International Journal of Cardiology xxx (2017) xxx–xxx

Contents lists available at ScienceDirect

International Journal of Cardiology

journal homepage: www.elsevier.com/locate/ijcard

Effect of improved door-to-balloon time on clinical outcomes in patients with ST segment elevation myocardial infarction

Wei-Chieh Lee [1], Hsiu-Yu Fang [2], Huang-Chung Chen, Shu-Kai Hsueh, Chien-Jen Chen, Cheng-Hsu Yang, Hon-Kan Yip, Chi-Ling Hang, Chiung-Jen Wu, Chih-Yuan Fang *

Division of Cardiology, Department of Internal Medicine, Kaohsiung Chang Gung Memorial Hospital, Chang Gung University College of Medicine, Kaohsiung, Taiwan, Republic of China

A R T I C L E I N F O

Article history:
Received 24 October 2016
Received in revised form 20 January 2017
Accepted 21 February 2017
Available online xxxx

Keywords:
Prognostic factors
ST segment elevation myocardial infarction
Door-to-balloon time

A B S T R A C T

Objective: Few studies have focused on the effects of an improved door-to-balloon time on clinical outcomes in patients with ST-segment elevation myocardial infarction (STEMI). The aim of this study was to explore the effect of improving door-to-balloon time on prognosis and to identify major predictors of mortality.
Methods: From January 2005 to December 2014, 1751 patients experienced STEMI and received primary percutaneous intervention in our hospital. During a 10-year period, the patients were divided into two groups according to the time period. Since mid-2009, shortening door-to-balloon time has been an important concern of health care. As a result of targeted efforts, as of January 2010, door-to-balloon time shortened significantly. In our study, a total 853 patients were in group 1 during January 2005 to December 2009, and a total 898 patients were in group 2 during January 2010 to December 2014.
Results: The incidence of major adverse cardiac cerebral events (26.7% vs. 23.2%; $p = 0.120$), the incidence of cardiovascular mortality (9.3% vs. 8.8%; $p = 0.741$), and the incidence of all-cause mortality (12.6% vs. 12.2%; $p = 0.798$) were similar between the two groups. The incidence of target vessel revascularization significantly decreased in group 2 (17.8% vs. 12.6%; $p = 0.008$). However, the incidence of stroke increased in group 2 (1.8% vs. 3.6%; $p = 0.034$).
Conclusion: Improving door-to-balloon time could not improve 1-year cardiovascular mortality whether low-risk or high-risk patients. The improvement in the door-balloon time does not improve outcomes studied, probably because it is not accompanied by a reduction in total reperfusion time, which means from onset of symptoms to reperfusion.

1. Introduction

Acute myocardial infarction (MI) remains the leading cause of morbidity and mortality worldwide [1]. MI causes a diminished blood supply to the heart and exceeds a critical threshold and overwhelms myocardial cellular repair mechanisms in case of myocardial ischemia. Early successful reperfusion using thrombolytic therapy or primary percutaneous coronary intervention (PCI) is an effective therapeutic strategy adopted to minimize the ischemic insult and infarct size of the myocardium [1,2]. Over the past two decades, the prognosis after ST-elevation myocardial infarction (STEMI) has been much improved, and the improvement is mainly because of early reperfusion therapies and the use of concomitant pharmacotherapy [3]. Several studies have shown that primary percutaneous coronary intervention (PCI) is associated with a good prognosis after STEMI [4]. Time to primary PCI is strongly associated with mortality risk and is important regardless of time from symptom onset to presentation and regardless of baseline risk of mortality, especially anterior wall MI and high risk patients [5]. Beyond this, all interventionists pursued shorter door-to-balloon time to improve the prognosis of patients with STEMI, considering the well-established adage “time is muscle.” However, limited studies focused on the change of prognostic factors after improving door-to-balloon time.

The aim of this study was to explore the change of prognostic factors and to identify the important predictors of mortality after improving door-to-balloon time.

2. Materials and methods

2.1. Patients and groups

From January 2005 to December 2014, 1751 patients experienced STEMI and received primary PCI in our hospital. During 10-year period, the patients were divided into two groups (group 1 and group 2) according to the time period. Since mid-2009, shortening

* Corresponding author at: Division of Cardiology, Department of Internal Medicine, Kaohsiung Chang Gung Memorial Hospital, 123, Ta Pei Road, Niao Sung District, Kaohsiung City 83301, Taiwan, Republic of China.
E-mail address: leeweichieh@yahoo.com.tw (C.-Y. Fang).
[1] Indicates equal contribution as correspondence author.
[2] Indicates equal contribution as first author.

http://dx.doi.org/10.1016/j.ijcard.2017.02.156
0167-5273/

door-to-balloon time has become an important focus of health care in our country. Thus, since January 2010, door-to-balloon time shortened significantly. In our study, a total 853 patients were in group 1 during January 2005 to December 2009, and a total 898 patients were in group 2 during January 2010 to December 2014. The Institutional Review Committee on Human Research at our institution approved the study protocol.

2.2. Definitions

MI definitions were in accordance with the most recent universal definition of MI [6]. Target vessel revascularization (TVR) was defined as any repeat PCI in a target vessel or coronary artery bypass graft (CABG) in a target vessel for the lesions with a diameter stenosis ≧70% [7]. The target vessel is defined as the entire major coronary vessel proximal and distal to the target lesion, which includes upstream and downstream branches and the target lesion itself [7]. Cardiovascular mortality was defined as death related to an MI, cardiac arrhythmia, and heart failure. All-cause mortality was defined as death from any cause. Major adverse cardiac cerebral events (MACCEs) included an MI, TVR, stroke, and cardiovascular mortality.

2.3. Study endpoints

The primary endpoints were an MI, TVR, stroke, cardiovascular mortality, and MACCEs during the 1-year follow-up period. The secondary endpoints were all causes of mortality, regardless of cause, during the 1-year follow-up period.

2.4. Statistical analysis

Data are expressed as a mean ± standard deviation or median and interquartile range for continuous variables when appropriate. Categorical variables are expressed as counts and percentages. Continuous variables were compared using an independent sample t or Mann–Whitney *U* tests. Median and interquartile ranges were used for timing of primary PCI since normal distribution could not be assumed; values for these parameters were compared using the Wilcoxon signed rank test. Categorical variables were compared using a Chi-square statistic. Univariate and multivariate cox regression analyses were performed to identify the associations of 1-year cardiovascular mortality. Each correlation between the variables is expressed as a hazard ratio with a 95% confidence interval (CI). A Kaplan-Meier curve was performed for 1-year cardiovascular mortality and MACEs. All statistical analyses were performed using SPSS 22.0 (IBM. Corp., Armonk. NY). A p-value <0.05 was considered statistically significant.

3. Results

3.1. Baseline characteristics (Table 1)

The average age of group 1 was 61.39 ± 12.72 years and 81.9% were male, and the average age of group 2 was 60.97 ± 13.01 years and 83.3% were male. There was no significant difference. In group 2, there was a higher prevalence of smokers (42.2% vs. 54.9%; $p < 0.001$), and higher prevalence of end stage renal disease (ESRD) (2.2% vs. 3.9%; $p = 0.043$). Higher systolic blood pressure presented in group 2 (129.64 ± 34.58 mm Hg vs. 134.34 ± 33.61 mm Hg; $p = 0.004$). Significantly improving door-to-balloon time (101 (55) minutes vs. (28) minutes; $p < 0.001$), reperfusion time (18 (12) minutes vs. 16 (8) minutes; $p < 0.001$), and chest pain-to-reperfusion time (289 (212) minutes vs. 207 (203) minutes; $p < 0.001$) presented in group 2. Lower serum hemoglobin levels (14.4 ± 2.1 g/dL vs. 14.1 ± 2.2 g/dL; $p < 0.001$) were noted in group 2. Higher fasting sugar levels (150.57 ± 67.73 mg/dL vs. 159.69 ± 88.75 mg/dL; $p = 0.032$), but lower glycohemoglobin (HbA1C) (7.33 ± 3.07% vs. 6.73 ± 1.72%; $p < 0.001$) were noted in group 2. Better lipid profiles expressed as lower total cholesterol (187.45 ± 42.88 mg/dL vs. 176.41 ± 44.54 mg/dL; $p < 0.001$), lower low-density lipoprotein (LDL) (120.79 ± 56.81 mg/dL vs. 111.03 ± 38.51 mg/dL; $p < 0.001$), and higher high-density lipoprotein (HDL)

Table 1
Patient characteristics of group 1 and group 2.

	Group 1 (*N* = 853)	Group 2 (*N* = 898)	*P*-value
General demographics			
Age (years)	61.39 ± 12.72	60.97 ± 13.01	0.496
Male sex (%)	81.9 (699)	83.3 (748)	0.452
Risk factors for MI			
BMI (kg/m^2)	25.96 ± 16.36	25.28 ± 3.69	0.233
Diabetes (%)	37.4 (319)	33.3 (299)	0.073
Current smoker (%)	42.2 (360)	54.9 (493)	<0.001
Hypertension (%)	57.8 (493)	59.5 (534)	0.478
Prior MI (%)	6.3 (54)	8.1 (73)	0.147
Prior stroke (%)	7.5 (64)	6.5 (58)	0.391
ESRD on maintenance hemodialysis (%)	2.2 (19)	3.9 (35)	0.043
The severity of MI			
SBP (mm Hg)	129.64 ± 34.58	134.34 ± 33.61	0.004
Killip level (%)			0.238
I, II	75.0 (639)	76.5 (687)	
III, IV	25.0 (214)	23.5 (211)	
Timing of primary PCI			
Chest pain-to- door time (minutes)	156 (197)	139 (179)	0.872
Door-to-balloon time (minutes)	101 (55)	54 (28)	<0.001
Reperfusion time (minutes)	18 (12)	16 (8)	<0.001
Chest pain-to-reperfusion time (minutes)	289 (212)	207 (203)	<0.001
Laboratory examination			
White blood cell count (×10^3)	11.4 ± 4.1	11.5 ± 4.5	0.476
Hemoglobin (gm/dl)	14.4 ± 2.1	14.1 ± 2.2	0.030
Blood fasting sugar (mg/dL)	150.57 ± 67.73	159.69 ± 88.75	0.032
HbA1C (%)	7.33 ± 3.07	6.73 ± 1.72	<0.001
Creatinine (except ESRD) (mg/dL)	1.47 ± 0.64	1.51 ± 0.71	0.667
Total cholestalol (mg/dL)	187.45 ± 42.88	176.41 ± 44.54	<0.001
LDL-cholesterol (mg/dL)	120.79 ± 56.81	111.03 ± 38.51	<0.001
HDL (mg/dL)	39.78 ± 10.54	43.73 ± 12.30	<0.001
Troponin-I (ng/mL)	5.22 ± 1.86	7.29 ± 4.99	0.026
CK-MB (ng/mL)	22.78 ± 5.32	29.25 ± 6.30	0.023
LVEF (%)	58.01 ± 13.79	56.78 ± 13.78	0.070
Infarcted territory (%)			0.502
Anterior	54.5 (465)	53.9 (484)	
Inferior	41.9 (357)	42.1 (378)	
Lateral	1.5 (13)	3.1 (28)	
Posterior	2.1 (18)	0.9 (8)	
Characteristics of coronary artery disease			
Single- or multiple-vessel disease (%)			0.011
Single vessel disease	38.6 (329)	34.7 (312)	
Multiple vessel disease	61.4 (524)	65.3 (586)	
Left main disease (%)	6.3 (54)	6.1 (55)	0.859
Primary PCI angiography			
Culprit vessel			
Pre-PCI TIMI flow			0.005
≧2	31.1 (265)	23.9 (215)	
≦1	68.9 (588)	76.1 (683)	
Pre-PCI stenosis (%)	93.85 ± 11.01	94.78 ± 9.06	0.052
Pre-PCI MLD (mm)	0.19 ± 0.36	0.18 ± 0.38	0.508
Pre-PCI RLD (mm)	3.08 ± 1.10	3.11 ± 0.68	0.407
Post-PCI TIMI flow			<0.001
≧2	98.8 (843)	97.1 (872)	
≦1	1.2 (10)	2.9 (26)	
Post-PCI stenosis (%)	13.26 ± 11.53	14.92 ± 8.57	0.001
Post-PCI MLD (mm)	2.82 ± 0.65	2.75 ± 0.58	0.013
Post-PCI RLD (mm)	3.25 ± 0.55	3.28 ± 0.61	0.264
Distal embolization	2.9 (25)	2.5 (22)	0.536
Procedural device			
IABP (%)	18.4 (157)	17.9 (161)	0.796
ECMO (%)	3.6 (31)	3.3 (30)	0.738
Method of eperfusion (%)			<0.001
Emergent CABG	0.5 (4)	0.3 (3)	
Balloon angioplasty alone	10.2 (87)	4.8 (43)	
Bare-metal stents	78.8 (671)	55.9 (502)	
Drug-eluting stents	10.5 (89)	38.8 (348)	
Post-MI Medications (%)			
ACEI/ARBs	81.2 (693)	88.3 (791)	<0.001
Beta-blockers	68.3 (583)	74.7 (670)	0.007
Statins	62.8 (536)	77.4 (694) I	<0.001
Post PCI acute kidney injury (%)	8.4 (72)	8.1 (73)	0.813

Notes to Table 1:
Data are expressed as mean ± standard deviation, or as median (interquartile range), or as number (percentage).
Abbreviation: MI: myocardial infarction; BMI: body mass index; ESRD: end stage renal disease; SBP: systolic blood pressure; PCI: percutaneous coronary intervention; HbA1C: glycohemoglobin; LDL: low density lipoprotein; HDL: high density lipoprotein; CK-MB: creatine kinase-MB; LVEF: left ventricular ejection fraction; TIMI: thrombolysis in myocardial infarction; MLD: minimal luminal diameter; RLD: reference luminal diameter; IABP: intra-aortic balloon pump; ECMO: extracorporeal membrane oxygenation; CABG: *Coronary artery bypass grafting*; ACEI: angiotensin converting enzyme inhibitor; ARB: angiotensin receptor blocker.