Complete atrioventricular block in acute coronary syndrome: prevalence, characterisation and implication on outcome

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Abstract

Purpose: The aim was to characterise acute coronary syndrome patients with complete atrioventricular block and to assess the effect on outcome.

Methods: Patients admitted with acute coronary syndrome were divided according to the presence of complete atrioventricular block: group 1, with complete atrioventricular block; group 2, without complete atrioventricular block. Clinical, electrocardiographic and echocardiographic characteristics and prognosis during one year follow-up were compared between the groups.

Results: Among 4799 acute coronary syndrome patients admitted during the study period, 91 (1.9%) presented with complete atrioventricular block. At presentation, group 1 patients presented with lower systolic blood pressure, higher Killip class and incidence of syncope. In group 1, 86.8% presented with ST-segment elevation myocardial infarction (STEMI), and inferior STEMI was verified in 79.1% of patients in group 1 compared with 21.9% in group 2 ($P<0.001$). Right ventricular myocardial infarction was more frequent in group 1 (3.3% vs. 0.2%; $P<0.001$). Among patients who underwent fibrinolysis complete atrioventricular block was observed in 7.3% in contrast to 2.5% in patients submitted to primary percutaneous coronary intervention ($P<0.001$). During hospitalisation group 1 had worse outcomes, with a higher incidence of cardiogenic shock (33.0% vs. 4.5%; $P<0.001$), ventricular arrhythmias (17.6% vs. 3.6%; $P<0.001$) and the need for invasive mechanical ventilation (25.3% vs. 5.1%; $P<0.001$). After a propensity score analysis, in a multivariate regression model, complete atrioventricular block was an independent predictor of hospital mortality (odds ratio 3.671; $P=0.045$). There was no significant difference in mortality at one-year follow-up between the study groups.

Conclusion: Complete atrioventricular block conferred a worse outcome during hospitalisation, including a higher incidence of cardiogenic shock, ventricular arrhythmias and death.

Keywords

Acute coronary syndrome, complete atrioventricular block

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Background

In the context of acute coronary syndrome (ACS), the incidence of high-degree atrioventricular (AV) block is 3–14%, complete AV block being the more severe manifestation of AV conduction disturbance. The presence of heart block has been associated with worse short-term prognosis regardless

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of the location of myocardial infarction. The impact on long-term prognosis remains uncertain but it seems to be more relevant in anterior myocardial infarction.^{1–9} However, the majority of previous studies dedicated to this complication were performed before the introduction of primary percutaneous coronary intervention (PCI). The aim of the present study was to assess the incidence of complete AV block in patients admitted with ACS, predominantly treated with primary PCI, to characterize this population and evaluate the prognosis including short and long-term survival.

Methods

A prospective analysis of patients admitted with ACS was carried out at a tertiary centre from 2005 to 2015.

At admission patients presented with symptoms thought to be due to acute coronary artery disease and electrocardiographic changes consistent with and/or elevated biomarkers of myocardial necrosis. This study included patients with ST-segment elevation myocardial infarction (STEMI), non-ST-segment elevation myocardial infarction (NSTEMI) and unstable angina (UA). STEMI was defined as a ST-segment elevation for more than 30 minutes and the remaining cases were considered non-ST-segment ACS, NSTEMI if troponin raised the upper reference limit and UA if there were no changes in biomarkers.

Patients were divided according to the presence of complete AV block: group 1 (G1), with complete AV block; group 2 (G2), without complete AV block.

In each patient, baseline clinical characteristics including demographic characteristics and comorbidities were collected. Laboratory data on admission, electrocardiographic and echocardiographic parameters were also analysed.

The outcome variables studied were heart failure, cardiogenic shock, mechanical complication, ventricular arrhythmias, the need for invasive mechanical ventilation, stroke, major bleeding and acute kidney disease. All-cause mortality was evaluated during hospitalisation, at 30 days after discharge and at one-year follow-up.

Follow-up evaluation by telephonic contact was performed to check the occurrence of cardiac events and death, at 30 days and one year after discharge.

The study protocol is according to the Declaration of Helsinki.

Statistical analysis

Statistical analysis was performed using dedicated software SPSS Statistics (v.19; IBM SPSS, Chicago, IL, USA). Continuous variables were expressed as mean $\pm$ standard deviation and categorical variables were expressed as a percentage. Study groups were compared using Student's *t* test or Wilcoxon–Mann–Whitney's test for continuous variables, and Pearson's chi-square or Fisher's exact test for categorical measures, as appropriate.

Propensity score analysis was used to compare both groups adjusting for confounding factors, using one to one match between patients with and without complete AV block. The analysis was performed using the R open source statistical programming language and the package MatchIt. From the data of propensity score analysis a multivariate regression model was built to identify the predictors of hospital mortality, using clinical characteristics at presentation, including gender, age, anterior STEMI, inferior STEMI, previous ACS, diabetes, smoking, chronic kidney disease, Killip class greater than I, left ventricular ejection fraction (LVEF) less than 35% and complete AV block.

95% Confidence intervals (CIs) were used and a *P* value less than 0.05 was considered statistically significant.

Results

During study period 4799 ACS patients were admitted with a mean age of 63.7 ± 13.1 years, 69.8% were men. STEMI was present in 2673 (55.7%) patients, of whom 2255 (84.4%) underwent primary PCI and 205 (7.7%) thrombolytic therapy.

Among all the population, 91 (1.9%) patients presented with complete AV block and were included in G1.

Baseline characteristics of the two groups are presented in Table 1. Heart block patients were slightly older (66.0 ± 12.4 vs. 63.7 ± 13.1 years; $P=0.108$) but there was no difference in gender (69.9% men in all the population). Cardiovascular risk factors were similar between patients with and without complete AV block, as well as comorbidities (peripheral arterial disease and chronic kidney disease). No significant differences were observed between the groups regarding the prevalence of coronary artery disease, including previous myocardial infarction, PCI and coronary artery bypass graft surgery (CABG). About 12% of patients took beta-blockers in both groups.

Although angina was the most frequent symptom in both groups at admission, the main symptom was syncope in 13.6% of G1 patients in contrast with 1.5% in G2. The frequency of other manifestations, such as dyspnoea, was not significantly different between the groups. Complete AV block patients presented with lower systolic blood pressure (107.8 ± 27.8 vs. 136.9 ± 28.6 mmHg; $P<0.001$) and heart rate (59.7 ± 23.4 vs. 79.2 ± 21.3 beats per minute; $P<0.001$) and higher Killip class (Killip $>I$ in G1 25.0% vs. G2 14.9%; $P=0.013$). On electrocardiogram, 86.8% of G1 patients presented with STEMI, inferior STEMI being the most frequent diagnosis in this group (79.1%) in contrast with only 21.9% of patients in G2. There was no significant difference in the presence of left and right bundle branch block between the groups (Table 2).

Among patients who underwent fibrinolysis, complete AV block was observed in 7.3% in contrast to 2.5% in patients submitted to primary PCI ($P<0.001$).

Table 1. Baseline clinical characteristics.

Characteristic	Overall population (n=4799)	Complete AV block (n=91)	Without complete AV block (n=4708)	P value
Age (years)	63.7±13.1	66.0±12.4	63.7±13.1	0.103
Male gender	3348 (69.8)	58 (63.7)	3290 (69.9)	0.205
Hypertension	3115 (64.9)	56 (61.5)	3059 (65.0)	0.496
Diabetes	1121 (23.4)	22 (24.2)	1099 (23.3)	0.853
Dyslipidaemia	2364 (49.3)	45 (49.5)	2319 (49.3)	0.971
Smoker	1732 (36.1)	37 (40.7)	1695 (36.0)	0.360
Previous angina	824 (17.2)	16 (17.6)	808 (17.2)	0.916
Previous myocardial infarction	745 (15.5)	10 (11.0)	735 (15.6)	0.228
Previous PCI	490 (10.2)	4 (4.4)	486 (10.3)	0.064
Previous CABG	193 (4.0)	3 (3.3)	190 (4.0)	1.000
Previous stroke	251 (5.2)	6 (6.6)	245 (5.2)	0.477
Peripheral arterial disease	156 (3.3)	2 (2.2)	154 (3.3)	0.770
Chronic kidney disease	120 (2.5)	2 (2.2)	118 (2.5)	1.000
Beta-blocker	584 (12.2)	11 (12.1)	573 (12.2)	0.981

Chronic kidney disease – creatinine >2.0 mg/dl; haemodialysis or renal transplantation.

AV: atrioventricular; PCI: percutaneous coronary intervention; CABG: coronary artery bypass graft.

Table 2. Clinical presentation, electrocardiographic and echocardiographic parameters at admission.

	Complete AV block (n=91)	Without complete AV block (n=4708)	P value
Main symptom at presentation			<0.001
Angina	63 (77.8)	3508 (87.2)	
Dyspnoea	2 (2.5)	89 (2.2)	
Syncope	11 (13.6)	61 (1.5)	
Killip class >I	20 (25.0)	641 (14.9)	0.013
I	60 (75.0)	3650 (85.1)	
II	5 (6.3)	400 (9.3)	
III	4 (5.0)	147 (3.4)	
IV	11 (13.8)	94 (2.2)	
Heart rate	59.7±23.4	79.2±21.3	<0.001
Systolic blood pressure	107.8±27.8	136.9±28.6	<0.001
Left bundle branch block	4 (4.4)	181 (3.8)	0.780
Right bundle branch block	2 (2.2)	219 (4.7)	0.443
STEMI	79 (86.8)	2594 (55.1)	<0.001
Anterior STEMI	14 (15.4)	1016 (21.6)	0.154
Inferior STEMI	72 (79.1)	1030 (21.9)	<0.001
Right ventricular myocardial infarction	3 (3.3)	8 (0.2)	0.001
Multivessel disease	41 (54.7)	1429 (54.6)	0.994
Left ventricular ejection fraction			0.013
LVEF >50%	41 (51.9)	2443 (62.8)	
LVEF 35–50%	25 (31.6)	1138 (29.3)	
LVEF <35%	13 (16.5)	307 (7.9)	

AV: atrioventricular; LVEF: left ventricle ejection fraction; STEMI: ST-segment elevation myocardial infarction.

The presence of multivessel disease was 54% in both groups; however, LVEF was significantly lower in G1, in which 48.1% of patients had LVEF less than 50% compared with 37.2% in G2.

Reflecting the higher incidence of inferior STEMI, right ventricular myocardial infarction was significantly more frequent in G1 (3.3% vs. 0.2%; $P<0.001$).

Complications during hospitalisation are shown in Table 3. With regard to hospital outcomes, patients with complete AV block presented with a worse prognosis. In G1, the incidence of heart failure was 11%, double that in G2, and cardiogenic shock was about seven times more frequent (33.0 vs. 4.5%; $P<0.001$). Ventricular arrhythmias and mechanical complications were also more frequent in

Table 3. Complications during hospitalisation, short and long-term mortality.

	Complete AV block (n=91)	Without complete AV block (n=4708)	P value
Heart failure	10 (11.0)	261 (5.5)	0.026
Cardiogenic shock	30 (33.0)	213 (4.5)	<0.001
Mechanical complications	4 (4.4)	29 (0.6)	0.003
Ventricular arrhythmias	16 (17.6)	168 (3.6)	<0.001
Invasive mechanical ventilation	23 (25.3)	239 (5.1)	<0.001
Stroke	2 (2.2)	38 (0.8)	0.175
Major bleeding	3 (3.3)	62 (1.3)	0.125
Acute kidney injury	8 (8.8)	152 (3.2)	0.010
Hospital mortality	21 (23.1)	165 (3.5)	<0.001
30-Day mortality	2 (2.2)	41 (0.9)	0.196
One-year mortality	5 (5.5)	134 (2.8)	0.190
Hospital plus one-year mortality	26 (28.6)	299 (6.4)	<0.001

AV: atrioventricular.

Table 4. Comparison of patients with and without complete AV block after match.

	Complete AV block	Without complete AV block	P value
Age (years)	66.27±12.38	66.1±13.3	0.935
Male gender	41	40	0.861
Smoker	25	30	0.382
Diabetes	15	15	1.000
Chronic kidney disease	1	1	1.000
Previous ACS	7	7	1.000
Anterior STEMI	10	12	0.641
Inferior STEMI	55	56	0.825
Killip Kimball class	18	15	0.548
LVEF <35%	10	9	0.805

AV: atrioventricular; ACS: acute coronary syndrome; LVEF: left ventricle ejection fraction; STEMI: ST-segment elevation myocardial infarction.

complete AV patients, as well as acute kidney injury and the need for invasive mechanical ventilation. Major bleeding and stroke were similar in both groups.

Among patients who developed complete AV block, eight (8.8%) underwent definitive pacemaker implantation. These patients were older, with a mean age of 72.0±12.6 years, 75% were men and six (75%) patients had STEMI, of those four had inferior STEMI.

Importantly, hospital mortality was almost eightfold higher in patients with complete AV block (23.1% vs. 3.5%; $P<0.001$). In heart block patients, the mortality was 18.1% in inferior STEMI patients and 50% in anterior STEMI patients. However, there was no significant difference in mortality after discharge evaluated at 30 days (2.2% vs. 0.9%; $P=0.183$) and at one-year follow-up (5.5% vs. 2.8%; $P=0.136$).

A propensity score analysis between study groups was performed before determination of the predictors of in-hospital mortality (Table 4).

After a propensity score analysis, in a multivariate regression model the predictors of in-hospital mortality were complete AV block (odds ratio (OR) 3.671; 95% CI

1.032–13.076; $P=0.045$), LVEF less than 35% (OR 3.994; 95% CI 1.012–15.765; $P=0.048$), anterior STEMI (OR 6.401; 95% CI 1.597–25.655; $P=0.009$), Killip class greater than I (OR 3.674; 95% OR 1.042–12.951; $P=0.043$) and age (OR 1.072; 95% CI 1.013–1.134; $P=0.016$).

Discussion

In the present study, the presence of complete AV block was verified in 1.9% of ACS patients and was associated with a worse hospital outcome in the context of ACS.

We found an incidence lower than previously described.^{1–5} This could be due to the fact that our data are more recent and were collected in the primary PCI era, with higher reperfusion rates. Furthermore, in our study NSTEMI patients were included, conferring less risk of complete AV block. Finally, we just included complete AV block, in contrast with previous studies that comprised high-degree AV block (second and third-degree AV block).

In contrast with previous data, we did not find an association with gender and cardiovascular risk factors and the presence of complete AV block.^{2,10} Also, there was no

significant difference in beta-blocker medication before ACS between the two study groups.

As expected, complete AV block was more frequent in inferior STEMI, in relation to hypoperfusion of the AV nodal artery that normally arises from the right coronary artery and also secondary to an increase of parasympathetic tonus. AV nodal presents with two mechanisms of protection against ischaemia. On the one hand, this structure receives collateral supply from septal perforators of the left anterior descending artery and adjacent venous sinusoids.¹¹ On the other hand, it has a high intracellular content of glycogen.¹² This fact explains the transition nature of complete AV block in ACS and the resolution of this conduction disturbance after revascularisation.^{13–15} In our study only 8.8% of patients with complete AV block underwent a definitive pacemaker implantation, this ratio being in line with previous data.¹⁶

The incidence of AV block was about 2–13% before the introduction of thrombolytic therapy. Since the beginning of this therapy the incidence decreased but mortality continued to be high.^{1,2} With the primary PCI approach the frequency of complete AV block in the context of ACS decreased to 3%.^{2,13} Our study is in agreement with these data, as we found that among patients who underwent fibrinolysis complete AV block was observed in 7.3% in contrast with 2.5% in primary PCI patients. It is likely that patients who underwent primary PCI had a higher reperfusion rate and consequently developed less severe conduction disorders secondary to prolonged ischaemia and irreversible necrosis.

The association between complete AV block and worse short-term outcomes has been shown in several papers.^{10,13}

In accordance with the published literature, in our registry patients who presented with complete AV block had higher hospital mortality. In our population, complete AV block patients had a sevenfold higher incidence of hospital mortality. After a propensity score analysis, in a multivariate regression model, we found that patients with complete AV block presented with about a fourfold increased risk of hospital death, in line with previous studies.^{1–5,16,17} Among the heart block group, the mortality was substantially higher in anterior STEMI compared with inferior STEMI (50.0% vs. 18.1%). This is line with the study by Kim and coworkers that demonstrated that the negative prognostic impact of high-degree AV block differs according to the location of infarction, being more prominent in anterior STEMI.¹⁸

Complete AV block was an independent predictor of hospital mortality, with an OR of 3.671. In the same multivariate analysis, inferior STEMI was not a predictor of mortality, reflecting the fact that more than association with inferior location, complete AV block could be a surrogate of extensive myocardial infarction, with consequent haemodynamic and electrical impairment. In our population, during hospitalisation AV block patients had a higher incidence of heart failure, cardiogenic shock, ventricular arrhythmias,

mechanical complications, acute kidney injury and the need for invasive mechanical ventilation. The other independent predictors of hospital mortality were age, anterior STEMI, LVEF less than 35% and Killip class greater than I.

In Kim's work the univariate analysis showed that the incidence of 30-day major adverse cardiac events, including all causes of death, non-fatal myocardial infarction and revascularisation, for patients with heart block was approximately two times higher than for those without heart block; however, this association was not significant in multivariate analysis.¹⁰ In the present study, we did not find an association between complete AV block and poor prognosis at 30-day and one-year follow-up. Before discharge the majority of G1 patients recovered AV conduction without the need for a pacemaker, consequently they presented with a similar prognosis after discharge compared with G2 patients. This similar prognosis was also demonstrated by the study of Singh et al., in which patients with heart AV block who survived the initial hospitalisation had similar long-term survival when compared with patients without conduction disorders.⁴

Study limitations

This was a single-centre retrospective study based on an ACS registry. All registries have the risk of underreporting, which could lead to underestimation of the incidence of AV block and right ventricular infarction. Furthermore, our registry does not specify the timing of the development of complete AV block during hospitalisation.

Conclusion

Despite the decreased incidence of complete AV block in the context of ACS in the primary PCI era, this conduction disorder continues to be associated with a worse short-term outcome. In the present study, complete AV block conferred a higher risk of heart failure, cardiogenic shock, ventricular arrhythmias, mechanical complications and death during hospitalisation. After discharge the survival was similar between patients with and without heart block.

Conflict of interest

The authors declare that there is no conflict of interest. All authors take responsibility for all aspects of the reliability and freedom from bias of the data presented and their discussed interpretation.

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