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IN-HOSPITAL MORTALITY IN PATIENTS OF ST ELEVATION MI PRESENTING WITH RIGHT BUNDLE BRANCH BLOCK

Muhammad Hashim[1], Shah Zeb[2], Ghazanfar Ali Shah[3], Syed Nadeem Hassan Rizvi[4]

[1,3,4] Department of Cardiology, National Institute of Cardiovascular Diseases, Karachi - Pakistan

[2]Department of Cardiology, Lady Reading Hospital, Peshawar - Pakistan

Address for Correspondence:

Shah Zeb,
Department of Cardiology, Lady Reading Hospital, Peshawar - Pakistan

Emails: hashim@gmail.com

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Contribution

MH conceived the idea, planned the study and drafted the manuscript. SZ, GAS & SNHR collected data, did statical analysis, drafted the manuscript and critically reviewed manuscript. All authors contributed significantly to the submitted manuscript.

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ABSTRACT

Objective: To determine the frequency of in-hospital mortality of patients having ST elevation MI with right bundle branch block (RBBB) after giving emergency treatment, within 72-hours of hospital admission.

Methodology: This observational cross-sectional study was conducted from February to August 2012 in casualty and medical wards at National Institute of Cardiovascular Diseases Karachi. All consecutive patients with ST elevation MI (STEMI) having right bundle branch block were included. In hospital mortality of every patient was assessed during 72-hrs of in-hospital admission. Data regarding age, gender, co-morbidities, type of ST elevation MI, type of emergency treatment and in-hospital mortality were documented. Frequencies and percentages of categorical variables, mean and standard deviation of continuous variables were calculated using SPSS version 17.

Results: Out of 120 patients 80.8% were males . Of all the patients 38.3% were diabetic, 35% were hypertensive, 33.3% were smokers and 25.0% were those who had no co morbidities. Acute anterior wall MI was found in 87.5%, inferior wall MI in 6.7% and acute lateral wall MI was found in 3.3% patients while in 2.5% patients both anterior wall and lateral wall MI was found. The mean age of the patients was 56.59 ± 9.92 years. The mean duration of diabetes and hypertension was 13.72 ± 6.49 years and $17.12 \pm .6.96$ years respectively. About 75% patients received streptokinase, and 25% were treated with primary PCI. The overall mortality rate was 28(23.3%) patients mostly males 23(82.1%). Mortality was high in 61-70 years age group 16(57.1%) while no mortality was observed in age groups < 40 years. Mortality rate was high in smokers 15(53.6%). Mortality in acute anterior wall myocardial infarction was 27(96.4%) and 01(3.6%) with anteriolateral wall MI. Mortality rate was very high in patients treated with streptokinase 23(82.1%) as compared to primary PCI ($p < 0.05$).

Conclusion: In STEMI, RBBB was an independent predictor of high in-hospital mortality. Patients who have RBBB accompanying anterior AMI at presentation or who develop new BBB early after fibrinolytic therapy independently have higher mortality than patients without these conduction abnormalities.

Key Words: Myocardial Infarction, ST elevation myocardial infarction, Mortality, Right bundle branch block

INTRODUCTION

Many studies have been done on left bundle branch block (LBBB) which have concluded that LBBB is important predictor of adverse outcome in patients with acute myocardial infarction but little is known about mortality in RBBB in settings of acute MI.[1] About 7% of patients in RENASICA II (National multicentre registry) found to have ST elevation myocardial infarction with RBBB.[2] Conduction defects are relatively common in acute myocardial infarction which increase the short and long term mortality.[3] European Society of Cardiology and American Heart Association recommend urgent reperfusion therapy for new or unknown onset LBBB but data is lacking regarding use of urgent reperfusion therapy in new or unknown onset RBBB.[4] Right bundle is comparatively narrow structure in conduction tissue of the heart and is relatively more prone to ischemia.[3] Blood supply of proximal right bundle is from AV nodal artery and remaining two-third of the segment is supplied by septal branches from left anterior descending artery, therefore patient having acute anterior and inferior wall MI get worse with RBBB.[3] Large bulk of myocardium including interventricular septum is at the risk of ischemia which is responsible for adverse outcome in patients with RBBB.[5] Data from reperfusion era has attributed high mortality of patients to BBB in early phases of ST elevation myocardial infarction.[5] BBB can be an independent marker for large anterior wall MI when it presents at onset of acute MI.[6] RBBB is an independent predictor of in-hospital mortality in patients with systolic heart failure as well.[2] One recently published study in European Heart Journal with the title of Primary Angioplasty in AMI with RBBB revealed 26% of patients with acute left main artery obstruction presented with RBBB on admission ECG and same study calculated in-hospital mortality of 18.8% in patients having acute MI with RBBB.[4,7]

Rationale of the study is that by determining the frequency of in-hospital mortality, we will be able to see the magnitude of patients with ST elevation MI having RBBB and therefore these patients should be risk stratified early in emergency department and offered revascularization therapy such as Primary coronary intervention (PCI) or Streptokinase as early as possible which reduces in-hospital mortality.

METHODOLOGY

This observational cross-sectional study was performed in Casualty and medical wards at National Institute of Cardiovascular Diseases Karachi from February to August 2012. The sampling technique was non probability sampling. All consecutive male and female patients between 20 to 70 years of age with ST elevation MI having right bundle branch block after giving emergency treatment admitted at NICVD were included after taking informed consent. By using open EPI sample size calculator using prevalence of 18.8% with confidence interval of 95% and standard deviation of 7% a sample size of 120 was calculated. While patients with incomplete right BBB, paced rhythm, LBBB and age <20 and >70 years were excluded. Approval of ethical committee was sought out. All patients admitted in Emergency Departments and other departments of Adult cardiology in NICVD including wards and CCU meeting the inclusion criteria were included in the study. Informed consent was taken from each patient in this study. In hospital mortality of every patient was assessed during 72-hrs of in-hospital admission from the time of arrival in the emergency department. Patients were assessed on the basis of ECG findings as per operational definitions. Data regarding age, gender, co-morbidities, type of ST elevation MI, type of emergency treatment and in-hospital mortality were documented. The information was entered on performa. Data were entered and analyzed in SPSS version17. Descriptive analysis was performed by calculating frequencies and percentages of categorical variables like gender, diabetes mellitus, hypertension, smoker, type of STEMI, in-hospital mortality and type of emergency treatment received. Mean and standard deviation were calculated for continuous variables such as age, duration of smoking, HTN, DM and mortality rate. Effect modifiers like age, gender, co-morbidities including diabetes mellitus, hypertension, smoking status, type of STEMI and emergency treatment given, were controlled through stratification. Chi-square test was applied and p-value less than or equal to 0.05 was taken as significant.

RESULTS

The results showed that there were 80.8% males. Among 120 study subjects, 38.3% were diabetic, 35% were hypertensive, and 33.3% were smokers and 25.0% were those who had no co morbidities (Table 1). Among diabetics, 18 patients were neither hypertensive nor smokers, 12 were hypertensive, 9 were smokers and 7 were hypertensive with smoking habits. Acute anterior wall myocardial infarction was found in 87.5% patients. Acute inferior wall myocardial infarction was found in 6.7% patients. Acute lateral wall myocardial infarction was found in 3.3% patients. In 2.5% patients anterior wall and lateral wall myocardial infarction was found. The mean age of the patients was 56.59±9.92 years (range from 29 to 70 years).The mean duration of diabetes was 13.72±6.49 years with range from 4 to 30 years. The mean duration of hypertension was 17.12±.6.96 years ranging from 4 to 30 years and mean duration of smoking was 25.5±12.44 with ranged from 3 to 50 years (Table 2).

The age was stratified in four groups. About 9 patients were < 40 years, 26 were in 41-50 years group, 37 were in 51-60 years group , and 48 were in 61-70 years age group. As far as treatment is concerned, 75% patients received streptokinase, and 25% were treated with primary PCI (Table 2). The overall mortality rate among 120 patients was 28(23.3%) patients (Table 3). Among those who scummed to it 23(82.1%) were males and 5(17.9%) were females and there was no significant association between mortality and gender. Mortality was high in 61-70 years age group, 16(57.1%) followed by 51-60 and 41-50 years groups, 7(25%) and 5(17.9%) respectively and there was no significant association between mortality and different age groups. No mortality was observed in age groups < 40 years. According to comorbidities, mortality rate was high in

Table 1: Demographic Variables of study Population (n=120)

Gender	Frequency (n)	Percentage (%)
Males	97	80.8%
Females	23	19.2%
Diabetic	18	15.0%
Hypertension	20	16.7%
Smoking	21	17.5%
Diabetic and Hypertension	12	10.0%
Diabetic and Smoking	9	7.5%
Hypertension and Smoking	3	2.5%
Diabetic, Hypertension and Smoking	7	5.8%
None	30	25.0%
Total	120	

Table 2: Duration of co morbidities in Study Population (n=120)

	Mean ±SD	95%CI	Median(IQR)	Max- Min
Overall Age (years)	56.59±9.92	54.80 to 58.39	58.0 (16)	29 – 70
Duration of Diabetic (years)	13.72±6.49	11.79 to 15.64	12.0 (10)	4 – 30
Duration of Hypertension (years)	17.12±	14.95 to 19.29	20.0 (10)	4 – 30
Duration of Smoking (packs/years)	25.5±12.44	21.52 to 29.48	20.0 (23)	3 – 50

Table 3: Frequency of Mortality in Study Population (n=120)

	Frequency (n)	Percentage (%)
Yes	28	23.3%
No	92	76.7%
Total	120	

Table 4: Frequency of Mortality According to Different Parameters (n=120)

Parameters	Description	Frequency (n)	Percentage (%)	p-value
Gender	Male	23	82.1%	< 0.05
	Female	5	17.9%	
Age groups	< 40	0	****	<0.05
	41 – 50	5	17.9%	
	51 – 60	7	25.0%	
	61 – 70	16	57.1%	
Comorbids	Diabetic	14	50.0%	<0.05
	Hypertension	11	39.3%	
	Smoking	15	53.6%	
Location of infarction	AAWMI	27	96.4%	< 0.05
	AIWMI	0	****	
	ALWMI	0	****	
	AAWMI+ALWMI	1	3.6%	
Treatment	Streptokinase	23	82.1%	<0.05
	Primary PCI	5	17.9%	

smokers, 15(53.6%) followed by diabetic patients with 14(50%) and hypertensive patients with 11(39.3%). There was no significant association between mortality and comorbids. Almost all mortality was with acute anterior wall myocardial infarction 27(96.4%) and only 1(3.6%) with anteriolateral myocardial infarction. Mortality rate was very high in patients treated with streptokinase, 23(82.1%) and mortality among patients treated with primary PCI was 5(17.9%) with no significant association between mortality and treatment. (Table 4).

DISCUSSION

Despite revolutionary achievements in diagnosis and management over the last three decades, acute myocardial infarction continues to be a major public health problem in the developing world.[8] The development of atrioventricular block (AVB), particularly in anterior MI, has been shown to confer higher in-hospital and long-term mortality. Atrioventricular block in the setting of inferior MI is also associated with higher in-hospital mortality.[9,10] The mortality associated with complete heart block in anterior myocardial infarction, with or without preceding right bundle-branch block and left fascicular block, may be as high as 80 percent.[9]

In the current study the majority of patients were male 80.8% and the overall average age was 56.59±9.92 years. Diabetics was common co morbidity followed by hypertension and smoking. Anterior wall myocardial infarction 87.5% was more frequent than inferior and lateral wall myocardial infarction. Streptokinase was used for thrombolysis in 75% patients. A large community based study consisting of 13,663 residents of the Worcester reported that the average age of the hospitalized study sample was 69 years and 58% were men.[10]

Anatomically, the right bundle is composed of a single group of fibers which arborists only at the periphery.[11] Physiological evidence demonstrates that the electrocardiographic pattern of RBBB is identical in both proximal and distal interruptions (block) of the right-sided His-Purkinje network.[11-14] It has been shown that interruption of the proximal portion of the right-sided His-Purkinje network leads to a delay in the onset of right ventricular contraction (manifesting clinically as a delay between tricuspid and mitral valve closure) with a normal subsequent sequence of right ventricular contraction, whereas a distal block (disease affecting the distal branches of the His-Purkinje network) will cause asynchronous contraction of the right ventricle, thus slowing the rate of rise of pressure in the right ventricle, without delaying its onset, manifesting as a delay in the opening of the pulmonary valve.[12-14]

Combined disease is also possible in the same patient, with generalized disease affecting the right-sided conduction system, causing both proximal and distal RBBB.[11] Prognostically, it has been shown that this distinction is important, as proximal block caused by a single, localized lesion has an excellent long-term prognosis, whereas distal block caused by diffuse disease may be a manifestation of a progressive process.[11,15]

In this study, it is proposed that there exists a third type of right bundle branch block—neither proximal, nor distal, but one caused by an increased velocity of conduction to the left ventricle, effected by a muscular subaortic tendon coursing between the sub-aortic portion of the interventricular septum and the apex of the left ventricle, in this way leading to a "relative" RBBB as conduction in the right ventricle lags behind the increased conduction in the left ventricle.[16]

Physiologically, this third type of RBBB behaves as a proximal block, with a delay in right ventricular contraction, manifested by a delay between mitral and tricuspid valve closure. This is not the first electrocardiographic manifestation of muscular, sub-aortic tendons. Ker demonstrated that such a tendon can be responsible for striking ST-segment elevation on the electrocardiogram.[17] The electrocardiographic feature shared by all three these cases is a broad and notched R wave in lead aVR. Furthermore, they also share a deep and notched S wave in leads I, II, aVL and V4, 5 and 6 with a broad R wave in lead V1. In the assessment of structural causes for right bundle branch block it is suggested that a closer look at endoventricular structures and specifically at muscular structures traversing the cavity of the left ventricle should be taken. Based on the demonstrated electrocardiograms it is suggested that a broad and notched R wave in lead aVR in patients with RBBB may serve as an electrocardio-graphic clue for an underlying endoventricular cause of RBBB.[16]

Historically, the mortality of patients with AMI and RBBB before the thrombolytic era reached 77%.[18] A more recent study from Denmark still revealed the highest mortality of AMI among patients with BBB (left or right): 33.3% patients died in-hospital.[19] In one study of 1238 consecutive patients with AMI,[20] RBBB was found in 10.9% of patients. It was newly diagnosed in 37.8%, was known to be old in 34.1%, and in 28.1% the time of RBBB origin could not be established. Right bundle branch block patients had 1-year mortality 40.7 vs. 17.6% mortality in patients without RBBB ($P<0.001$). Mortality was significantly higher for new RBBB (43.1%, $p<0.001$) than for old (15.5%) and indeterminate (15.3%) RBBB. For isolated RBBB vsbifascicular block, early mortality was 14.4 vs. 40.6%, and 1-year mortality was 30.2 vs. 54.2% ($p<0.05$ for both).[4] In our study the in-hospital mortality rate 23.3%.

Kurisu et al in patients with anterior myocardial infarction found significantly higher 30-day mortality in patients with

RBBB compared with those without RBBB (14.0 vs. 1.9%, p<0.01).[21] The study of Kleemanet al. found that patients presenting with RBBB had higher in-hospital (26% vs. 11%,p <0.001) mortality than patients without RBBB.[22] After adjustment for differences in baseline characteristics, RBBB remained an independent predictor of increased mortality. Hirano et al. found that 37% of patients with AMI caused by the LMCA occlusion present with RBBB.[23]

Some authors insist on other ECG changes (e.g. ST-segment elevations) with RBBB to be present, while this is not the case for LBBB (where it is generally accepted that LBBB masks ST-segment shifts) for MI diagnosis.[24,25] Right bundle branch block is thought not to mask the repolarization phase changes or Q waves, therefore other ECG changes have to be present to conclude the diagnosis of AIM.

Gussak et al. showed that RBBB after myocardial infarction shortened Q wave duration, thus enabling false-negative diagnosis of inferior myocardial infarction.[26] Also the term 'RBBB-dependent Q-wave' was introduced by Rosenbaum et al. who described appearance of new Q waves in leads V1–V2 that disappeared after restoration of normal conduction.[27] Thus false-positive and false negative diagnosis of myocardial infarction can be made when describing ECG with RBBB in suspicion of myocardial infarction.

Outcome of STEMI patients with BBB was characterized by a high mortality. As compared with LBBB, RBBB ECG finding was a mortality predictor too. In our study, patients with RBBB had trend to major incidence of anterior infarction followed by inferior and lateral MI. In these patients ECG criteria for diagnosis of STEMI with LBBB possibly were not used. An analysis based on simple ST segment changes, may help identify patients with acute myocardial infarction who can then receive an appropriate reperfusion treatment.[28] Abnormal conduction disturbance traverses the interventricular septum toward the cardiac apex. In anterior acute myocardial infarction, the proximal occlusion of the left anterior descending artery produces ischemia of the septum and RBBB. The variable anatomy in the conduction system produces variations when ischemia or necrosis occurs and causes conduction disturbances in STEMI, explaining the variable incidences and prognostic meanings of the left fascicular blocks occurring simultaneously to RBBB.[29]

In present study patients with RBBB with anterior location AMI had high in-hospital mortality. This mortality in STEMI and RBBB may be explained by septal ischemia from a more proximal left anterior descending artery occlusion (before the large septal branch). It is important to emphasize that RBBB was a consistent risk marker for in-hospital mortality. A wider QRS duration ($\geqslant$ 160 msec) during anterior STEMI and RBBB may reflect more extensive ischemia in the conduction system; currently this ECG finding has been used in the risk stratification.[30]

In our study patients with AMI and RBBB were older and with more frequently severe heart failure than chest pain on admission, but even when they were matched with group for age and Killip class, RBBB remained an independent predictor of mortality. Patients with BRBB had larger anterior infarcts. The severe ventricular dysfunction (lower ejection fraction), cardiogenic shock and cardiac arrest were more frequent among patients with AMI and BBB during hospitalization.[6]

LIMITATIONS

Some asymptomatic, short lived RBBB patients may have been underestimated, since their recognition depends primarily on the careful attention of the ward nurse and sensitivity of the electrical alarm in response to the changes of the QRS pattern during ECG monitoring. Furthermore, the number of RBBB patients, especially new permanent RBBB patients, in this study was too small to apply for general consideration. As is well known, the management of MI has dramatically changed, and the prognosis of MI, even in new patients with new RBBB has been improved year by year. As in all clinical trials, a selection bias could have occurred in our study resulting in under representation of very high-risk patients, including those with RBBB accompanying anterior STEMI in the study. In addition, the ECG interpretation was not performed by experts in electrocardiography. Thus, it is not possible to study the different types of RBBB. Our analysis was included a relative small number of patients. We could not determine timing of onset or persistent RBBB if "new" or "old", so we can't appreciate the importance and the influence of this factor on patient prognostics and we can't confirm or comment the significance of a new or a preexisting RBBB. This study was limit to the hospitalization period, so the conclusions regard only the short-term outcome of patients.

CONCLUSION

The occurrence of bundle branch block in acute myocardial infarction is indicates that infarction may be extensive and may result in cardiac failure or death. The presence of bundle branch block is important because it indicates seriously jeopardized AV conduction and if hospitalized in time these high risk subsets of patients with myocardial infarction, their mortality can be decrease. Right bundle branch block was found to be common in elderly men. Patients with the abnormal ECG consisting on Right Bundle Branch Block and ST-segment elevation and without demonstrable structural heart disease are at high risk for sudden death. In STEMI, RBBB was an independent predictor of high inhospital mortality and had at least the same risk implication than LBBB. Patients who have RBBB accompanying anterior AMI at presentation or who develop new BBB early after fibrinolytic therapy independently have higher mortality than patients without these conduction abnormalities.

REFERENCES

1. Alan SG, Rundle AC, Joseph P, Andrew LA. Bundle –Branch Block and In-Hospital Mortality in Acute Myocardial Infarction. Ann Intern Med. 1998;129:690-97.
2. Antman EM. Bundle branch block in ST-elevation myocardial infarction: evidence for action. Arch Cardiol Mex. 2010 Apr;80(3):159-62.
3. Bhalli MA, Khan MQ, Samore NA, Mehreen S. Frequency and clinical outcome in conduction defects in acute myocardial infarction. J Ayub Med Coll Abbottabad. 2009;21(3):32-7.
4. Widimsky P, Rohac F, Stasek J, Kala P, Rokyta R, Jakle M, et al. Primary angioplasty in acute myocardial infarction with Right bundle branch block: Should new onset right branch block be added to new future guideline as an indication to reperfusion therapy: J European Heart. 2012;33:86-95.
5. Herrera UJ, Sanchez CJ, Pacheco HG, Sanchez CM. In-hospital outcome in patients with ST elevation myocardial infarction and right bundle branch block. A Sub-study from RENASICAS, a national multicentre registry. Arch Cardiol Mex. 2010;80(3):154-8.
6. Daniela T. Clinical characteristics and prognosis significance of bundle -branch block (BBB) associated with acute myocardial infarction (AMI). Ishemic Heart Disease. 2003;53:130-7.
7. Methew J. Non-glucose oral rehydration solution does it make a good thing better? Indian Paeds. 2009;46: 501-5.
8. Alam NH, Yunus M, Faruque ASG, Gyr N, Sattar S, Parvin S, et al. Symptomatic hyponatremia during treatment of dehydrating diarrheal disease with reduced osmolarity oral rehydration solution. J A M A. 2006; 296:567-73.
9. Meine TJ, Al-Khatib SM, Alexander JH, Granger CB, White HD, Kilaru R, et al. Incidence, Predictors, and Outcomes of High-Degree Atrioventricular Block Complicating Acute Myocardial Infarction Treated With Thrombolytic Therapy. Am Heart J. 2005;149(4):670-4.

10 Nguyen HL, Lessard D, Spencer FA, YarzebskiJ, Zevallos JC, Gore GM, et al. Thirty years trends (1975-2005) in the magnitude and hospital death rates associated with complete heart block in patients with acute myocardial infarction: a population-based perspective. Am Heart J. 2008;156(2):227-33.

11. Dancy M, Leech G, Leatham A. Significance of complete right bundle branch block when an isolated finding. An echocardiographic study. Br Heart J. 1982;48:217-21.
12. Smith LA, Fields J, Kennamer R, Prinzmetal M. Studies on the mechanism of ventricular activity. III: Contraction of the ventricles in experimental bundle branch block. Am Heart J. 1952;44:231-7.
13. Abildskov JA, Eich RH, Harumi K, Smulyan H. Observations on the relation between ventricular activation sequence and the hemodynamic state. Circ Res. 1965;17:236-47.
14. Millar K, Burgess MJ, Abildskov JA, Eich RH. Dependence of intraventricular pressure on activation order before and after experimental Purkinje net block. J Electrocardiol. 1970;3:51-6.
15. Rotman M, Triebwasser JH. A clinical and follow-up study of right and left bundle branch block. Circulation. 1975;51:477-84.
16. Ker J. Structural causes of right bundle branch block—Time for a closer Look? The Open Cardiovascular Med J. 2010;4:105-09.
17. Ker J. Sub aortic tendon induced ST segment elevation- a new echo electrocardiographic phenomenon? Cardiovasc Ultrasound. 2009;7:13.
18. Gould L, Venkataraman K, Mohhamad N, Gomprecht RF. Prognosis of right bundle-branch block in acute myocardial infarction. J A M A. 1972;219:502–03.
19. Terkelsen CJ, Lassen JF, Nørgaard BL, Gerdes JC, Jensen T, Gøtzsche LB, et al. Mortality rates in patients with ST-elevation vs. non-ST-elevation acute myocardial infarction: observations from an unselected cohort. Eur Heart J. 2005;26:18–26.
20. Melgarejo-Moreno A, Galcera´-Toma´s J, Garcia-Alberola A, Valde´s-Chavarri M, Castillo-Soria FJ, Mira-Sa´nchez E, et al. Incidence, clinical characteristics, and prognostic significance of right bundle-branch block in acute myocardial infarction. A study in the thrombolytic era. Circulation. 1997;96:1139–44.
21. Kurisu S, Inoue I, Kawagoe T, Ishihara M, Shimatani Y, Hata T, et al. Right bundle-branch block in anterior acute myocardial infarction in the coronary intervention era: acute angiographic findings and prognosis. Int J

Cardiol. 2007;116:57–61.

22. Kleemann T, Juenger C, Gitt AK, Schiele R, Schneider S, Senges J, et al. Incidence and clinical impact of right bundle branch block in patients with acute myocardial infarction: ST elevation myocardial infarction versus non-ST elevation myocardial infarction. Am Heart J. 2008;156:256–61.
23. Hirano T, Tsuchiya K, Nishigaki K, Sou K, Kubota T, Ojio S, et al. Clinical features of emergency electro-cardiography in patients with acute myocardial infarction caused by left main trunk obstruction. Circ J. 2006;70:525–29.
24. Thygesen K, Alpert JS, White HD, Joint ESC/ACCF/AHA/WHF Task Force for the Redefinition of Myocardial Infarction. Universal definition of myocardial infarction. Eur Heart J. 2007;28:2525–38.
25. Wong CK, Stewart RAH, Gao W, French JK, Raffel C, White HD, et al. Prognostic differences between different types of bundle branch block during the early phase of acute myocardial infarction: insights from the Hirulog and Early Reperfusion or Occlusion (HERO)-2 trial. Eur Heart J. 2006;27:21–8.
26. Gussak I, Zhou SH, Rautaharju P, Bjerregaard P, Stocke K, Osada N, et al. Right bundle branch block as a cause of false negative ECG classification of inferior myocardial infarction. J Electrocardiol. 1999;32:279–84.
27. Rosenbaum MB, Girotti LA, Lazzari O, Halpern MS, Elizari MV. Abnormal Q waves in right sided chest leads provoked by onset of right bundle branch block in patients with anteroseptal infarction. Br Heart J. 1982;47:227–32.
28. Sgarbossa EB, Pinski SL, Barbagelata A, for the GUSTO Investigators. Electrocardiographic diagnosis of evolving acute myocardial infarction in the presence of left bundle-branch block. N Engl J Med. 1996;334: 481-7.
29. Ricou F, Nicod P, Gilpin E. Influence of right bundle branch block on short- and long- term survival after acute anterior myo-cardial infarction. J Am CollCardioll. 1991;17:858-63.
30. Wong CK, Wanzhen G, Ralph AH. On behalf of Hero 2 Investigators. Risk stratification of patients with acute anterior myocardial infarction and right bundle branch block. Importance of QRS duration and early ST segment resolution after fibrino¬lytic therapy. Circulation. 2006;114:783-89.