Right bundle-branch block and left axis deviation in acute myocardial infarction

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Of 114 patients with acute myocardial infarction admitted consecutively to a coronary care unit, 10 had recent antero-septal myocardial infarction associated with right bundle-branch block and obvious left axis deviation, and 1 had recent antero-septal myocardial infarction with right bundle-branch block and right axis deviation. Attention is drawn to the high mortality (7 out of 11 patients), due mainly to cardiogenic shock. Frequent complications were sudden complete heart block (5 patients) and ventricular asystole (4 patients) without previous lengthening of the atrioventricular conduction time. An external on-demand pacemaker was inserted in 10 patients, and no patient died of complete heart block or ventricular asystole.

Wilson, Johnston, and Barker (1934) described a conduction disturbance characterized by right bundle-branch block and marked left axis deviation. Histological investigation (Grant, 1956) indicated that left axis deviation was often associated with fibrosis or infarction of the anterior-superior part of the interventricular septum, through which the anterior division of the left bundle-branch runs. Experimentally (Watt, Murao, and Pruitt, 1965; Watt *et al.*, 1968) this division was interrupted in primates by producing lacerations in this part of the septum. This resulted in an obvious shift to the left of the electrical axis and a 20-milli-second delay in the arrival of the excitation wave at the epicardium of the left ventricle. When left axis deviation is caused by interruption of the anterior division of the left bundle-branch and is associated with right bundle-branch block, atrioventricular conduction depends solely on the posterior division of the left bundle-branch. If this last conduction pathway also becomes involved in a pathological process, complete atrioventricular block results from complete bilateral bundle-branch block. A histological investigation (Lenègre, 1964) of the conduction system in patients with right bundle-branch block and left axis deviation, who died from total heart block, showed that both bundles were indeed involved in a fibrosing process which often spared the atrioventricular node completely. In two series of

patients with intermittent complete heart block but without myocardial infarction, right bundle-branch block with left axis deviation was found in 59 and 33 per cent, respectively (Lasser, Haft, and Friedberg, 1968; Pistolesse, Richichi, and Catalano, 1969). It was concluded that the combination of these features on the electrocardiogram often preceded periods of complete atrioventricular block and Adams-Stokes attacks. We have found only one report (Wanka and Lajos 1969) which treats the syndrome of right bundle-branch block and left axis deviation in acute myocardial infarction. Of 440 patients, 33 were found to have this combination, and of these 16 died, a mortality rate of 48 per cent. We wish to draw attention to the frequency of right bundle-branch block with left axis deviation in acute myocardial infarction, the atrioventricular conduction disturbances associated with it, and the poor prognosis it carries.

Patients and methods

Between March and November 1969, a total of 195 patients was admitted to the coronary care unit. One hundred and fourteen had acute myocardial infarction, and of these 10 (8.7%) presented at some time with right bundle-branch block and left axis deviation. One patient had right bundle-branch block and right axis deviation. All of the 11 subjects had a recent myocardial infarction and fulfilled the following criteria.

- 1 Characteristic history of substernal pain of recent onset, lasting for more than 30 minutes;
- 2 Increase in the serum enzymes (CPK, GOT, and LDH);

FIG. 1 Case 3. Upper tracing, recent antero-septal myocardial infarction with normal conduction. Lower tracing, the same day: development of conspicuous left axis deviation and right bundle-branch block.

3 Electrocardiographic signs of transmural infarction (ST-T elevation, pathological Q waves, and subsequent development of inverted T waves).

The diagnosis of right bundle-branch block and left axis deviation was based on pathological S waves in leads I, aVL, and left precordial leads, on rsR', rSR', or qR complexes of more than 0.12 sec. duration in the right precordial leads, and left axis deviation of more than -30° in the standard leads. A characteristic example is shown in Fig. 1, and the electrocardiogram of the patient with right bundle-branch block and right axis deviation is reproduced in Fig. 2. Electrocardiograms were monitored constantly in all patients and 13-lead electrocardiograms were recorded daily. Standard treatment consisted of opiates for the relief of pain and anticoagulants. Ventricular premature beats were treated with lignocaine intravenously, in a standard dose of 100 mg. per hour. Ventricular tachycardia, flutter, and fibrillation were treated by direct current shock (400 Watt sec.). Because a high incidence of complete

heart block was expected, 10 of the patients received an external on-demand pacemaker. Floating catheters were inserted in a cubital vein or an external jugular vein and were electrocardiographically positioned in the right ventricle. If this did not succeed, a standard no. 5 endovenous electrode wire was inserted in the apex of the right ventricle under fluoroscopy.

Results

The mortality associated with different localization of myocardial infarction is shown in Table 1. Overall the death rate was 27 per cent. The incidence of incomplete bilateral bundle-branch block in patients with antero-septal myocardial infarction was 19 per cent. Patients with myocardial infarction associated with right bundle-branch block and left axis deviation had a mortality rate about three times that of the other patients (Table 2). The characteristic electrocardiographic pattern

FIG. 2 Case 11. Upper tracing, recent antero-septal myocardial infarction with normal conduction. Lower tracing, the same day: development of right axis deviation with right bundle-branch block and first-degree AV block.

TABLE 1 Localization of myocardial infarction and mortality in 114 consecutively-admitted patients

	No. of patients	No. of deaths	%
Anterior wall	58	17	29
Inferior wall	49	8	16
Combined	7	6	85
Total	114	31	27

TABLE 2 Mortality in patients with myocardial infarction with and without right bundle-branch block with left or right axis deviation

	No. of patients	No. of deaths	%
Right bundle-branch block with right axis deviation and myocardial infarction	1	1	100
Right bundle-branch block with left axis deviation and myocardial infarction	10	7	70
Myocardial infarction only	103	23	22
Total	114	31	27

TABLE 3 Details of 11 patients with right bundle-branch block and left or right axis deviation

Case No.	Sex	Age	Electrocardiogram on admission	Subsequent course	Pacemaker required	Complications	Course
1	M	80	Recent antero-septal infarction; rt. bundle-branch block	Lt. axis deviation on same day	—	Mild congestive heart failure	Discharged with persisting rt. bundle-branch block and lt. axis deviation
2	M	72	Recent antero-septal inf.; rt. bundle-branch block and lt. axis deviation; periods of complete AV block	4:1 AV block; rt. bundle-branch block and lt. axis deviation	Complete AV block and ventricular asystole	Cardiogenic shock	Died 2 days after admission
3	M	66	Recent antero-septal inf.; normal conduction	Rt. bundle-branch block and lt. axis deviation on same day	—	Congestive heart failure	Sudden death after 9 days, ventricular rupture
4	M	68	Recent antero-septal inf.; rt. bundle-branch block and lt. axis deviation	Rt. bundle-branch block and lt. axis deviation. disappeared after 1 day	Slow nodal rhythm	Congestive heart failure	Discharged
5	M	74	Recent antero-septal inf.; supraventricular tachycardia; rt. bundle-branch block	Rt. bundle-branch block and lt. axis deviation after cardioversion	Complete AV block and ventricular asystole	Cardiogenic shock; ventricular asystole	Died 1 day after admission
6	M	71	Recent antero-septal inf.; complete AV block; ventricular asystole	Atrial flutter; rt. bundle-branch block and lt. axis deviation after 1 day; rt. bundle-branch block and lt. axis deviation disappeared after 10 days	Complete AV block and ventricular asystole	Cardiogenic shock; ventricular tachycardia, ventricular fibrillation	Died 16 days after admission
7	F	63	Recent antero-septal inf.; rt. bundle-branch block and lt. axis deviation	Rt. bundle-branch block and lt. axis deviation persisted	Slow nodal rhythm	Congestive heart failure	Discharged with persisting rt. bundle-branch block and lt. axis deviation
8	M	86	Recent antero-septal inf.; rt. bundle-branch block and lt. axis deviation	Rt. bundle-branch block and lt. axis deviation persisted	No pacemaker inserted	Intractable congestive heart failure	Died 26 days after admission
9	F	71	Recent antero-septal inf.; rt. bundle-branch block and lt. axis deviation; periods of complete AV block	Rt. bundle-branch block and lt. axis deviation disappeared after 9 days	Complete AV block	Intractable congestive heart failure; ventricular fibrillation after 2 weeks	Died 2 months after admission
10	M	48	Recent antero-septal inf.; normal conduction	Rt. bundle-branch block and lt. axis deviation after 2 days, disappeared after 2 days	—	Congestive heart failure; ventricular septal perforation	Died 2 months after admission
11	F	71	Recent antero-septal inf.; normal conduction	Rt. bundle-branch block and rt. axis deviation on same day with first degree AV block	Complete AV block and ventricular asystole	Cardiogenic shock	Died 2 days after admission

TABLE 4 Complications in 11 patients with acute myocardial infarction and right bundle-branch block with left or right axis deviation

Ventricular asystole	4
Complete atrioventricular block	5
Cardiogenic shock	4
Congestive heart failure	11
Ventricular septal perforation	1
Ventricular rupture	1

was already evident in 5 patients on admission, while the other 6 developed right bundle-branch block with left or right axis deviation within 48 hours after the onset of myocardial infarction (Table 3). The electrocardiographic signs of incomplete bilateral bundle-branch block disappeared in 4 out of 7 patients who survived their infarction for more than 10 days. All patients with right bundle-branch block and left axis deviation had a normal PQ interval when in sinus rhythm. Complete heart block and ventricular asystole appeared very suddenly without gradually developing atrioventricular block. Only in Case 11 with right bundle-branch block and right axis deviation was there first-degree atrioventricular block.

Complete heart block occurred in 5 out of 11 patients and was associated with ventricular asystole in 4 (Table 4). No patients died as an immediate consequence of these complications, as an external on-demand pacemaker had already been inserted prophylactically, or was inserted immediately on admission, if they presented with complete atrioventricular block. Cardiogenic shock occurred in 4 patients and was the commonest cause of death. One patient died of progressive congestive heart failure the day before surgical closure was scheduled for an interventricular septal defect, which occurred the day after admission. One patient died of ventricular rupture and 2 of intractable congestive heart failure. Congestive heart failure, as evidenced by dyspnoea, râles, gallop rhythm, and engorged jugular veins, was a complication in all 11 patients. The on-demand pacemaker functioned in 7 patients: in 5 because of complete heart block and in 2 because of slow nodal rhythm.

Discussion

It is clear from these findings that right bundle-branch block with left or right axis deviation in acute myocardial infarction carries a high mortality. In the present series the death rate was about three times higher than that expected in the coronary care unit.

Necropsy revealed very extensive myocardial infarction, involving the anterior wall of the left ventricle and most of the interventricular septum. There was no statistically significant difference between the mean age of the 11 patients (70.0 years) and that of the patients without right bundle-branch block and left or right axis deviation (63.9 years).

It appears that patients presenting with recent antero-septal myocardial infarction in association with right bundle-branch block and left or right axis deviation are susceptible to two risks: (1) the development of cardiogenic shock, a condition that is nearly always fatal; (2) the development of complete heart block with Adams-Stokes attacks and ventricular asystole; this tends to happen very suddenly, without premonitory lengthening of the PQ time.

Conspicuous left axis deviation is an electrocardiographic pattern that may be caused by interruption of the anterior division of the left bundle-branch, in which case the term 'left anterior hemiblock' can be used (Rosenbaum *et al.*, 1969). Other conditions, such as diffuse myocardial fibrosis, certain congenital defects, extreme left ventricular hypertrophy, and extensive old inferior wall infarction may also be associated with obvious left axis deviation. Sometimes no organic heart disease can be found histologically (Entman, Estes, and Hackel, 1967). To determine whether left axis deviation is the result of left anterior hemiblock, the time interval between the depolarization of the His bundle and the activation of the ventricular myocardium may be measured. To this purpose, an electrogram of the His bundle should be recorded and the interval between the His bundle deflection and the onset of ventricular activation (HV time) measured (Scherlag *et al.*, 1969). Measurements in 10 patients with right bundle-branch block alone (Narula *et al.*, 1969) disclosed a normal HV time (30–50 msec.). In 6 patients with right bundle-branch and left axis deviation without myocardial infarction, the HV time was found to be lengthened (65–75 msec.). In 16 patients with old myocardial infarction and right bundle-branch block with left axis deviation the HV time was normal in 9 and lengthened in 7 (55–75 msec.). Therefore only these 7 patients had documented right bundle-branch block associated with left axis deviation due to left anterior hemiblock.

Though the HV time was not measured in our patients, we feel that left axis deviation must have been due to left anterior hemiblock, because they either developed deviation during observation or it disappeared after a

few days (8 patients). Association with total heart block and extensive involvement of the interventricular septum at necropsy made left anterior hemi-block very likely in 2 others. The interventricular septum was, in fact, involved in all patients who died. In Case 7, left axis deviation could have been caused by other conditions; this case presented with recent antero-septal infarction and right bundle-branch block with left axis deviation and had no periods of atrioventricular conduction disturbance. She was discharged with the syndrome persisting. In this case the conduction disturbance may have existed before myocardial infarction occurred. Right bundle-branch block with right axis deviation (Case 11) due to interruption of the posterior division of the left bundle-branch seems to be a much rarer condition. This can be explained by the anatomy of the conduction system. The right bundle-branch and the anterior division of the left bundle-branch run close together in the interventricular septum, and share a common blood supply from septal branches of the left anterior descending coronary artery. The atrioventricular node and the posterior division of the left bundle-branch have a different blood supply. Right bundle-branch block with right axis deviation is therefore possibly even more dangerous in acute myocardial infarction than right bundle-branch block with left axis deviation because a greater part of the septum must be involved. Case 11 was admitted with recent antero-septal infarction and normal conduction. She developed right bundle-branch block and obvious right axis deviation subsequently, with periods of sudden complete heart block and Adams-Stokes attacks during insertion of an electrode wire for external on-demand pacing. She died on the second day after admission in cardiogenic shock. At necropsy a very extensive recent antero-septal myocardial infarction was found.

It is clear that early recognition of right bundle-branch block with left or right axis deviation in acute myocardial infarction and the insertion of an on-demand pacemaker may reduce mortality from total heart block and ventricular asystole. Even then the prognosis remains grave in these patients due to the high frequency of cardiogenic shock, reflecting extensive myocardial damage.

Addendum

Since this paper was submitted for publication, another 3 patients with recent antero-septal myocardial infarction and right bundle-branch block with left axis deviation were admitted. They died from severe pump failure. Two of them had complete heart arrest after DC shock for ventricular fibrillation in the end stage of pump failure, and one patient had periods of complete atrioventricular block with ventricular asystole.

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