Prognostic Significance of Bundle-Branch Block in Acute Myocardial Infarction: The Importance of Location and Time of Appearance

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Summary

Background: The presence of bundle-branch block (BBB) is associated with high mortality rates and is considered an important predictor of poor outcome in patients with acute myocardial infarction (AMI).

Hypothesis: The objective of this study was to assess the prognostic significance of BBB in patients with AMI depending on its form of presentation.

Methods: A multicenter prospective 1-year follow-up study involving 1,239 consecutive patients diagnosed with AMI was performed.

Results: Bundle-branch block was present in 177 cases (14.2%), associated with worse clinical characteristics, lower rate of thrombolytic therapy, and higher mortality: in-hospital (23.8 vs. 9.7%, $p < 0.01$) and 1-year (40.9 vs. 16.9%, $p < 0.01$). Compared with right BBB ($n = 135$), left BBB ($n = 42$) was more often associated with female gender and higher prevalence of cardiovascular diseases, but had a similar 1-year mortality. In the absence of heart failure or complete atrioventricular (AV) block, there was no difference in in-hospital mortality of patients with BBB ($n = 76$) and without BBB ($n = 786$) (2.6 vs. 3.9%). Compared with existing BBB ($n = 113$), BBB of new appearance ($n = 64$) was more often accompanied by complete AV block and heart failure and higher in-hospital and 1-year mortality rates. Only BBB of new appearance was an independent predictor of mortality: in-hospital (odds ratio [OR] 2.3, 95% confidence interval [CI] 1.1–4.7) and 1-year mortality (OR 3.2, 95% CI, 1.7–9.1).

Conclusions: In patients with AMI, the classification of BBB according not only to location but also to time of appearance is of practical interest. New BBB is an independent predictor of short- and long-term mortality.

Key words: acute myocardial infarction, bundle-branch block, prognosis

Introduction

Bundle-branch block (BBB) is associated with acute myocardial infarction (AMI) in between 8 and 23% of cases.^{1–10} Published studies usually consider right and left BBB together, or they consider right BBB^{2, 11–13} or, less frequently, left BBB^{14, 15} independently. In prethrombolytic studies, the time of appearance of BBB has a practical interest: new BBB usually expresses a large infarction, frequently accompanied by heart failure, complete atrioventricular (AV) block, arrhythmias, and high mortality rates.^{1, 2, 4, 6, 9, 14, 16, 17–20} Most of the data available in the thrombolytic era²¹ appear to indicate a reduction in the incidence of BBB that could be attributed to the reversibility of conduction disturbances related to coronary reperfusion.^{22–25} However, the most recent extensive study²⁶ does not take into account the time of appearance of BBB or its association or nonassociation with other determining complications of the prognosis, such as complete AV block or congestive heart failure.^{5, 6, 13}

With all this in mind, our aim was to assess the clinical characteristics and prognostic significance of BBB with due regard to its localization, time of appearance, and association with heart failure and/or AV block.

Methods

Patients

Between June 1992 and January 1994, we conducted a prospective study on 1,239 consecutive patients admitted to the coronary care units of three hospitals in the Murcia region of Spain for acute myocardial infarction of < 24 h from the onset of symptoms. Clinical variables and methodological procedures have been published previously.²⁷

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Diagnostic Criteria for Bundle-Branch Block

Bundle-branch block was defined using the standard electrocardiographic (ECG) criteria;^{28,29} a QRS duration of ≥ 120 ms was required. The diagnostic criteria used for the determination of left BBB included (1) QS or rS complex in lead V₁; (2) R peak time ≥ 0.06 s without Q waves in leads I, V₅, or V₆. Diagnostic criteria for the presence of right BBB included (1) a secondary R wave (R') in the right precordial leads, with the R' greater than the initial R wave (rSR' or QR); (2) a delay in intrinsicoid deflection in the right precordial leads ≥ 0.06 s; and (3) a wide S wave in leads I, V₅, and V₆.

Bundle-branch block was also classified according to time of appearance: new if it appeared after admission or was present on admission but not recorded on a prior ECG; old if it was present on admission and documented on a previous ECG; and of indeterminate age if it was present on admission and no previous ECG was available. Old and indeterminate BBBs were considered as a single group, existing BBB for some comparisons. New BBBs were classified as transient when there was no BBB present at the time of hospital discharge, and permanent when the patient either died or was discharged with BBB present. Blocks that were found in the terminal phase of cardiogenic shock were excluded from analysis.

Follow-Up

All patients were followed up from the time of admission to the coronary care unit to either death or 1 year. In-hospital mortality was defined as death occurring during hospital stay and total mortality as death that occurred between admission and 1 year of follow-up. The in-hospital follow-up was accomplished in 100% of cases, and the 1-year follow-up in 96.5% of all those discharged alive from the hospital.

Statistical Analysis

A descriptive analysis was done on all the variables to obtain a frequency distribution. For the quantitative variables we also determined the mean, median, standard deviation, and range. The relationships between categorical variables were assessed using contingency tables and the chi-square test. Between-group comparisons were studied using analysis of variance (ANOVA) complemented with means equality contrasts using the Student's *t*-test. The level of significance was $p < 0.05$. To determine whether new BBB had independent value for predicting in-hospital and 1-year mortality, a logistic regression analysis was performed in all patients, adjusting for several variables with influence on mortality: age, gender, previous infarction, previous congestive heart failure, hypertension, diabetes, anterior location, creatine kinase (CK) > 1000 U/l, heart rate, systolic blood pressure, and Killip class $> I$ at admission, and administration of thrombolytic treatment. To determine the possible independent prognostic value of existing (old or indeterminate) BBB, the same analysis was repeat-

TABLE I Classification of 177 bundle-branch blocks (BBB)

	New	Indeterminate	Old	Total n (%)
Right BBB n (%)	51 (28.8)	39 (22)	45 (25.4)	135 (76.2)
Left BBB n (%)	13 (7.3)	4 (2.2)	25 (14.1)	42 (23.7)
Total n (%)	64 (36.1)	43 (24.2)	70 (39.5)	177 (100)

ed in all patients except in those with new BBB. The statistical package used was Statistical Package for Social Sciences (SPSS Inc., Chicago, Ill., USA).³⁰

Results

Incidence, Time of Appearance of Bundle-Branch Block, and Association with Thrombolytic Treatment

During the study period 1,239 patients with AMI were admitted. The presence of BBB was documented in 177 patients (14.2%): right BBB in 135 patients (76%) and left BBB in the remaining 42 patients (24%). According to location and time of appearance, BBB was considered of new appearance in 64 patients (36%) (Table I). New BBB was transient in 34 patients (53%), lasting < 6 h in 19 patients.

Right BBB of new appearance was more often observed in patients treated with thrombolytics, 34 (5%) vs. 17 (3%) cases ($p < 0.05$), as it was more frequently transient (56 vs. 30%), although this difference did not reach statistical significance. On the other hand, new left BBB was associated with thrombolytic therapy in 4 patients (0.6%) and was observed in 9 patients (1.6%) in the absence of this treatment.

Clinical History and Characteristics of Patients with Bundle-Branch Block

Patients with BBB were older, more likely to be of female gender, and presented with more antecedents of angina, congestive heart failure, hypertension, diabetes, and previous treatment for cardiovascular diseases. Bundle-branch block was associated with a higher heart rate and Killip class on admission, more frequent anterior localization of the infarction, higher CK peak, and lower ejection fraction (Table II).

Patients with left BBB had a more adverse profile of clinical characteristics for cardiovascular disease, were admitted with greater admission delay, and received a lower rate of fibrinolytic treatment (Table II).

Complications and Mortality Depending on the Presence and Location of Bundle-Branch Block

Patients with BBB presented more frequently with complications and had a higher mortality rate: in-hospital (23.8 vs. 9.7%) and first year (40.9 vs. 16.9%). Ventricular fibrillation and cardiogenic shock were more frequently associated with right BBB. Left BBB was associated with a higher proportion

TABLE II Baseline characteristics depending on presence and location of bundle-branch block (BBB)

	No BBB (n = 1,062)	BBB (n = 177)	Right BBB (n = 135)	Left BBB (n = 42)
Age (years)	63.5 ± 11.5	67.7 ± 10.1 ^a	66.9 ± 10.4 ^a	70 ± 8.8 ^a
Female %	22.7	32.3 ^b	26.6	50 ^{a,d}
Previous myocardial infarction %	19.2	24.2	17	47 ^{a,d}
Previous heart failure %	4.1	16.4 ^a	11.8 ^b	30 ^{a,d}
Diabetes %	29.2	42.6 ^a	40.7 ^b	50 ^b
Hypertension %	38.8	48.8 ^c	42.9	66 ^{a,d}
Smoking %	44.4	28.9 ^a	31.8 ^b	21 ^b
Hypercholesterolemia %	23.8	18.7	19.2	16
Previous treatment for CVD %	22.6	38 ^a	29.6	64 ^{a,d}
Time to arrival (min)	324 ± 403	378 ± 454	346 ± 424	477 ± 530 ^c
Heart rate at admission (beats/min)	81.6 ± 29.2	89.8 ± 25.5 ^a	88.7 ± 23.2 ^b	95 ± 32 ^c
Anterior location %	39.2	66.1 ^a	67.2 ^a	50
Peak CK (U/l)	1585 ± 1293	1962 ± 1514 ^b	1995 ± 1358 ^b	1985 ± 1880
Killip class > I at admission %	19	46 ^a	40.7 ^a	64 ^{a,d}
Left ventricular ejection fraction %, (n)	47 ± 12 (n = 623)	37 ± 12 ^a (n = 100)	39 ± 13 ^b (n = 73)	33 ± 10 ^{a,d} (n = 27)
Thrombolysis %	56.3	46.5 ^c	54	21.4 ^{a,d}
Use of pacemaker %	3.4	10.2 ^a	11.1 ^a	7

Differences with non-BBB patients: ^a $p < 0.001$, ^b $p < 0.01$, ^c $p < 0.05$.

^d Statistically significant differences between patients with right BBB and left BBB.

Abbreviations: CK = creatine kinase, CVD = cardiovascular diseases. Previous treatment included any of calcium-channel blockers, beta blockers, digoxin, diuretics, antiarrhythmic drugs, or angiotensin-converting enzyme inhibitors.

of congestive heart failure. Patients with right and left BBB showed similar 1-year mortality rates (Table III).

Some Peculiarities Depending on the Time of Appearance of Bundle-Branch Block and Its Association with Severe Congestive Heart Failure or Complete Atrioventricular Block

New BBB was associated with higher rates of congestive heart failure, complete AV block, use of pacemakers, and mortality (Table IV). Patients with new transient BBB received

thrombolytic treatment in 67% of cases and had an in-hospital mortality rate similar to that of patients without BBB.

In the absence of complete AV block and heart failure, patients with and without BBB had similar short-term mortality rates (Table V).

Multivariate Analysis

The presence of new BBB proved to be a variable independently associated with in-hospital and 1-year mortality

TABLE III Complications and mortality depending on presence and location of bundle-branch block (BBB)

	No BBB (n = 1,062)	BBB (n = 177)	Right BBB (n = 135)	Left BBB (n = 42)
Atrial fibrillation %	6.9	13 ^a	12.5 ^c	14
Ventricular tachycardia %	3.5	7.3 ^c	7.4 ^b	7
Ventricular fibrillation %	4.6	7.3	8.8 ^b	2
Complete atrioventricular block %	4.7	9 ^c	7.4	14 ^a
Killip class > I %	22.6	54.5 ^b	46.6 ^b	80 ^{b,d}
Killip class > II %	12.4	37.5 ^b	34.8 ^b	47.6 ^b
Killip class IV %	2.3	9.6 ^b	11.1 ^b	4.7
Mechanical complications	2.2	1.1	1.4	0
In-hospital mortality %	9.7	23.8 ^b	25.9 ^b	19
1-year mortality %	16.9	40.9 ^b	41.4 ^b	40.4 ^b

Mechanical complications included septal, free wall, or mitral cordae rupture.

Differences with non-BBB patients: ^a $p < 0.001$, ^b $p < 0.01$, ^c $p < 0.05$.

^d Statistically significant differences between patients with right BBB and left BBB.

TABLE IV Some clinical characteristics and complications depending on time of appearance of bundle-branch block (BBB)

	Old or indeterminate BBB (n = 113)	New BBB (n = 64)
Age (years)	68.5 ± 10	66.4 ± 11.5
Female %	27	41 ^{a, d}
Previous angina %	45	28 ^d
Previous myocardial infarction %	28	17
Previous heart failure %	19	11 ^b
Diabetes %	45	37
Previous treatment for CVD %	43	38 ^a
Peak CK (U/l)	1363 ± 1307	2572 ± 1650 ^c
Killip class at admission > I %	41	53.9 ^c
Left ventricular ejection fraction % (n)	38.8 ± 11.7 (n = 65)	36.5 ± 14.6 (n = 35) ^c
Thrombolysis %	40	58 ^b
Pacemaker %	2	23 ^{c, d}
Auricular fibrillation %	9.7	18.7 ^a
Ventricular tachycardia %	6.1	9.3 ^b
Ventricular fibrillation %	2.6	15.6 ^{a, d}
Complete atrioventricular block %	1.7	21.8 ^{c, d}
KILLIP class > I %	47.7	64 ^{c, d}
KILLIP class IV %	4.4	18.7 ^{c, d}
In-hospital mortality %	16.8	36.5 ^{c, d}
1-year mortality %	34.5	51.5 ^{a, d}

Previous treatment included any of calcium-channel blockers, beta blockers, digoxin, diuretics, antiarrhythmic drugs, or angiotensin-converting enzyme inhibitors.

Differences with non-BBB patients:

^a p < 0.01.

^b p < 0.05.

^c p < 0.001.

^d Statistically significant differences between new BBB and old+indeterminate BBB.

Abbreviations as in Table II.

TABLE V Mortality depending on the presence of bundle-branch block (BBB) and its association with complete atrioventricular (AV) block or severe congestive heart failure

	Patients without BBB	Patients with BBB
Non-complete AV block and Killip = I	n = 786	n = 79
In-hospital mortality, %	3.9	2.6
1-year mortality, %	8.6	18.4 ^a
Complete AV block	n = 51	n = 16
In-hospital mortality, %	9.1	36.9 ^b
1-year mortality, %	25.4	57.1 ^b
Killip class > II	n = 132	n = 66
In-hospital mortality, %	49.2	59
1-year mortality, %	67.4	75.7

Differences between patients with and without BBB.

^a p < 0.01.

^b p < 0.05.

TABLE VI Multiple logistic regression analysis

Variable	All patients (n = 1239)	
	In-hospital mortality Adjusted odds ratio (95% CI) ^a	1-year mortality
Age	1.4 (1.3–1.6)	1.5 (1.3–1.6)
Previous CHF	3.3 (1.4–5.9)	4.1 (2.0–8.2)
Systolic BP, mmHg	1.2 (1.1–1.3)	1.1 (1.0–1.2)
Heart rate, (beats/min)	1.1 (1.0–1.1)	1.1 (1.0–1.2)
Killip > I at admission	3 (1.9–4.8)	2.9 (1.9–4.3)
New BBB	2.4 (1.2–4.8)	3.2 (1.7–9.1)

^a Adjusted for age, gender, previous congestive heart failure, previous myocardial infarction, diabetes, anterior location, Killip class > I at admission, heart rate and systolic blood pressure at admission, thrombolytic treatment, creatine kinase > 1000 U/l, and new BBB.

Age considered at 5-year increments; heart rate considered at 10 beats/min increments; systolic blood pressure considered at 10 mmHg increments.

Abbreviations: BBB = bundle-branch block, CHF = congestive heart failure, BP = blood pressure, CI = confidence interval.

whereas existing BBB had no independent predictive value (Table VI).

Discussion

The overall rate of BBB in our patients (14.2%) was within the range described in studies from the prethrombolytic era^{1–9, 11, 12, 17} and was similar to that described recently in the study by Go *et al.* (NORMI 2).²⁶ Differences in the incidence of BBB may be attributed to various factors: the exclusion of patients with BBB on admission,³¹ the consideration of only new BBB, and other limitations dependent on the methodology of selection of patients for thrombolytic therapy.³²

With regard to time of appearance, 37% of our patients with BBB were considered as new, a figure similar to that found by Hindman *et al.*⁶ but much lower than the 64% found by Ricou *et al.*¹³ in patients with anterior infarction more often complicated by conduction disturbances.^{13, 18–20} In the present study, 40% of cases were classified as old BBB, almost double the 21% reported by Hindman *et al.*⁶ whereas our proportion of indeterminate BBB was lower than that found by Hindman. Only 10% of our left BBB cases were considered as indeterminate, compared with the 21.4 and 20% reported by Hindman *et al.*⁶ and Nimetz *et al.*,⁵ respectively. Our higher proportion of old left BBB may be more a consequence of the present-day greater availability of previous ECGs in this population than due to a real change in the appearance pattern of left BBB.

Although new right BBB was more often seen in patients treated with thrombolytics, this finding was probably related to the usually large underlying infarction¹⁶ more prone to undergo fibrinolysis. Our rate of transient new BBB (53%) is a higher figure than the 12–30% referred to in prethrombolytic studies,^{1, 8, 12} a finding attributed to the beneficial effects of reperfusion.^{23–25}

Bundle-Branch Block and Complications

As found in other reports, patients with BBB had a higher rate of heart failure,^{10, 14, 16} supraventricular⁹ and ventricular^{17–20} arrhythmias, complete AV block,^{1–3, 6, 9} and mortality.^{1–14} Bundle-branch block was associated with complete AV block in 9% of our patients, a figure similar to the 10.5 % reported in the National Registry study²⁶ and lower than the 22.6–30.8%^{1, 4, 17} found in the prethrombolytic era. Among other reasons, our higher incidence of “true” old BBB may have resulted in this lower rate of complete AV block.²⁷ The rate of complete AV block in our patients with new BBB was similar to that reported in studies made in the prethrombolytic era.

The in-hospital mortality of patients with BBB (23.8%) was also similar to that found in the National Registry study²⁶ and was lower than the 28–51.3% reported in prethrombolytic studies.^{6, 17, 33} On the other hand, our mortality rate was higher than the 18% reported by the Global Utilization of Streptokinase and t-PA for Occluded coronary arteries (GUSTO) study³⁴ in which the study population selection was biased by the exclusion of high-risk patients.³⁵

Bundle-branch block seems to have a worse prognosis when associated with complete AV block^{5, 6} or severe congestive heart failure.^{5, 6, 13} In the present study, both these entities were accompanied by a higher mortality rate. It is interesting that the presence of severe heart failure, Killip > II, characterizes a population with a mortality rate of close to 50% independent of the presence or absence of BBB; however, the appearance of complete AV block seems to have a different prognostic significance depending on the presence or absence of BBB. From a practical point of view, the 43% of all BBB documented in the absence of heart failure and complete AV block had a good short-term prognosis.

Some Peculiarities Depending on BBB Characteristics

In the present study, both conduction disturbance localizations presented a similar clinical course and prognosis, with the same long-term deleterious effect, as reported by Dubois *et al.*⁹ As in previous studies,^{26, 36} left BBB was associated with worse baseline characteristics and poorer systolic function than right BBB. Considering this poor clinical profile associated with left BBB,^{6, 14, 36} a relatively small infarction, as the CK figures suggest, might have contributed to the appearance of congestive heart failure. In accord with Go *et al.*,²⁶ our data indicate that the existence of left BBB in the infarction appears to be more the expression of a previous cardiovascular condition as a consequence of which a not necessarily large infarction may lead to a poor prognosis. A striking finding is that only a fifth of our patients with left BBB received thrombolysis; this may well be attributed to their clinical characteristics: old age, high prevalence of female gender and diabetes, and delay in admission, all factors associated with a low rate of fibrinolysis.³⁵ Our low rate of thrombolysis among patients with left BBB suggests the lack of awareness among physicians of the clear benefit of thrombolysis in this setting.³⁷ However, in some cases patients presenting with left BBB and suspected

AMI may have been unnecessarily retained in the emergency rooms, thus contributing to the long interval from the onset of symptoms and, therefore, to the low rate of thrombolysis. Although some of the diagnostic problems of AMI in the presence of left BBB may be answered by considering that concordant ST-elevation -depression are specific findings for diagnosing AMI,¹⁵ these criteria have limited value and their clinical usefulness has been questioned.³⁸

On the other hand, right BBB occurs in patients with less previous cardiovascular disease and is accompanied by a deterioration of the ventricular function more attributable to large infarctions and associated with a higher and statistically significant in-hospital mortality.^{14, 27} Despite the fact that consideration of left and right BBB characterizes two populations, each with its own peculiarities, long-term mortality rates are similar. On the other hand, classification of BBB according to time of appearance and duration results not only in different characteristics but also in a different prognosis. Thus, although patients with new BBB and patients without BBB received thrombolytic treatment at a similar rate, the former presented with larger infarctions and had more frequent complications, including a high incidence of congestive heart failure (65%). With regard to BBB duration, patients with transient BBB had a better prognosis, with an in-hospital mortality rate similar to that of patients without BBB^{10, 23} and a rather higher cumulative mortality rate in the first year not significantly different from that of patients without BBB.

Conclusions

The overall incidence of BBB associated with AMI was similar to that found in previous studies. The incidence of new BBB was relatively low (5%) and was transient and of short duration in 50% of cases. Bundle-branch block was associated with a low ejection fraction and was accompanied by more frequent complications.

The classification of BBB with regard to localization is associated with certain clinical and prognostic peculiarities: left BBB was associated with a longer interval from the onset of symptoms to admission, presented in patients with more cardiovascular antecedents, and received a lower rate of fibrinolysis, whereas right BBB was associated with larger infarctions and higher in-hospital mortality. In spite of these differences, both BBBs had similar mortality rates in the long run. Classification of BBB according to time of appearance seems to be of greater prognostic interest: only new BBB has an independent predictive value for mortality. From a simple point of view, the consideration of BBB depending only on its association or nonassociation with heart failure or complete AV block constitutes a useful and categorical short-term risk stratification.

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