VENTRICULAR COMPLEXES IN HEART BLOCK

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In electrocardiograms of complete A-V block, the ventricular complexes may be of normal supraventricular type, of typical bundle branch block (B.B. block) type, or may exhibit lesser degrees of widening and notching of QRS and T wave changes. The association of B.B. block with complete A-V block is recognized as common. Campbell (1944) found B.B. block in 19 of 64 cases of complete block. Similar findings have been recorded by White and Viko (1923) who found evidence of intraventricular block in 15 out of 27 cases of complete heart block, and by Fatzer (1946) who described intraventricular block in 60 per cent of cases; Mouquin and Macrez (1947) in a series of 124 cases of complete heart block, found normal ventricular complexes in only 25 instances. Graybiel and Sprague (1933) record 17 cases of complete A-V block in 395 cases of B.B. block, and Freund and Sokolov (1939) found complete A-V block in 5 per cent of 210 cases of B.B. block. It is also recognized that the form of QRS during complete A-V block may differ from that recorded during sinus rhythm in the same case.

For purposes of investigating the form of the ventricular complexes, a series of 100 cases of complete A-V block has been assembled, comprising patients seen at the National Heart Hospital during the last few years, and others seen at the Middlesex Hospital or in practice by Dr. Evan Bedford, at whose suggestion this investigation was undertaken. The cases were unselected and as far as possible consecutive from both sources. Fifteen patients have been under personal observation during the past year.

ÆTIOLOGY

The ætiology of the heart block in this series of 100 cases is shown in Table I.

The cases of uncertain ætiology included five patients with a history of "heart trouble" in childhood, six with a history of rheumatic fever but without clinical evidence of rheumatic valvulitis, four in whom there was a possible cardiac infarction, two with a family history of complete heart block, and two in whom the block followed surgical operation.

TABLE I
ÆTIOLOGY AND SEX INCIDENCE

	Number of cases	Male	Female
Coronary heart disease:			
(a) Chronic	43	30	13
(b) Associated with recent cardiac infarction	9	8	1
Congenital	20	9	11
Rheumatic heart disease	3	2	1
Diphtheric heart disease	2	1	1
Syphilis	1	1	—
Pneumonia	1	1	—
Associated with neurological disease	2	2	—
Ætiology uncertain	19	7	12
Total	100	61	39

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There were eight cases in which complete A-V block was transient. In seven of them there was associated coronary heart disease, one having recent cardiac infarction, and the other case was of doubtful aetiology. In only two of these cases was the P-R interval prolonged during the phase of sinus rhythm.

THE VENTRICULAR COMPLEXES

The ventricular complexes have been classified into three groups: (1) Supraventricular pattern. (2) Bundle branch block pattern. (3) Varying complexes.

(1) SUPRAVENTRICULAR PATTERN

Ventricular complexes of normal duration, 0.06–0.10 sec., and with normal S-T and T segments, including cases in which axis deviation was the only abnormality, occurred in 47 of the 100 cases. Of these 47 cases, 19 were congenital, 11 had coronary heart disease, 4 followed rheumatic fever or diphtheria, 1 was associated with neurological disease, 1 followed pneumonia, and 11 were of doubtful aetiology; of this latter group, 5 had a previous history of rheumatic fever and 4 gave a history of heart trouble in early life. Fig. 1 shows the electrocardiograms of two cases of congenital A-V block, with QRS-T complexes of supraventricular pattern.

In addition, in 6 patients with coronary heart disease, the electrocardiograms showed left ventricular preponderance, with QRS complexes of normal duration. Four of them had associated hypertension with systolic blood pressure greater than 200 mm., the blood pressure in the other cases being 170/90 and 180/70 mm. of mercury.

The pulse rate in these cases with normal ventricular complexes varied between 25 and 60 a minute. As shown in Table II, in most of them the rate was relatively high, between 36 and 60 a minute, especially in the cases of congenital heart block, whereas in cases with widened ventricular complexes the rate was slower, between 26 and 40

a minute. The readings recorded in Table II are the average pulse rates, but in individual patients the rate actually varied when observed over a period; for instance, with an average rate of 30 beats a minute, the rates actually recorded varied between 26 and 34.

FIG. 1.—Complete A-V block with normal QRS complexes.

(A) From a baby six days old; ventricular rate 75 a minute.

(B) From a man aged 18 years; ventricular rate 42 a minute.

The ventricular complexes of complete heart block are usually of supraventricular pattern when the pacemaker is situated in the main bundle and the bundle branches function normally. This is the rule in congenital heart block, and all but one of the 20 cases in this series classed as congenital showed normal QRS complexes, whereas in the cases with coronary heart disease normal QRS complexes occurred in only one-third.

Supraventricular QRS complexes may also occur in complete heart block due to lesions of both

TABLE II
AVERAGE PULSE RATE

Pulse rate per minute	21–25	26–30	31–35	36–40	41–45	46–50	51–55	56–60
Congenital:								
Normal complexes	—	1	1	—	5	4	6	2
Widened complexes	—	—	—	—	1	—	—	—
Coronary heart disease (chronic):								
Normal complexes	1	—	—	3	4	4	0	3
Widened complexes	2	5	7	7	2	5	0	1
Total cases:								
Normal complexes	1	3	3	8	15	9	7	7
Widened complexes	3	8	13	14	3	5	—	1

bundle branches (illustrated schematically in Fig. 5A). Wilson and Hermann (1921) found that, in experimental section of both bundle branches, the ventricular complexes might be of the form indicating a right-sided pacemaker, of the form indicating a left-sided pacemaker, or might be of relatively normal outline. To explain the occurrence of relatively normal QRS complexes, they postulated the existence of two pacemakers, one in each bundle branch, acting synchronously, the summation of a lævocardiogram and dextrocardiogram resulting in a ventricular complex of normal outline and duration. In support of this view is the fact that cardiograms showing a change in site of the pacemaker from one side to the other also show transitional forms of QRS complex resembling the normal supraventricular pattern. Cases of complete heart block in which these changes were demonstrated have been reported by Gilchrist and Cohn (1928), and by Bain (1941).

As an alternative explanation, Yater (1936) believes that there is probably a single pacemaker in one or the other bundle branch, sending impulses directly through the interventricular septum into the Purkinje network of the contralateral, as well as into that of the homolateral ventricle.

Mahaim (1931) and Yater (1936) describe cases of complete A-V block in which detailed histological examination of the conducting system showed lesions confined to the bundle branches, and a normal appearance of the A-V node and the main bundle. According to Mahaim (1932), the two branches of the bundle of His are not isolated in their course along the interventricular septum, but are connected by branches as high as the top level of the musculature. The common trunk of the bundle of His is likewise connected with the ventricular myocardium. Because of these high connections, auriculo-ventricular conduction may be normal in spite of destruction of the branches—"bilateral missed block."

In interpreting electrocardiograms of complete A-V block exhibiting QRS complexes of supraventricular pattern, the following points may be considered in favour of bilateral B.B. block as the underlying mechanism: (a) heart disease of coronary ætiology, (b) a relatively slow inherent rate of the pacemaker, (c) the association of supraventricular QRS complexes with those of widened type, or the occurrence of periods of sinus rhythm with B.B. block, especially when the ventricular complexes alternate between right and left branch block.

In two cases of this group widened QRS complexes changed to QRS of normal duration, without any alteration in the pulse rate, which was slow, namely 30 to 36 a minute in both cases (Fig. 2).

FIG. 2.—Complete A-V block with variation in QRS complexes in a man aged 51.

(A) On 24/8/42 shows QRS complexes of normal duration, rate 36 a minute.

(B) On 27/8/42 shows widened QRS complexes, rate 34 a minute.

In another case with widened QRS complexes, the pulse rate was 28 a minute, but increased to 40 a minute when the QRS complexes became normal in duration.

(2) VENTRICULAR COMPLEXES OF BUNDLE BRANCH BLOCK PATTERN

The B.B. block pattern of ventricular complex is characterized by axis deviation, widening of the QRS, and T waves directed oppositely to the main deflection of QRS. Wilson *et al.* (1944) consider that when QRS has a duration of 0.12 sec. or more and, in lead I, is monophasic and consists of a broad, slurred, flat-topped or bifid R deflection, the præcordial curves almost always show left B.B. block. But when QRS is similarly widened and, in lead I, is biphasic or triphasic and tends to a broad slurred or notched S deflection, the præcordial curves are mainly characteristic of right B.B. block. The occasional exceptions to this general rule may be due to (a) a vertical position of heart, when limb leads suggest right B.B. block and præcordial leads left B.B. block, and vice versa; (b) arborization block, most often seen with extensive myocardial infarction, and due to general depression of conductivity of Purkinje tissue or to local lesions involving the subendocardial Purkinje network over a considerable area. In some cases there is no obvious relation between the form of QRS in præcordial leads and that in limb leads; in these the position of the heart must be classed as indeterminate.

In the present series, 47 per cent of cases showed widened ventricular complexes, with a QRS interval of 0.12 seconds or more, in the presence of complete heart block (see Table III). In the earlier cases, præcordial leads were not available to confirm the type of B.B. block.

(a) In 29 cases the ventricular complexes were of

FIG. 3.—Complete A-V block with widened QRS complexes.
(A) QRS complexes 0.14 sec. duration and of right B.B. block pattern (Wilson type).
(B) QRS complexes 0.14 sec. duration and of right B.B. block pattern.

right B.B. block type, 23 being of the Wilson or S type, and 6 of the uncommon type (Fig. 3). Of these, 20 had coronary heart disease, 5 had associated cardiac infarction, 1 was in association with neurological disease, and 3 were of doubtful ætiology.

TABLE III

THE TYPE OF VENTRICULAR COMPLEX IN CASES WITH WIDENED QRS

Right bundle branch block.	(a) S type	..	23
	(b) Uncommon type	..	6
Left bundle branch block.	Common type	..	6
Concordant pattern	..	..	2
Both right and left bundle branch block	..	..	4
Varying complexes	..	..	6
	Total	..	47

(b) In 6 cases the ventricular complexes were of left B.B. block type. Of these, 3 had coronary heart disease, 1 had congenital heart block, 1 was associated with rheumatic aortic and mitral valvular disease as confirmed by necropsy, and 1 was of doubtful ætiology.

(c) In 2 cases the ventricular complexes were of the concordant type, one of the common and one of the uncommon type. No præcordial leads had

FIG. 4.—Complete A-V block with variation of QRS complexes in a man aged 71.
(A) On 27/7/42 the complexes were of left B.B. block pattern.
(B) On 3/9/42 they were of concordant right B.B. block pattern.

been recorded, so that further elucidation of the block was impossible.

(d) In 4 cases, observed for periods of 1–5 years, the site of the pacemaker varied between left and right ventricle. Of these, one had coronary heart disease and the others were of uncertain ætiology. An example of the cardiograms in this group is given in Fig. 4, which shows (a) QRS complexes of left B.B. block pattern, rate 34 a minute, and (b), four weeks later, QRS complexes of concordant right B.B. block pattern, rate 25 a minute.

(e) Finally, in 6 cases, the widened ventricular complexes assumed varying patterns in the same tracings.

THE RELATION OF BUNDLE BRANCH BLOCK TO COMPLETE A-V BLOCK

The original interpretation of the B.B. block pattern of QRS, based on experiments in dogs, has in recent years been reversed, largely by the work of Wilson and his associates. Histological investigation of the bundle system in diseased hearts has failed to supply convincing proof of either the

FIG. 5.—Diagram of bundle showing location of ventricular pacemaker (P) site of lesion (shaded zone), and ventricular complexes of electrocardiogram. R.B.B.: right bundle branch. L.B.B.: left bundle branch.

(A) Production of QRS complexes of normal duration. P 1 and P 2 are simultaneous pacemakers in right and left ventricle.

(B) and (C). Production of widened ventricular complexes.

(D) (I) Sinus rhythm; ventricular pacemaker in A-V node; lesion involves the left branch of bundle; cardiogram shows left B.B. block complex.

(II) Complete A-V block; ventricular pacemaker in left branch distal to lesion, now involving also main stem of bundle; cardiogram shows right B.B. block complex.

FIG. 6.—Alteration of QRS complexes with change in rhythm.

(A) On 10/1/45, sinus rhythm, rate 50 a minute, P-R interval normal, and QRS complexes of left B.B. block pattern.

(B) On 7/8/47, complete A-V block, rate 30 a minute, and QRS complexes of right B.B. block.

This patient, a woman aged 32, died suddenly on 22/8/47.

old or the new view. Master *et al.* (1940) believe that the B.B. block curve is more often due to diffuse myocardial damage associated with great enlargement of the corresponding ventricle than to a localized lesion of a bundle branch, and Rasmussen and Thingstead (1939) have supported a similar view.

When a lesion of the ventricular septum involves the main stem of the bundle it is likely to extend to the bundle branches and, therefore, we should expect to find complete A-V block sometimes associated with B.B. block in the cardiogram. In fact, QRS of B.B. block pattern occurred in 47 per cent of the present cases of complete block. We may consider this association in relation to the pathogenesis of the B.B. block cardiogram. It is usually assumed that ventricular complexes of, say, right B.B. block pattern indicate defective conduction in the right branch of the bundle, but an alternative explanation is to assume that the

ventricular pacemaker is located in the left branch of the bundle. This is illustrated schematically in Fig. 5 (B and C).

Variations in the form of QRS may accompany the change from sinus rhythm to complete heart block, or vice versa, and these are of particular interest in regard to locating the ventricular pacemaker and to fixing the site of the bundle lesion. In 6 cases where records of both sinus rhythm and of complete A-V block were obtained, significant changes in the form of QRS occurred. In five of them, complete A-V block was combined with QRS of right B.B. block pattern, and sinus rhythm with a QRS of left B.B. block pattern (see Fig. 6). This may be explained by supposing that there is a lesion of the left branch and that during sinus rhythm the right branch only conducts. When the lesion extends from the left branch to the main stem of the bundle, causing complete A-V block, the ventricular pacemaker shifts to the left branch distal to the site of the lesion, thus producing right B.B. block pattern in the cardiogram. This hypothesis is illustrated schematically in Fig. 5 (D). Fig. 7 shows the cardiograms of a man aged 54; during sinus

FIG. 7.—(A) Electrocardiogram on 5/10/43, shows in lead I, and latter part of leads II and III, sinus rhythm, rate 48 a minute, and normal P-R interval; the QRS complexes are of the Wilson type of B.B. block. In the first half of leads II and III there is complete A-V block, rate 34 a minute, QRS complexes being of left B.B. block pattern.

(B) On 14/10/43, shows complete A-V block, with QRS complexes of left B.B. pattern.

FIG. 8.—Schematic illustration of the blood supply of the junctional tissues. The area supplied by the posterior perforating branches is shown in black, and the shaded area represents the area supplied by the anterior branches.

rhythm the QRS complexes are of right B.B. block pattern and during complete A-V block, of left B.B. block pattern.

THE BLOOD SUPPLY TO THE BUNDLE

Gross (1921) describes the blood supply to the A-V node and the main bundle as being mainly from a special artery, the ramus septi fibrosi arising from the posterior interventricular artery, which is a branch of the right coronary artery in 90 per cent of hearts; the posterior division of the left bundle branch is also supplied from the same source. The right bundle branch and the anterior division of the left bundle branch are supplied mainly by anterior perforating septal branches of the anterior interventricular artery, a branch of the left coronary artery; the terminal part the right bundle branch may receive some supply from the posterior perforating arteries. The blood supply of the junctional tissues is illustrated schematically in Fig. 8. In normal hearts, the anastomoses between the anterior and posterior perforating septal arteries are very fine, but with the slow obliteration of these arteries by coronary vascular disease, the anastomoses undoubtedly become more effective. Blumgart *et al.* (1940) consider that, irrespective of age, anastomoses measuring 40 micra or more in diameter between the right and left coronary arteries rarely exist in the absence of partial or complete arterial occlusion. Permanent complete A-V block is usually associated with

slow and progressive diminution of the blood supply of the posterior portion of the heart, which is through the posterior perforating septal arteries, and it has been shown that these vessels, besides supplying the main bundle, also supply the posterior division of the left bundle branch. The common occurrence of QRS of right B.B. block pattern in complete heart block has been noted; in 5 such cases there were intervals of sinus rhythm with left B.B. block. It is postulated that, with gradual diminution of blood supply, there is functional block of part of the left bundle branch and eventually of the main bundle and that, with the occurrence of complete A-V block, the new pacemaker is situated in the area of irritable tissue below the block, giving rise to a right B.B. block pattern of ventricular complex.

VARYING VENTRICULAR COMPLEXES

The appearance of varying ventricular complexes in complete heart block may be associated with

FIG. 9.—Complete A-V block with varying ventricular complexes in the same tracing.

(A) On 19/1/44, shows widened QRS complexes varying in shape in lead I, and multiple extrasystoles producing coupling.

(B) On 18/4/45, showing QRS complexes of right B.B. block pattern. Coupling due to extrasystoles still persists.

This patient, a woman aged 47, was seen again in July 1947; the aetiology of the heart block was unknown.

(a) changing site of the pacemaker; (b) the conduction of occasional auricular impulses; or (c) the occurrence of ventricular extrasystoles.

(a) *Changing site of the pacemaker.* There were six cases in which the ventricular complexes varied in the same tracing (see Fig. 9), indicating either a changing site of the pacemaker, or a varying path of the impulses. In only one of them were transitional complexes between the dextro- and lævo-cardiogram types detected. Five of the cases had coronary heart disease, and the other was of uncertain ætiology. As already described under group 2, there were also 4 cases in which, during observation over a period, the complexes varied between left B.B. block and right B.B. block pattern (see Fig. 4).

(b) *The conduction of auricular impulses* was clearly responsible for variation in the ventricular complexes in records of only three cases (Fig. 7). In one, each of the left B.B. block complexes was closely related to a P wave, although the P-R interval was variable, i.e. 0.24 to 0.36 seconds (Fig. 10).

FIG. 10.—Variation in the QRS complexes due to conducted auricular impulses in which the P-R interval varies.

(c) *Ventricular extrasystoles* were recorded in 20 cases, originating in the right ventricle in 7, in the left in 8, and from both ventricles in 5 cases. When ventricular extrasystoles occur in association with widened ventricular complexes, the site of origin of the extrasystoles is usually in the same ventricle as the pacemaker. Thus there were 6 cases with a left-sided pacemaker and extrasystoles, and in 5 of them the extrasystoles arose in the left ventricle (Fig. 11). In one case with a right-sided

FIG. 11.—Complete A-V block, with ventricular extrasystoles resembling the main complexes.

pacemaker extrasystoles arose in both ventricles. Coupling due to ventricular extrasystoles was recorded in 6 cases of which only one was receiving digitalis. When complexes suggesting both left and right-sided pacemakers are seen, it is necessary to consider the possibility of intermittent auriculo-ventricular conduction, especially if there are no transitional complexes. In this case, the conducted ventricular complex bears a certain relation to the P wave although the P-R interval may show some variation. According to Katz, this is a more common cause of variation in form of the QRS complexes than is the occurrence of extrasystoles. Fig. 12 shows a tracing in which, in lead III, the

FIG. 12.—The second and third complexes in lead III of this tracing are ventricular extrasystoles, bearing no relation to P waves.

second and third complexes are definitely extrasystolic, as they bear no relation to P waves.

When varying complexes, due to a changing site of pacemaker, accompany complete heart block, the lesions are more likely to be found in the bundle branches than in the main bundle, according to the work of Wilson and Hermann, though destructive lesions of the terminal portion of the main bundle were found by Don, Grant, and Camp (1932).

As already stated, to explain the appearance of variable complexes, Wilson and Hermann (1921), and Gilchrist and Cohn (1928) postulate the existence of two pacemakers, with a change in leadership from one to the other. Yater *et al.* (1936), while accepting this concept, also consider that the site of the pacemaker may change from time to time in the same bundle branch and, in addition, that the path of the excitation wave may vary after leaving the pacemaker. Clinically, bilateral bundle branch lesions can only be diagnosed with certainty when there are intervals of sinus rhythm with alternate right and left B.B. block complexes.

THE ÆTIOLOGY OF COMPLETE HEART BLOCK IN RELATION TO THE FORM OF THE QRS COMPLEXES

(a) *Congenital Heart Block.* According to Yater (1929), complete heart block may be regarded as congenital when a slow pulse has been found at an early age, and when there is no history of infection such as diphtheria, rheumatic fever, chorea, or congenital syphilis. A history of syncopal attacks early in life, though rare, and the presence of signs of congenital heart disease, are supporting evidence of a congenital ætiology.

In 20 cases of this series, heart block was regarded as being congenital on the grounds of its recognition in childhood or adolescence, of the absence of any relevant history of infection, and, in four cases, of the presence of signs of congenital heart disease. In eleven of them, electrocardiograms showed QRS complexes of characteristically normal supra-ventricular form and of short duration (0.06–0.08 sec.) without any axis deviation. In the four cases with associated congenital heart disease, there was right axis deviation with QRS complexes of normal duration. Four cases showed somewhat wider QRS complexes (0.08–0.1 sec.) which were slightly notched, and one case showed widened QRS complexes (0.12 sec.) of left B.B. block pattern. Thus in congenital heart block the QRS complexes are commonly of supraventricular type, and the ventricular rate is relatively rapid, between 40 and 60 a minute. Similar findings have been reported by Leech (1930). On this evidence, we may assume that, in congenital complete block, the lesion usually involves the main bundle.

(b) *Cardiac Infarction.* There were nine cases of complete A-V block associated with clinical evidence of cardiac infarction and six of them showed QRS complexes of right B.B. block type. (1) In three cases definite cardiographic changes indicative of acute infarction were recorded; it was posterior in two (see Fig. 13) and anterior in the other. (2) In one case progression from partial to complete A-V block was recorded and the T waves in leads II and III were observed to become inverted and later upright again; the QRS complexes were of normal duration. (3) In the remaining five cases there was a reliable history of cardiac infarction but no definite electrocardiographic evidence of it. All of them exhibited widened ventricular complexes which were of right B.B. block pattern in four, and of concordant uncommon B.B. block pattern in the other.

Whilst heart block is common with gradual ischaemia of the junctional tissues, it is uncommon in cardiac infarction in which it is more often temporary, lasting hours or days, than permanent. Levine found only two cases of complete block in a

FIG. 13.—Complete A-V block, rate 37 a minute, associated with recent posterior cardiac infarction in a man aged 65, who suddenly collapsed with præcordial pain and dyspnoea. The electrocardiogram was recorded several hours later. (Time marker 0.05 sec.)

series of 145 cases of cardiac infarction with autopsy control; Schwartz (1936) described 15 cases, and Cookson (1942) described 5 cases in a review of 200 cases of cardiac infarction. Complete heart block is usually associated with posterior infarction involving the septum when, as shown in this series, it is often associated with QRS complexes of right B.B. block pattern. Antero-septal infarcts are rarely associated with complete heart block unless the infarct extends to the upper part of the septum.

In the presence of bundle branch lesions, the electrocardiographic changes of cardiac infarction may be obscured, especially in the case of left B.B. block. Wilson *et al.* (1944) have found that right B.B. block does not obscure the changes characteristic of posterior infarction in the limb leads, though it may cause inversion of the T waves in right-sided præcordial leads and occasionally in lead III (Wolferth and Levezey, 1947). The cardiogram in Fig. 14, from a patient giving a history of cardiac infarction, shows complete A-V block with QRS complexes of right B.B. block pattern, and sharply inverted T waves in leads CR 3 and CR 4, suggesting anterior septal damage.

THE PROGNOSTIC SIGNIFICANCE OF THE QRS PATTERN

In cases of complete A-V block exhibiting normal QRS complexes, in which the lesion is located high up in the bundle stem and is often congenital in

FIG. 14.—Complete A-V block, rate 25 a minute, in a man aged 43, with a history of cardiac infarction. The limb leads show QRS of right B.B. block pattern; leads CR 3 and CR 4 show sharp deeply inverted T waves, suggesting anterior septal damage.

origin, the heart rate is faster and the liability to Adams-Stokes attacks is far less than in cases exhibiting widened QRS complexes, in which the lesion involves the bundle branches, often due to coronary disease, and the heart rate is slower. Thus in my 53 cases with normal QRS complexes, only 20 (38 per cent) were recorded as having Adams-Stokes attacks compared with 31 (66 per cent) of the 47 cases with widened QRS complexes.

Katz considers that the expectation of life is

seldom longer than a year or two in complete block with widened QRS complexes. Three of my cases of this type died suddenly before the age of 40, though four others had been under observation for a period of five years. In general terms, however, the prognosis in complete A-V block may be assessed on the basis of the underlying heart disease, being relatively good when the ætiology is congenital and more serious when it is coronary.

SUMMARY

A series of 100 cases of complete heart block has been investigated with special regard to the form of the ventricular complexes exhibited in electrocardiograms. The most frequent ætiological cause of complete heart block was coronary heart disease which occurred in 52 cases, and next a congenital origin which was probable in 20 cases.

The ventricular complexes found in complete heart block may be classified as follows:—

(1) *Supraventricular pattern* (a) due to block in the main bundle stem, (b) occasionally due to bilateral bundle branch block.

(2) *Bundle branch block pattern* (a) due to block in a bundle branch, (b) due to block in the main stem associated with bundle branch block.

(3) *Varying pattern* (a) due to shifting pacemaker, (b) due to conducted auricular beats, (c) due to extrasystoles.

In coronary heart disease, complete heart block is usually associated with obstruction of the posterior blood supply, and occurs more often with posterior than with anterior cardiac infarction. The frequency of associated right B.B. block in coronary disease can be explained in terms of the blood supply to the conducting system. In congenital complete heart block, the QRS complexes were of supraventricular pattern in 19 out of 20 cases.

In complete block exhibiting QRS complexes of B.B. block pattern, the pacemaker is situated lower in the bundle, its inherent rate is slower, Adams-Stokes attacks occur more often, and the expectation of life is less than in cases of complete block exhibiting normal ventricular complexes.

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