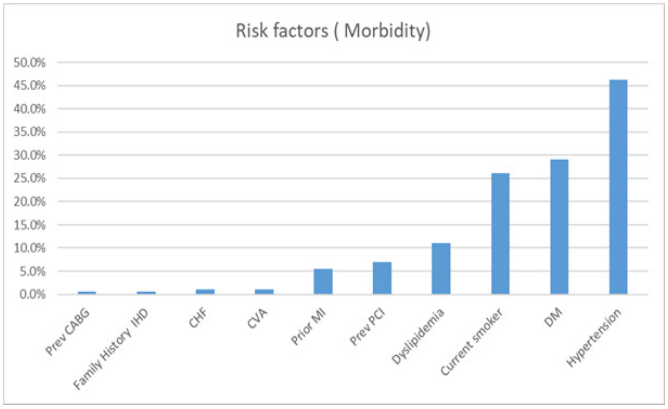

Figure 1. Risk factors prevalence.

Table 3. Percentage of a patient with DTB time delay and adverse outcomes.

The adverse cardiovascular outcome in 30 days/ door to balloon time delay		Door to balloon time delay		Total	P-value
		No Delay	Delay		
Adverse cardiovascular the outcome in 30 days	No adverse outcome	94 (83.2%)	37 (43.0%)	131 (65.8%)	
	LV dysfunction or angina	12 (10.6%)	40 (46.5%)	52 (26.13%)	< 0.001*
	Death	7 (6.2%)	9 (10.5%)	16 (8.0%)	
Total		**113 (100%)**	**86 (100%)**	**199 (100%)**	

*** Performed by Chi-square test**

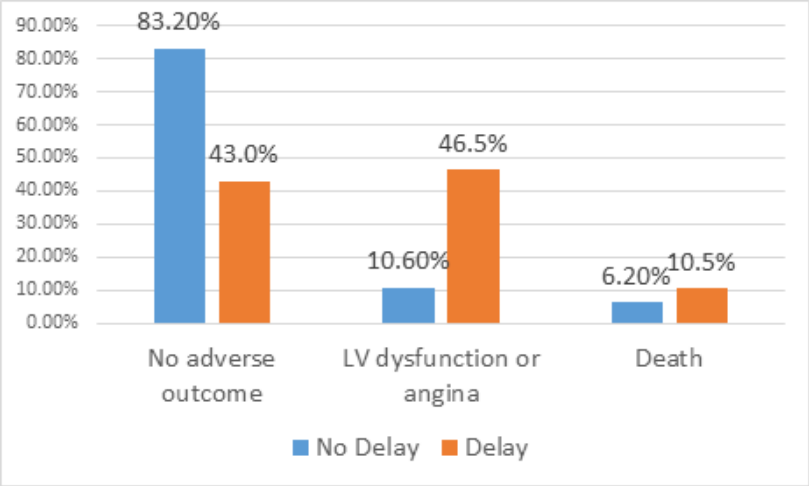

Figure 2. Door to balloon time delay / adverse reactions.

Table 4. The adverse cardiac outcome in 30 days.

Adverse cardiovascular outcome in 30 days /DTBT	Door to Balloon time (minutes)			P-value
	Number	Mean ±Standard deviation	Median ± mean rank	
The adverse cardiovascular outcome in 30 days				
No adverse outcome	131	92.78 ± 92.41	60 ± 83.44	< 0.001 *
LV dysfunction or angina	52	168.06 ± 101.78	146.5 ± 138.75	
Death	16	115.0 ± 77.11	100 ± 109.66	
Total	**199**	**114.24 ± 98.95**	**73**	

*** Performed by ANOVA and Kruskal Wallis test**

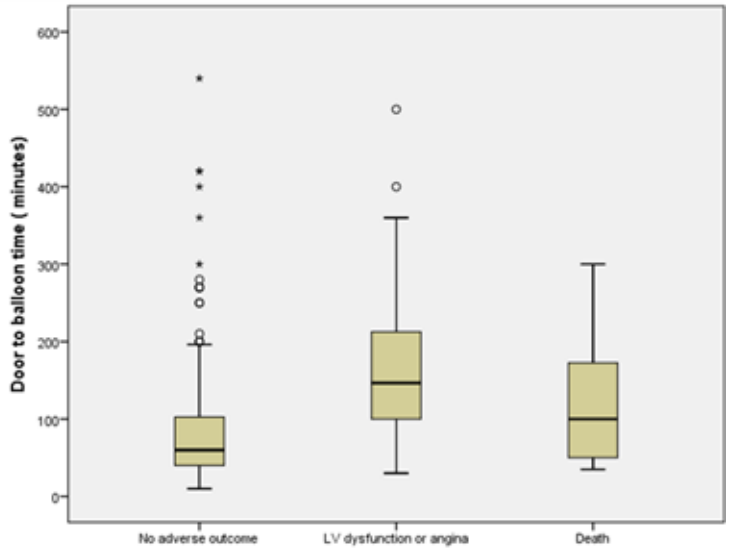

Figure 3 (A). Adverse cardiovascular outcomes in 30 days.

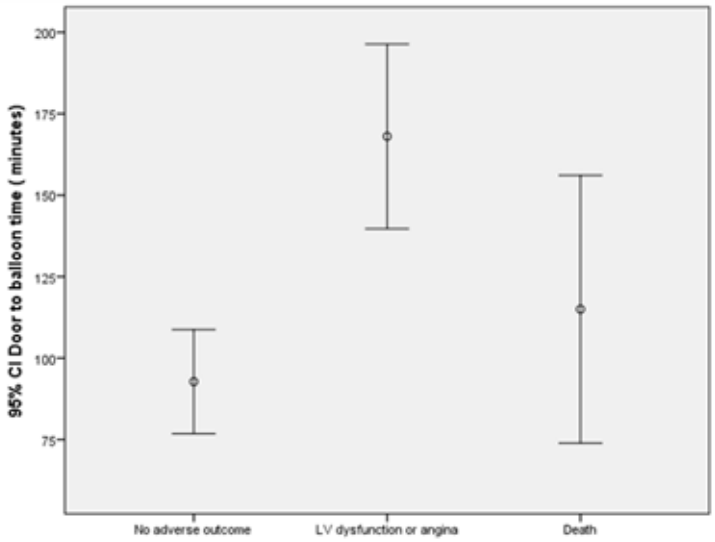

Figure 3 (B). Adverse cardiovascular outcomes in 30 days.

Table 5. Thirty days of adverse cardiovascular outcomes according to symptom onset to balloon time.

The adverse cardiovascular outcome in 30 days / symptom onset-to-balloon time		Symptom onset-to-balloon time (hours)			P-value
		Mean	Standard deviation	Median	
Adverse cardiovascular the outcome in 30 days	No adverse outcome	11.98	16.63	6	0.004
	LV dysfunction or angina	22.14	24.64	9.75	
	Death	22.15	27.2	11.21	
Total		**15.45**	**20.43**	**6.67**	

Table 6. Impact of patient comorbidities on adverse outcomes with DTB delay .

	Relative risk for complication {cardiac complication or death} (95% CI)	P value
Door to balloon time Delay	3.39 (2.16 - 5.31)	< 0.001
Comorbidity	1.95 (1.08 - 3.51)	0.02
Comorbidity and delay	3.03 (1.91 - 4.82)	< 0.001
No comorbidity / delay	6 (1.42 - 25.39)	0.004

DISCUSSION

Our study found that the most important work for improving cardiovascular outcomes and reducing deaths from STEMI patients undergoing primary PCI is minimizing DTB time to the greatest extent possible; patients with DTB time greater than 90 minutes were associated with higher morbidities and mortality rates. We also found that the longer total time from symptom onset-to-balloon time was associated with a higher death rate and adverse outcomes—these findings confirm that a shorter interval between ischemia and reperfusion results in improved myocardial salvage.

Our results are similar in several studies; in the Global Use of Strategies to Open Occluded Arteries in Acute Coronary Syndromes (GUSTO) IIb trial, 30-day mortality rates increased progressively with time from randomization to balloon inflation, a close surrogate for door-to-balloon time [11]. In addition, McNamara et al., in a study of data from US NRMI (National Registry of MI), reported that shorter DTB but not symptom onset-to-balloon (OTB) was associated with lower in-hospital mortality [12].

However, other studies found a positive correlation between shorter OTB time and decreased mortality [13, 14].

In contrast, Brodie et al. found that short DTB times (<90 min) are associated with a lower mortality rate in patients presenting early after the onset of symptom (OTB time) with less impact on the mortality rate in patients presenting later [15].

In conclusion, both symptom OTB and DTB time delay in a patient with STEMI treated with primary PCI significantly increase morbidities and mortality rate, so the health care system should work to shorten DTB time as well as media and educational campaigns to shorten the time taken by patients with MI to decide to go to the hospital.

REFERENCES

1. O'Gara PT, Kushner FG, Ascheim DD, Casey Jr DE, Chung MK, de Lemos JA, et al. ACCF/AHA guideline for the management of ST-elevation myocardial infarction: executive summary: a report of the American College of Cardiology Foundation/ American Heart Association Task Force on Practice Guidelines: developed in collaboration with the American College of Emergency Physicians and Society for Cardiovascular Angiography and Interventions. Catheter Cardiovasc Interv. 2013; 82(1): E1–27.

2. Boersma E, Primary Coronary Angioplasty vs Thrombolysis Group. Does time matter? A pooled randomized clinical trial analysis compares primary percutaneous coronary intervention and in-hospital fibrinolysis in acute myocardial infarction patients. Eur Heart J 2006; 27(7):779–788.

3. Boersma E, Maas ACP, Deckers JW, Simoons ML. Early thrombolytic treatment in acute myocardial infarction: a reappraisal of the golden hour. Lancet 1996; 348(9030):771–775.

4. Mun K. Hong. Recent Advances in the Treatment of ST-Segment Elevation Myocardial Infarction. Scientifica Volume 2012 (2012), Article ID 683683.

5. Fordyce CB, Al-Khalidi HR, Jollis JG, Roettig ML, Gu J, Bagai A, et al. Association of rapid care process implementation on reperfusion times across multiple ST-segment-elevation myocardial infarction networks. Circ Cardiovasc Interv 2017; 10(1):e004061.

6. Stowens JC, Sonnad SS, Rosenbaum RA. Using EMS dispatch to trigger STEMI alerts decreases door-to-balloon times. West J Emerg Med 2015; 16(3):472–480.

7. Squire BT, Tamayo-Sarver JH, Rashi P, Koenig W, Niemann JT. Prehospital cardiac catheterization lab activation affects door-to-balloon time, mortality, and false-positive activation. Prehosp Emerg Care 2014; 18(1):1–8.

8. Nallamothu BK, Normand SL, Wang Y, Hofer TP, Brush JE, Messenger JC, et al. Relation between door-to-balloon times and mortality after primary percutaneous coronary intervention over time: a retrospective study. Lancet 2015; 385(9973):1114–1122.

9. Zijlstra F, Hoorntje JC, de Boer MJ, Reiffers S, Miedema K, Ottervanger JP, et al. Long-term benefit of primary angioplasty as compared with thrombolytic therapy for acute myocardial infarction. N Engl J Med 1999; 341(19):1413–1419.

10. Kastrati A, Dibra A, Spaulding C, Laarman GJ, Menichelli M, Valgimigli M, et al. Meta-analysis of randomized trials on drug-eluting stents vs bare-metal stents in patients with acute myocardial infarction. Eur Heart J 2007; 28(22):2706–2713.

11. Peter B. Berger, Stephen G. Ellis, David R. Holmes Jr, Christopher B. Granger, Douglas A. Criger, Amadeo Betriu, et al. Relationship between delay in performing direct coronary angioplasty and early clinical outcome in patients with acute myocardial infarction: results from the Global Use of Strategies to Open Occluded Arteries in Acute Coronary Syndromes (GUSTO-IIb) trial Circulation, 1999;100(1): 14-20.

12. McNamara RL, Wang Y, Herrin J, Curtis JP, Bradley EH, Magid DJ, et al. Effect of door-to-balloon time on mortality in patients with ST-segment elevation myocardial infarction. J Am Coll Cardiol. 2006; 47(11):2180–2186.

13. De Luca G, Suryapranata H, Zijlstra F, van't Hof AW, Hoorntje JC, Gosselink AT, et al. Symptom-onset-to-balloon time and mortality in patients with acute myocardial infarction treated by primary angioplasty. J Am Coll Cardiol. 2003; 42(6):991–997.

14. Shiomi H, Nakagawa Y, Morimoto T, Furukawa Y, Nakano A, Shirai S, et al. Association of onset to balloon and door to balloon time with long-term clinical outcome in patients with ST-elevation acute myocardial infarction having primary percutaneous coronary intervention: an observational study. BMJ. 2012; 344:e3257.

15. Brodie BR, Gersh BJ, Stuckey T, Witzenbichler B, Guagliumi G, Peruga JZ, et al. When is door-to-balloon time critical? Analysis from the HORIZONS-AMI (Harmonizing Outcomes with Revascularization and Stents in Acute Myocardial Infarction) and CADILLAC (Controlled Abciximab and Device Investigation Lower Late Angioplasty Complications) trials. J Am Coll Cardiol. 2010; 56(5):407–413.