Significance of left anterior hemiblock¹

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SUMMARY To determine the relation between left anterior hemiblock and cardiovascular abnormalities in an ambulatory population, the clinical records and electrocardiograms of 16 600 male applicants for life insurance between 1966 and 1974 were reviewed. There were 413 applicants with left anterior hemiblock; they were compared with an age-matched control group. The subjects with left anterior hemiblock were divided into 2 subgroups based on the direction of the mean frontal plane QRS axis: (a) greater than -30° but less than -60° , and (b) between -60° and -90° . The prevalence of left anterior hemiblock increased with age for each decade after the third. Left anterior hemiblock was not associated with cardiovascular abnormalities in 53.4 per cent of subjects age 30 and over and thus occurred as an isolated finding. There was no significant difference in the prevalence of isolated left anterior hemiblock when subjects with a mean QRS axis greater than -30° but less than -60° were compared with those with a mean QRS axis between -60° and -90° .

When men of 30 and over with left anterior hemiblock were compared with an age and sex matched control group, there was a significant relation between electrocardiographic abnormalities, hypertension, and cardiac disease. There were no intergroup differences when subjects with a mean QRS axis greater than -30° but less than -60° were compared with subjects with a mean QRS axis between -60° and -90° . However, left anterior hemiblock was not a sensitive marker of clinical cardiac disease in these subjects since this diagnosis was absent in 86 per cent of subjects with left anterior hemiblock. In subjects under 30 a significant relation was present between clinical cardiac disease and left anterior hemiblock because of the high incidence of congenital heart disease in the left anterior hemiblock group.

The significance of left anterior hemiblock in the general population remains controversial. Grant (1956) stressed the value of deviation of the mean manifest QRS axis in the frontal plane to the left beyond -30° as a sign of cardiac abnormality and postulated that left axis deviation signifies a conduction disturbance in the anterolateral wall of the left ventricle. On the basis of experimental evidence (Uhley and Rivkin, 1964; Watt *et al.*, 1965; Rosenbaum *et al.*, 1970), selected surgical experience (Samson and Bruce, 1962; Wigle *et al.*, 1963; Kulbertus *et al.*, 1969), electrocardiographic-pathological-clinical correlative studies (Davies and Evans, 1960; Curd *et al.*, 1961; Eliot *et al.*, 1963; Banta *et al.*, 1964; Corne *et al.*, 1965; Pryor and Blount, 1966; Bahl *et al.*, 1969; Rosenbaum *et al.*, 1970), and study of cases of intermittent left axis deviation (Rosenbaum *et al.*, 1969), investigators concluded that left axis deviation was usually the

result of a lesion involving the anterior division of the left bundle-branch. Impaired conduction of the anterior division of the left bundle has been termed left anterior hemiblock by Rosenbaum and associates (1970).

These results, however, are based on data obtained from animal experiments, necropsy studies, and/or selected clinical populations. In 1967 Blackburn and associates reported a similar leftward shift of the mean QRS axis in men from 3 countries with different prevalence rates of manifest coronary heart disease. Blackburn *et al.* (1970) have subsequently reported only suggestive evidence that left axis deviation beyond -30° had prognostic value among coronary heart disease free cohorts age 40 to 59 drawn from populations in the United States and 6 other countries. Recent studies on the general population have reported that 40 to 60 per cent of subjects with a mean frontal plane QRS axis greater than -30° have no associated cardiovascular abnormalities (Ostrander, 1971; Yano *et al.*, 1975). When left anterior hemiblock is not associated with

¹This work was supported by the Great-West Life Assurance Company.

Received for publication 25 April 1977

other major electrocardiographic findings or clinical evidence of cardiac disease a normal mortality has been found (Seavey and Sexton, 1970; Ostrander, 1971; Schaaf, 1974; Yano *et al.*, 1975).

The present study was undertaken among applicants for life insurance to determine the relation between left anterior hemiblock, and cardiovascular abnormalities.

Subjects and methods

There were 16 600 applicants for life insurance at Great-West Life with electrocardiograms between 1966 and 1974. The mean QRS axis in the frontal plane was deviated to the left beyond -30° in 427 men. Fourteen were excluded; 10 had evidence of localised inferior infarction, 2 had pulmonary emphysema, and 2 had the Wolff-Parkinson-White syndrome. The remaining 413 subjects satisfied criteria for left anterior hemiblock (Castellanos and Lemberg, 1971): mean frontal plane QRS axis greater than -30° , rS complexes in leads II, III, aVF, and Q waves in lead aVL. The mean QRS axis in the frontal plane was determined by inspection of the QRS complexes in the limb leads as advocated by Grant (1957). The subjects were divided into two subgroups based on the degree of left axis deviation: (a) greater than -30° but less than -60° ; (b) between -60° and -90° . One hundred and sixty-five (40%) of these subjects had a mean frontal plane QRS axis between -60° and -90° .

For each left anterior hemiblock age group, a random sample of identical size was obtained from male applicants for life insurance during the same time period and constituted the control group. Cases with inferior infarction, emphysema, and the Wolff-Parkinson-White syndrome were excluded.

A standard 12 lead electrocardiogram, chest x-ray, and each individual's medical record were reviewed. The following electrocardiographic abnormalities were noted. Right bundle-branch block and left bundle-branch block were defined according to the New York Heart Association Criteria Committee (1973). First degree atrioventricular block was present when the PR interval was greater than 0.20 s. Voltage criteria of left ventricular hypertrophy were those of Sokolow and Lyon (1949). Q waves were considered indicative of myocardial infarction when they were ≥ 0.04 s in duration. ST-T changes referred to ST segment depression and/or T wave inversion in the absence of bundle-branch block. Hypertension was defined as systolic blood pressure ≥ 140 mmHg and diastolic blood pressure ≥ 90 mmHg. Cardiac disease comprised one or more of the following: (a) ischaemic heart disease (angina pectoris or myocardial infarction);

(b) valvular heart disease (mitral regurgitation, aortic regurgitation, or mitral and aortic regurgitation); (c) cardiac enlargement (cardiothoracic ratio $>50\%$ without demonstrable cause); (d) congenital heart disease. Chest pain of indeterminate aetiology referred to chest pain that was not clearly the result of myocardial ischaemia, pericarditis, pleural irritation, or pulmonary emboli. Isolated left anterior hemiblock referred to those subjects with left anterior hemiblock in whom there was no evidence of additional electrocardiographic abnormalities hypertension, cardiac disease, or chest pain of indeterminate aetiology.

Results

The prevalence rates of left anterior hemiblock by age are shown in Table 1. Combining ages, the

Table 1 Prevalence of left anterior hemiblock

Age	Population	Total left anterior hemiblock		Mean QRS axis			
				-31° to -59°		-60° to -90°	
		No.	%	No.	%	No.	%
< 30	1208	23	1.90	8	0.66	15	1.24
30-39	4694	65	1.38	36	0.77	29	0.61
40-49	5556	146	2.63	94	1.69	52	0.94
50-59	4210	134	3.18	79	1.88	55	1.30
> 60	932	45	4.83	30	3.22	15	1.61
Total	16 600	413	2.49	247	1.49	166	1.00

prevalence of left anterior hemiblock was 2.49 per cent; the prevalence increased with age for each decade after the third. For each age group 30 years of age and over, the prevalence rates were greater for a mean QRS axis between -31° and -59° than for a mean QRS axis between -60° and -90° .

The incidence of additional electrocardiographic abnormalities, hypertension, and cardiac disease increased with age in both the left anterior hemiblock and control groups age 30 and over. When cardiac disease was evaluated, cases with chest pain of indeterminate aetiology were excluded from the analyses. Because the trends for both groups age 30 and over were similar, and the number of subjects in each group identical, these age groups were combined for subsequent analyses. The age group under 30 differed and was analysed separately; combining all the ages would have produced a statistically significant interaction effect caused principally by the age group under 30.

The number of subjects in the left anterior hemiblock and control groups with the above abnormalities is shown in Table 2. These results are presented separately for subjects age 30 and over and for those under age 30. In subjects age 30 and

Table 2 *Abnormalities in left anterior hemiblock and control groups*

	<i>Left anterior hemiblock</i>		<i>Control</i>		χ^2	<i>P value</i>
	<i>No.</i>	<i>%</i>	<i>No.</i>	<i>%</i>		
≥ 30 years						
Electrocardiographic abnormalities	117/390	30.0	81/390	20.8	8.29	0.005
BP ≥ 140 and ≥ 90 mmHg	71/390	18.2	47/390	12.1	5.28	0.025
Cardiac disease	49/347	14.1	19/363	5.2	15.17	0.001
< 30 years						
Electrocardiographic abnormalities	13/23	56.5	6/23	26.1	5.64	0.025
BP ≥ 140 and ≥ 90 mmHg	0/23	0.0	3/23	13.0	1.43	NS
Cardiac disease	13/22	59.1	1/22	4.5	12.68	0.001

over, a significant relation was present between left anterior hemiblock and electrocardiographic abnormalities, hypertension, and cardiac disease. In subjects under age 30, significant relations were present between left anterior hemiblock and each of these abnormalities except hypertension. There was no relation between the degree of left axis deviation and additional electrocardiographic abnormalities, hypertension, or the presence of cardiac disease (Table 3). The electrocardiographic abnormalities in the total group with left anterior hemiblock and the subgroups of left anterior hemiblock are presented in Table 4. The incidence of abnormal Q waves and of ST-T changes was similar in the subgroups with a mean QRS axis between -31° and

59° and between -60° and -90° ; they were primarily localised to the anterolateral region of the left ventricle.

The results of the cardiac examination for the total group with left anterior hemiblock and for the subgroups with a mean QRS axis between -31° to -59° and -60° to -90° are presented in Table 5. Ischaemic heart disease was the most common type of heart disease in subjects age 30 and over; it was present in 28 cases (8.1%). Myocardial infarction of the anterior and/or lateral wall was documented in 15 of these cases (4.3%). There was no significant difference between the two subgroups of left anterior hemiblock. Of the 13 cases with congenital heart disease, 10 were under age 30. There were 3 cases with an atrial septal defect of the ostium primum type, 3 cases with a secundum atrial septal defect, 3 cases with a ventricular septal defect, and 4 individual cases with complex anomalies.

In the total group with left anterior hemiblock age 30 and over isolated left anterior hemiblock was found in 194 of 363 cases (53.4%). In the subgroup with a mean QRS axis between -31° and -59° , isolated left anterior hemiblock was present in 114 of 222 cases (51.4%) compared with 80 of 141 cases (56.7%) in the subgroup with a mean QRS axis between -60° and -90° . There was a tendency for the incidence of isolated left anterior hemiblock to decrease for each age group 30 years of age and over. In subjects under 30 years of age isolated left anterior hemiblock occurred in 5 of 23 cases (21.7%).

Table 3 *Abnormalities related to degree of left axis deviation*

	<i>Mean QRS axis</i>			
	-31° to -59°		-60° to -90°	
	<i>No.</i>	<i>%</i>	<i>No.</i>	<i>%</i>
≥ 30 years				
Electrocardiographic abnormalities	69/239	28.9	48/151	31.8
BP ≥ 140 and ≥ 90 mmHg	50/239	20.9	21/151	13.9
Cardiac disease	30/213	14.1	19/134	14.2
< 30 years				
Electrocardiographic abnormalities	5/8	62.5	8/15	53.3
BP ≥ 140 and ≥ 90 mmHg	0/8	0.0	0/15	0.0
Cardiac disease	3/7	42.9	10/15	66.7

All comparisons were found to be statistically non-significant at the 0.05 level.

Table 4 *Electrocardiographic abnormalities in left anterior hemiblock*

	<i>RBBB</i>	<i>LBBB</i>	<i>1°AVB</i>	<i>LVH</i>	<i>Abnormal Q waves</i>	<i>ST-T changes</i>	<i>Total</i>
≥ 30 years							
LAH total	11	4	9	2	15	76	117
AQRS -31° to -59°	2	3	6	1	9	48	69
AQRS -60° to -90°	9	1	3	1	6	28	48
< 30 years							
LAH total	1	0	3	3	1	5	13
AQRS -31° to -59°	0	0	0	1	1	3	5
AQRS -60° to -90°	1	0	3	2	0	2	8

RBBB, right bundle-branch block; LBBB, left bundle-branch block; 1°AVB, first degree atrioventricular block; LVH, left ventricular hypertrophy; LAH, left anterior hemiblock; AQRS, mean frontal plane QRS axis.

Table 5 Types of cardiac disease in left anterior hemiblock

	Ischaemic		Valvular			Cardiac enlargement	Congenital	Total
	Angina	Infarction	AR	MR	AR and MR			
≥ 30 years								
LAH total	13	15	3	5	2	8	3	49
ÅQRS -31° to -59°	6	8	2	3	2	7	3	31
ÅQRS -60° to -90°	7	7	1	2	0	1	0	18
< 30 years								
LAH total	0	1	0	2	0	0	10	13
ÅQRS -31° to -59°	0	1	0	0	0	0	2	3
ÅQRS -60° to -90°	0	0	0	2	0	0	8	10

AR, aortic regurgitation; MR, mitral regurgitation; AR and MR, aortic and mitral regurgitation; LAH, left anterior hemiblock; ÅQRS, mean frontal plane QRS axis.

Discussion

The selection of a mean frontal plane QRS axis to the left and superior of -30° was employed as one criterion for the electrocardiographic diagnosis of left anterior hemiblock. Previous studies (Grant, 1957; Blackburn *et al.*, 1967) have shown that while left ventricular hypertrophy, a horizontal position of the heart in the chest, advancing age, and increased body weight may be associated with a leftward mean QRS axis, this rarely exceeds -30°. Furthermore, a mean QRS axis greater than -30° is similar to that used in previous series (Grant, 1957; Corne *et al.*, 1965; Pryor and Blount, 1966; Castellanos and Lemberg, 1971; Demoulin *et al.*, 1975). While Rosenbaum *et al.* (1970) have employed a mean QRS axis of -45° as the inferior limit in left anterior hemiblock, they state that this is arbitrary and that in some cases the axis may be -30°. Furthermore, Das (1976) has suggested that all leftward shifts in the mean QRS axis represent a spectrum of intraventricular conduction block. For clinical convenience in the routine interpretation of electrocardiograms, the reference points -30°, -60°, and -90° were employed because they represent easily reproducible landmarks with reference to the direction of the mean QRS axis in the frontal plane using the inspection method of Grant (1957). A delay in the time of inscription of the intrinsicoid deflection in lead aVL (Medrano *et al.*, 1972) was not used in this study. Earlier reports using the term left axis deviation have been referred to when the mean frontal plane QRS axis was -30° or greater; not all of these studies provided adequate information to diagnose left anterior hemiblock.

Left anterior hemiblock and left axis deviation are not synonymous. The mean frontal plane QRS axis may be deviated to the left beyond -30° in the absence of a conduction disturbance of the anterior fascicle of the left bundle-branch. Other causes of left axis deviation include extensive inferior myo-

cardial infarction, pulmonary emphysema, hyperkalaemia, the Wolff-Parkinson-White syndrome, and right ventricular apical pacing (Castellanos and Lemberg, 1971). In certain types of congenital heart disease left axis deviation has been attributed to early activation of the posterior left ventricular wall (Durrer *et al.*, 1966; Boineau *et al.*, 1973). Recent anatomical (Uhley, 1972; Demoulin *et al.*, 1975; Massing and James, 1976; Rossi, 1976) and electrophysiological studies (Durrer *et al.*, 1970; Waldo *et al.*, 1974) have created a controversy regarding the validity of the trifascicular nature of the intraventricular conduction system and the sequence of ventricular excitation. The term left anterior hemiblock has been employed in this paper because of its current widespread use.

This study was designed to evaluate the significance of left anterior hemiblock in an ambulatory population of North American men who applied for life insurance. It is recognised that selection factors inherent in life insurance applicants do not permit a direct comparison to be made between this population and the general population. Nevertheless, the prevalence rate of left anterior hemiblock by age groups was similar to that reported in the Honolulu heart study (Yano *et al.*, 1975), though it was lower than in the Tecumseh survey (Ostrander, 1971). The prevalence rate of left anterior hemiblock increased with age similarly in men with a mean QRS frontal plane axis greater than -30° but less than -60°, and in those with a QRS axis between -60° and -90°.

In the present study, in subjects age 30 and over, there were no other electrocardiographic abnormalities or clinical disease in 53 per cent of those with left anterior hemiblock; these results are similar to those reported for the general population with left anterior hemiblock (Ostrander, 1971; Yano *et al.*, 1975). The prevalence of isolated left anterior hemiblock decreased with advancing age in subjects age 30 and over. Furthermore, there was no significant difference in the prevalence of isolated left

anterior hemiblock when subjects with a mean QRS axis between -60° and -90° were compared with those with a mean QRS axis greater than -30° but less than -60° . Schaaf (1974) has reported that individuals with mean frontal plane QRS axes greater than -60° did not have a significant increase in mortality compared with those with an axis between -45° and -60° .

When men age 30 and over with left anterior hemiblock were compared with age-matched men in a control group, there was a significant relation between electrocardiographic abnormalities, hypertension, and cardiac disease. There were no inter-group differences when subjects with a mean QRS axis greater than -30° but less than -60° were compared with subjects with a mean QRS axis between -60° and -90° . In subjects under age 30 a significant relation was present between cardiac disease and left anterior hemiblock; this was a result of the high incidence of congenital heart disease in the left anterior hemiblock group. Follow-up studies will be devoted to the morbidity and mortality experience of the left anterior hemiblock and control groups.

Left anterior hemiblock was not a sensitive marker of cardiac disease in subjects age 30 and over since clinical cardiac disease was absent in 86 per cent of subjects with left anterior hemiblock. This observation is supported by recent histopathological studies by Demoulin *et al.* (1975) and Rossi (1976) who found diffuse fibrosis throughout the left bundle-branch system in left anterior hemiblock. Therefore, the following considerations must be entertained as being aetiological factors in those cases with left anterior hemiblock not associated with clinical cardiac disease or hypertension: (1) sclerosis of the left side of the cardiac skeleton primarily involving the anterior division of the left bundle (Lev, 1964); (2) a sclerodegenerative disorder described by Lenegre (1964); (3) a congenital anomaly of the left ventricular conduction system; (4) a clinically unrecognised episode of myocarditis; (5) microscopical myocardial fibrosis and/or clinically and electrocardiographically silent infarction (Master and Geller, 1969).

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