Observational Study

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Clinical and electrocardiographic characteristics of infarctional ventricular ectopic beats

An observational study

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Abstract

The purpose of this study was to explore the clinical and electrocardiographic characteristics of infarctional ventricular ectopic beats (IVEBs).

Thirty-eight acute myocardial infarction (AMI) patients with IVEB and 109 AMI patients without IVEB were analyzed. The morphological changes of QRS complex, ST segment, and T wave were compared to IVEB with sinus rhythm from the same period and fully evolved phase.

An IVEB QRS complex often revealed the right bundle branch block morphology, in addition to Q wave AMI; no-Q wave AMI also had IVEB. Single-factor analysis found that IVEB often appeared in early AMI (<6 hours), and they were more frequent in inferoposterior with/without right ventricular involvement, large area AMI and thrombolytic reperfusion than in anterior or anteroseptal myocardial infarction, small area AMI, and unthrombolytic nonreperfusion. Multifactors no conditional logistic regression analysis revealed a positive correlation between IVEB and early AMI, AMI size, Killip heart function degree, inferoposterior with/without right ventricular involvement, and thrombolytic reperfusion. The Q wave of IVEB was wider, and the ST segment elevation was higher than those of the same period in sinus rhythms. The infarctional morphological changes of IVEB could be found before the same period in sinus rhythm and elevated myocardial enzymes.

IVEBs were not rare. They were useful for early diagnosis and location of AMI.

Abbreviations: AMI = acute myocardial infarction, AVT = accelerated ventricular tachycardia, IVEB = infarctional ventricular ectopic beats, IVPC = infarctional ventricular premature contractions, LBBB = left bundle branch block morphology, RBBB = right bundle branch block morphology, VPB = ventricular premature beats, VT = ventricular tachycardia.

Keywords: acute myocardial infarction, electrocardiography, infarctional ventricular ectopic beats

1. Introduction

The morphology of ventricular premature beats (VPBs) with a qR, QR, or QRS pattern, arched ST segment elevation, or symmetrically vertical or inverted T-wave is useful in detecting acute myocardial infarction (AMI).[1–7] The VPBs were called infarctional ventricular premature contractions (IVPCs). However, the morphology of ventricular escape or ventricular escape rhythm, accelerated ventricular tachycardia (AVT), and ventricular tachycardia (VT) as above IVPCs was rarely investigated. After a long period of clinical observation, we found that in patients with AMI, except IVPCs, ventricular escape or ventricular escape rhythm, AVT, and VT were also revealed as above IVPCs. All the morphological changes were designated infarctional ventricular ectopic beats (IVEBs). Therefore, we further studied the clinical, electrocardiographic characteristics of IVEB and the value of IVEB in early diagnosis and location of AMI.

2. Methods

2.1. Study population

From January 2001 to February 2006, 147 patients with AMI were studied in our hospital. The patients included 115 men and 32 women, aged 37 to 85 (mean age 70.1 ± 8.8) years. Among the 147 AMI patients, 124 with Q wave AMI and 23 with no-Q wave AMI matched the diagnostic standard established by American College of Cardiology Foundation/American Heart Association.[8]

All the patients were traced routinely on the 12 or 18-lead electrocardiogram (ECG) every 2 to 4 hours within the first 24 hours after AMI, at least 2 times a day after the first 24 hours, and had routine electrocardiographic monitoring after the first week. Once IVEB was found, 12 or 18-lead ECG (3-lead synchronous recording) was timely traced. Each lead should record at least 1 ventricular ectopic beat for analysis. All patients had their serum myocardial enzymes tested at least once every 8 hours within the first 24 hours after AMI, and once every day for 3 consecutive days after the first 24 hours. All patients had venous blood

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Table 1

The factors impacting IVEB ($\bar{x} \pm s$).

Influencing factors	IVEB (n=38)	Non-IVEB (n=109)	χ^2 or t	P
Sex (male/female)	28/10	87/22	0.38	>.05
Age, y	71.0±6.4	69.8±10.3	1.09	>.05
Location (anterior/inferior wall)	8/30	79/30	30.28	<.001
Size* (large size/small size)	28/10	60/49	5.10	<.05
Type (Q wave/non-Q wave)	34/4	90/19	0.49	>.05
Killip classification (I/II/III–IV)	3/23/12	31/50/28	8.14	<.05
Infarctional time (<6 h/≥6 h)	31/7	50/59	16.65	<.001
Prognosis (cure/death)	34/4	97/12	0.0003	>.05
Thrombolytic therapy (yes/no)	15/23	25/84	5.37	<.05
Coronary reperfusion (yes/no)	14/24	16/93	10.76	<.01
CK peak, IU/L	3799.1±1001.2	3060.1±1416.2	4.67	<.001
CK-MB peak, IU/L	300.1±136.3	230.2±94.4	3.41	<.001
Blood K+, mmol/L	3.93±0.67	4.127±0.37	1.60	>.05
Blood Na+, mmol/L	141.25±3.44	140.507±5.02	0.92	>.05
Blood Cl^-, mmol/L	101.2±3.54	101.353±4.39	0.27	>.05
QRS scoring	22.2±9.61 (n=34)	18.1±9.82 (n=90)	2.65	<.01
Cardiac chamber sizes	n=34	n=97		
LAV, mm	38.2±6.87	38.4±3.79	0.09	>.05
LVEDV, mm	53.9±7.31	55.1±3.74	1.30	>.05
LVESV, mm	36.6±7.01	36.72±5.29	0.08	>.05
Ejection fraction (%)	43.5±12.04	48.82±13.86	2.35	<.05*

CK=creatine kinase, IVEB=Infarctional ventricular ectopic beats, LAV=left atrial, LVEDV=left ventricular end-diastolic volume, LVESV=left ventricular end-systolic volume.
* Large size refers to the area at 2 sites (such as inferior wall+posterior wall or right ventricular) or anterior wall infarction of more than 5 leads with Q wave.

electrolytes drawn at 7 to 8 o'clock the next morning after hospitalization, and cardiac chamber sizes were measured with echocardiography when they were in stable condition after 1 to 2 weeks.

Table 2

The IVEB Q waves compared with sinus rhythm of the same period and fully evolved phase.

		Q wave in infarctional location			
Group	n	Total number of leads	$\chi \pm s$	Width, ms	Depth, mm
IVEB	38	188	4.95±0.89*	58.36±14.23*,†	4.49±1.81*,†
SRSP	38	77	2.03±1.02	41.03±6.48	3.07±1.01
SREP	38	177	4.66±0.93‡	47.79±12.01‡	3.46±1.84§

IVEB=infarctional ventricular ectopic beats, SREP=sinus rhythm of fully evolved phase, SRSP=sinus rhythm of the same period.
* $P<.01$, IVEB vs. SRSP.
† $P<.01$, IVEB vs. SREP.
‡ $P<.01$.
§ $P<.05$, SREP vs. SRSP.

Table 3

Morphology of the IVEB ST segment compared with sinus rhythm of same period and fully evolved phase.

		Morphology of ST		Leads of ST elevation		
Group	n	Arched elevation	Non-ard elevation	Total number	$\chi \pm s$	Height of ST elevation, mm
IVEB	38	38*	0	196	5.16±1.24*	3.74±1.52*
SRSP	38	19	19	180	4.74±1.27	2.56±1.29

IVEB=infarctional ventricular ectopic beats, SRSP=sinus rhythm of the same period.
* $P<.01$ vs. sinus rhythm in the same period.

All patients were divided into 2 groups: IVEB group, at least ≥2 adjacent leads had IVEB, a total of 38 patients, 28 males, and 10 females, 50 to 85 years of age (mean age 71.0±6.4 years); non-IVEB group, (including ventricular ectopic beats but not IVEB patterns) a total of 109 patients, 87 males and 22 females, 37 to 86 years of age (mean age 69.8±10.3). The sex, age, infarctional location, size, time, type, heart function, prognosis (the number of cases of death during hospitalization), serum electrolytes, serum myocardial enzymes, electrocardiographic QRS scoring, cardiac chamber sizes, and left ventricular ejection fraction were analyzed, and the morphological changes of QRS complex (Q wave width, depth, and total number of leads), ST segment (height and total number of leads), and T wave were compared to IVEB with sinus rhythm of the same period and fully evolved phase (3–7 days after AMI, the deepest pathological Q wave was chosen).

2.2. Ethics approval

Ethical approval was obtained from the Ethics Committee of the Second Affiliated Hospital of Wenzhou Medical University, and all patients gave informed consent before participation in the study. The study methods were conducted in accordance with approved national and international guidelines.

Table 4

IVEB compared with SRSP for the value of early diagnosis and location of AMI.

		Early diagnosis of AMI		Early location of AMI	
Group	n	Diagnosis	%	Correct number	%
IVEB	31	31*	100	26*	83.87
SRSP	31	18	58.06	15	48.39

IVEB=infarctional ventricular ectopic beats, SRSP=sinus rhythm of the same period.
* $P<.01$ vs. sinus rhythm in the same period.

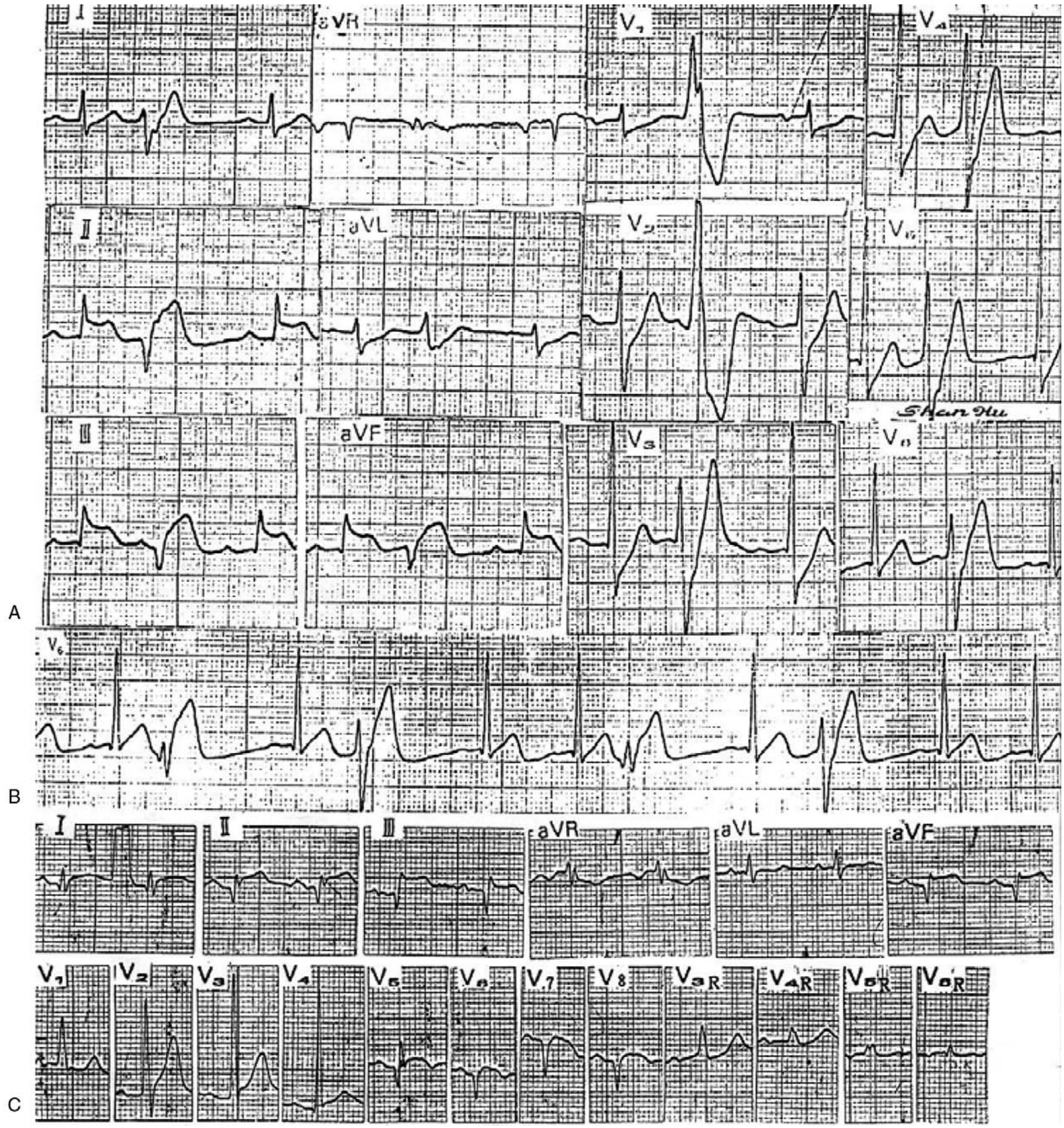

Figure 1. Double-derived infarctional ventricular premature contraction revealed acute myocardial infarction. Male patient, aged 65 years, chest squeezing pain for 0.5 h, had a history of hypertension. (A and B) Electrocardiogram done upon admission after about 0.5 hours, presented sinus rhythm. ST $_{\text{II, III, and aVF}}$ arched down to raise approximately 0.3 mV with T-wave fusion into a 1-way curve. Double-derived ventricular premature contractions can be seen frequently. One type was a right bundle branch block and had a longer coupling interval. Its QRS $_{\text{II,III,aVF}}$ complex morphology had a QS and arched ST segment elevation with T wave fusion into a one-way curve. Another had a shorter coupling interval. Its QRS $_{\text{V6}}$ complex morphology had a QRSR and arched ST segment elevation of 0.4 mV with T wave fusion into a one-way curve. (C) An electrocardiogram the next day indicated acute inferoposterior and lateral myocardial infarction.

2.3. Statistical analysis

Results are expressed as mean value ± standard deviation. SAS 6.12 software was used for statistical analysis. Group *t* test, analysis of variance, and q test were used; enumeration count data were collected using the χ^2 test (χ^2 test), and multifactors correlation analysis used no conditional logistic regression analysis. A value of $P<.05$ was considered significant.

3. Results

3.1. The IVEB type and QRS morphology

Thirty-eight patients with IVEB had IVPC 29 times (QRS morphology showed right bundle branch block morphology [RBBBM]), infarctional ventricular tachycardia (all showed RBBBM) 6 times, AVT (showed RBBBM 3 times and left bundle branch block morphology [LBBBM] 2 times) 5 times, and

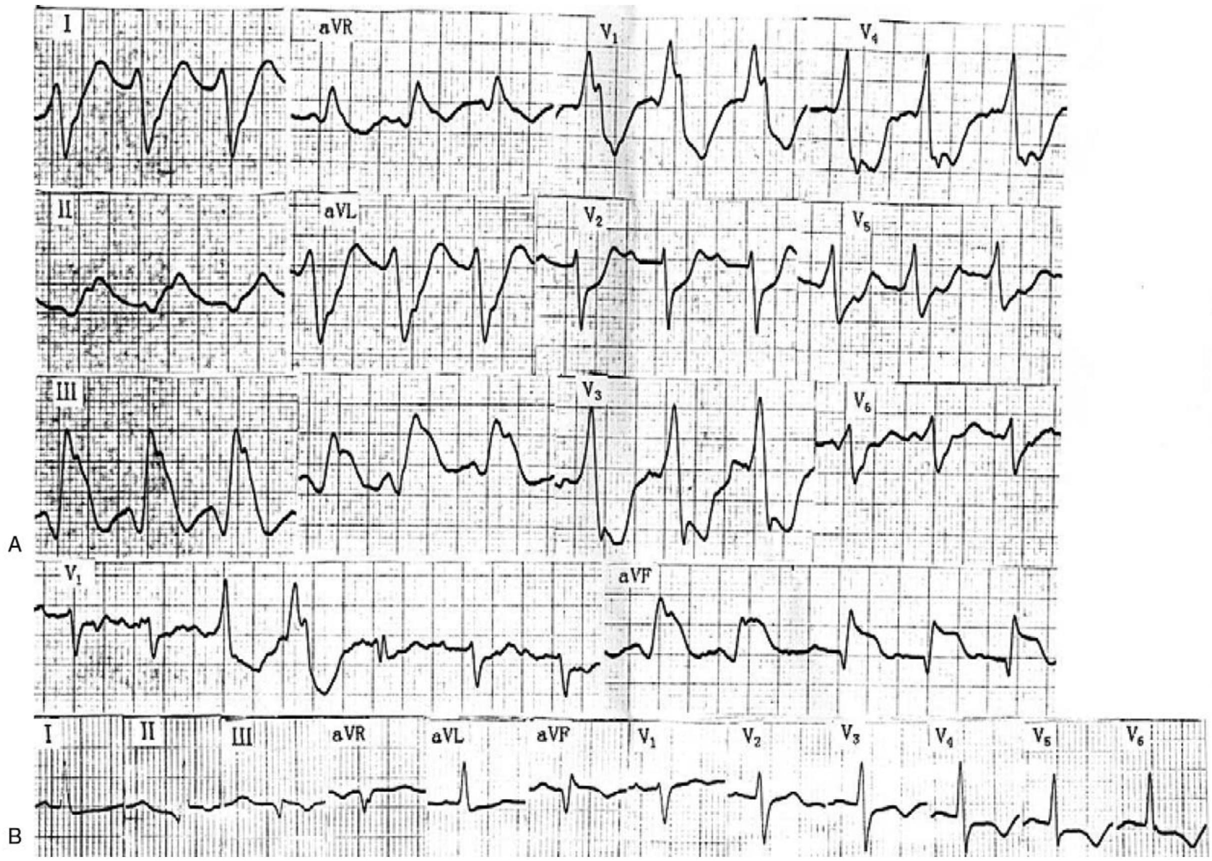

Figure 2. Ventricular tachycardia reveals acute myocardial infarction. Male patient, aged 75 years, chest pain for 2 hours. Patient suddenly loses consciousness, with eyes staring upward and limbs twitching. His electrocardiographic monitor revealed ventricular fibrillation. After defibrillation, sinus rhythm, ventricular premature contraction, and ventricular tachycardia appeared in turn. (A) Ventricular tachycardia and ventricular premature contraction for complete right bundle-branch block. Its morphology of QRS $_{II,III,AVF}$ complex had qR or qr with arched ST segment elevation and T wave fusion into a 1-way curve. We considered inferior myocardial infarction with infarctional ventricular premature contraction and ventricular tachycardia. (B) ECG after 4 hours revealed a typical inferior myocardial infarction graphic evolution.

infarctional ventricular escape (showed RBBBM) and ventricular escape rhythm (showed LBBBM), respectively, 2 times. Two types of IVEB existed in some patients.

3.2. The factors impacting IVEB

Single-factor analysis found that IVEB often appeared in early AMI (<6 hours), and they were more frequent in inferoposterior with/without right ventricular involvement, large size AMI (high QRS score and low left ventricular ejection fraction) and thrombolytic reperfusion than those in anterior or anteroseptal myocardial infarction, small size AMI, and unthrombolytic nonreperfusion ($\chi^2=5.10\sim30.28$, $P<.05\sim<.01$). Multifactors no conditional logistic regression analysis revealed that IVEB was positively correlated with inferoposterior with/without right ventricular involvement, large size AMI, poor heart function, early AMI, and thrombolytic reperfusion ($\chi^2=5.23\sim30.28$, $P<.05$–$<.01$) (Table 1).

3.3. The IVEB Q waves compared with sinus rhythm of the same period and fully evolved phase

The IVEB and sinus rhythm of fully evolved phases did not differ significantly in the number of Q waves ($P>.05$), but much more than the sinus rhythm of the same period ($P<.01$); the depth and width of the IVEB Q wave in infarctional localization were significantly deeper and wider than sinus rhythm of the same period and fully evolved phase ($P<.05$–$.01$) (Table 2). This showed that the IVEB pathological Q wave in infarctional localization appeared earlier. IVEB was useful for the early diagnosis of AMl.

3.4. The IVEB ST segments compared with sinus rhythm of the same period and fully evolved phase

The height and total lead numbers of ST segment elevation and numbers of arched elevation in IVEB were significantly higher (or more) than sinus rhythm in the same period ($P<.01$) (Table 3).

3.5. The value of IVEB to early diagnosis and location of AMI

The early diagnosis of acute myocardial infarction was based on the presence of ischemic chest pain ≥30 minutes and pathological Q waves or ST segment elevation of IVEBs and sinus rhythm. Among 38 IVEB patients, 31 had early AMI (<6 hours) when CK-MB and cardiac troponin I (or T) were not increased or only increased slightly (it was only slightly increased in 8 cases in this group), and sinus rhythm of the same period had an atypical ECG (31 cases, only 10 patients with pathological Q waves, 15 patients

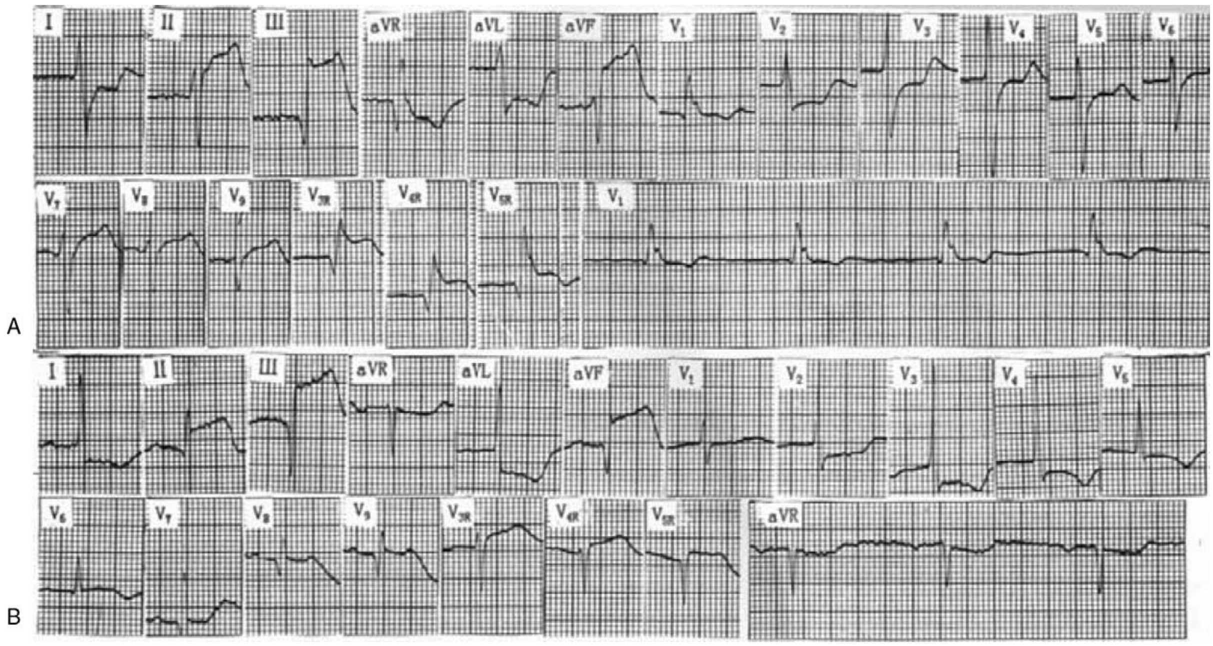

Figure 3. Accelerated ventricular tachycardia revealed acute myocardial infarction. Male patient, aged 75 years, chest tightness for 2 hours. (A) Electrocardiogram upon admission, which revealed sinus arrest and accelerated ventricular tachycardia. Its morphology of QRS complex was a complete right bundle-branch block. The ST $_{III,aVR,V1,v3\sim V5R}$ segment arched elevated 0.10–0.70 mV with T wave fusion into a one-way curve. We considered this inferior and right ventricular acute myocardial infarction. (B) ECG after 1.5 hours resumed sinus rhythm, and revealed an inferior and right ventricular myocardial infarction.

with arched ST segment elevations). The 31 IVEB patients are compared with sinus rhythm of the same period for the value of early diagnosis and location of AMI in Table 4. The table shows that IVEB is more useful to early diagnosis and location of AMI than sinus rhythm in the same period. Analysis of the VEBs morphology may be useful for the diagnosis of MI when the morphology of sinus beats is not diagnostic. The typical ECG is shown in Figures 1–3.

4. Discussion

After 5 years of clinical observation, we found that IVEB was not uncommon. The 38 AMI patients of the IVEB group accounted for 25.85% (38/147) of all hospitalized AMI patients during the same period, and the 28 patients of IVEB group with inferior wall (with or without posterior and/or right ventricular AMI) accounted for 50.00% (30/60) during the same period of all hospitalized inferior (posterior) wall AMI patients. Moreover, we found that not only Q wave AMI, but also non-Q wave AMI, had IVEB. This study of the factors impacting IVEB showed the following results: Single factor analysis revealed that the incidence of IVEB was associated with the infarctional location, infarctional time, infarction size, and the acceptance of thrombolytic therapy ($P < .05$). IVEB easily appeared in the conditions of the inferior (posterior) wall infarction, early period of infarction (<6 hours), large-size infarction (high QRS score and low left ventricular ejection fraction), and coronary reperfusion ($P < .05$–$< .01$). Multifactors no conditional logistic regression analysis revealed that the infarctional location, infarctional size, infarctional time, heart function (Killip classification), and coronary reperfusion receiving thrombolytic therapy were risk factors of IVEB ($\chi^2 = 5.23\sim18.73$, $P < .05$), whereas sex, age, blood electrolytes, cardiac chamber sizes, and prognosis were not correlated with IVEB.

4.1. ECG features of IVEB

The most common morphology of the 38 IVEB patients was IVPC (29 times), followed by ventricular tachycardia (6 times), AVT (5 times), ventricular escape (2 times), and ventricular escape rhythm (2 times). Two types of IVEB existed in some patients. In the majority, the QRS morphology showed RBBBM (35 cases), and the minority showed LBBBM (3 cases). This phenomenon may not be a mere coincidence. It may be associated with the fact that the AMI Q waves (initial vector) of RBBBM were not influenced; instead, QRS waves of LBBBM at both the beginning and ending vectors were abnormal following secondary ST segment changes, covering the AMI Q wave and ST segment elevation.[9,10] The Q waves of IVEBs compared with sinus rhythm of the same period and fully evolved phase showed ① the total and average number of leads that had Q waves appearing in infarctional location, and the depth and width of Q waves, increased more significantly in the IVEB group than those of sinus rhythm in the same period ($P < .01$). The IVEB Q wave was wider and deeper than those of in sinus rhythm of fully evolved phase ($P < .05\sim.01$). ② The height of ST segment elevation, lead numbers of all ST segment elevation, and only arched elevations in IVEB were significantly higher (or more) than those of sinus beats in the same period ($P < .01$).

4.2. The value of IVEB to location and early diagnosis of AMI

Thirty-one of the 38 patients had IVEB occurring in early AMI. The early diagnosis of AMI by IVEB in the study had a 100% accuracy rate, and the location accuracy rate was 83.87%, significantly higher than that of sinus rhythm of the same period (58.06% and 48.39%, $P < .01$).

In conclusion, our study indicates that: ① IVEB often appeared in early AMI (<6 hours), and the majority of cases with IVEB QRS complex often revealed RBBBM. These occurred frequently in inferoposterior with/without right ventricular involvement, large size AMI, poor Killip heart function degree, and thrombolytic reperfusion. In addition to Q wave AMI, non-Q wave AMI may have IVEB; ② The occurrence of Q wave and ST segment arched elevation of IVEB were not only earlier than those of sinus rhythm in the same period, but they were more characteristic of AMI; ③ IVEBs appeared before myocardial enzymes and cardiac troponin I (or T) increased; ④ IVEB is more useful to early diagnosis and location of AMI than sinus rhythm of the same period. Therefore, suspected early AMI patients should be routinely monitored. Once ventricular ectopic beats occur, patients should begin receiving 12 or 18-lead ECG. If the ventricular ectopic beats are morphological of IVEB, it is helpful for early diagnosis and location of AMI.

References

[1] Katz KH, Berk MS, Mayman CI. Acute myocardial infarction revealed in an isolated premature ventricular beat. Circulation 1958;18:897–901.

[2] Cohen AI. Acute myocardial infarction revealed by interpolated premature ventricularcontractions. Dis Chest 1967;52:83–4.

[3] Lichtenberg SB, Schwartz MJ, Case RB. Value of premature ventricular contraction morphology in the detection of myocardial infarction. J Electrocardiol 1980;13:167–71.

[4] Sclarovsky S, Strasberg B, Lahav M, et al. Premature ventricular contractions in acute myocardial infarction. Correlation between their origin and the location of infarction. J Electrocardiol 1979;12: 157–61.

[5] Biel SI, Kleiger RE. Ventricular premature complexes in the early diagnosis of acute myocardial infarction. South Med J 1985;78:7–10.

[6] Terasawa F, Matsushita S, Kuramoto K, et al. The diagnostic value of ventricular premature beats in myocardial infarction. Jpn Circ J 1967;31:397–403.

[7] Dash H, Ciotola TJ. Morphology of ventricular premature beats as an aid in the electrocardiographic diagnosis of myocardial infarction. Am J Cardiol 1983;52:458–61.

[8] Ryan TJ, Antman EM, Brooks NH, et al. 1999 update: ACC/AHA Guidelines for the Management of Patients With Acute Myocardial Infarction: Executive Summary and Recommendations: A report of the American College of Cardiology/American Heart Association Task Force on Practice Guidelines (Committee on Management of Acute Myocardial Infarction). Circulation 1999;100:1016–30.

[9] Lopes RD, Siha H, Fu Y, et al. Diagnosing acute myocardial infarction in patients with left bundle branch block. Am J Cardiol 2011;108:782–8.

[10] Widimsky P, Rohác F, Stásek J, et al. Primary angioplasty in acute myocardial infarction with right bundle branch block: should new onset right bundle branch block be added to future guidelines as an indication for reperfusion therapy? Eur Heart J 2012;33:86–95.