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POLYGRAPHIC ANALYSIS OF THE LEFT VENTRICULAR FUNCTION AND SYSTOLIC TIME INTERVALS IN CASES OF BUNDLE-BRANCH BLOCKS

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Abstract

Polygraphic analyses were carried out on the left ventricular function and systolic time intervals in patients with various types of bundle-branch blocks. The subjects were consisted of 31 cases with complete right bundle-branch block (CRBBB), 14 with CRBBB+left axis deviation (LAD), 18 with complete left bundle-branch block (CLBBB), and 2 with intermittent CRBBB.

A decrease of the left ventricular function in the descending order of those with CLBBB, CRBBB+LAD, and CRBBB was found. In the CRBBB group the left ventricular function was directly dependent upon the severity of the basic disease. In the first two groups, however, in addition to the basic disease the left intraventricular conduction disturbance itself also seemed to affect the left ventricular function.

As for the left ventricular systolic time intervals in the first two groups the beginning of the left ventricular ejection was delayed, and such a delay was especially marked in those with CLBBB. The delay in the beginning of the left ventricular ejection in those with CRBBB+LAD was mostly due to a prolongation of the isovolumic contraction time (ICT), while in those with CLBBB was mostly due to a prolongation in both electromechanical interval (Q-C) and ICT.

INTRODUCTION

In examining patients with bundle-branch blocks in informations available by electrocardiogram (ECG) alone are quite limited so that it may not be possible to evaluate the cardiac function. In contrast, the polygraphic analysis is a simple method by which we are able to assess the cardiac function noninvasively and has been widely used. Therefore, in combined use of the two methods the clinical significance will be much enhanced.

Previously we reported the results of analysis of the left ventricular function and systolic time intervals (STI) in patients with intermittent left bundle-branch block by means of the polygraphic approach[1]. In the present study we used the same method and analyzed the STI as well as the cardiac function in three types of bundle-branch block; namely, in those with complete right bundle-branch block (CRBBB), with CRBBB+LAD (two-fascicular block), and with complete left bundle-branch block (CLBBB).

SUBJECTS AND METHOD

The subjects consisted of 31 cases with CRBBB in the average age of 55.0 (16-80), 14 with CRBBB+LAD in the average age of 57.5 (19-82), and 18 with CLBBB in the average age of 65.8 (40-84) (Table 1), and also

TABLE 1

Clinical data of the three groups with bundle branch blocks.

	CRBBB	CRBBB+LAD	CLBBB
No. of cases	31	14	18
Age			
Average	55	57.5	65.8
Range	16~80	19~82	40~84
Etiologic factor			
IHD	2	4	9
MD	0	1	4
HT	2	2	1
No heart disease	27 (87%)	7 (50%)	4 (22%)
Gallop			
S_3	3	1	5
S_4	6	6	9
S_3+S_4	1	1	2
Total	10 (32%)	8 (57%)	16 (88%)
CTR($\bar{x}\pm$C.L.)	48 ± 1.9	51 ± 1.5	60 ± 4.6

CRBBB=complete right bundle branch block
CRBBB+LAD=complete right bundle branch block+left axis deviation
CLBBB=complete left bundle branch block
IHD=ischemic heart disease,
MD=myocardial disease, HT= hypertension
CTR=cardio-thoracic ratio
$\bar{x}\pm$C.L.=mean$\pm$95 % confidence limits.

2 with intermittent CRBBB. The criteria for LAD were used as follows[2]; 1) the major axis of standard limb leads on ECG of over -30° and 2) qR in lead 1 and rS in lead III. Everyone of these patients was selected at random, and those with valvular heart disease, congenital heart disease, and those receiving drugs that might modify the cardiac function were excluded. These patients with heart disease were all mild and had a functional class of New York Heart Association less than II.

After 15 minute-bed rest in each patient polygraphic tracings with ECG, phonocardiogram (PCG), carotid artery pulse (CAP) and apexcardiogram (ACG) were simultaneously taken at the mid-expiratory apnea in the left lateral position.

Each item of STI was measured as shown in Fig. 1. They were consisted of 6 items: the total systole (Q-II), ejection time (ET), preejection period (PEP)=(Q-II)−ET, electromechanical interval (Q-C)=from the beginning of the Q wave of ECG to the C point where the apexcardiographic systolic wave begins to rise, isovolumic contraction time (ICT)=(C-II)−ET and isovolumic relaxation time (IRT)=II-0. Since three values of Q-II, ET and PEP are influenced by heart rate (HR), we calculated them by our method as an "index" as follows: Q-II index (Q-IIi)=1.7×HR+(Q-II), ET index (ETi)=1.09×HR+ET, and PEP index (PEPi)=0.6×HR+PEP[3]. Moreover, the a-wave ratio (a/E-0) was also calculated on ACG. For the measured values the average of 5 consecutive beats was taken in each instance.

In addition, observations were made on the presence or absence of gallop rhythm on PCG[4] and cardiothoracic ratio (CTR) on the Chest X-ray film.

RESULTS

1. CRBBB+LAD as against CRBBB

The CRBBB+LAD group had organic heart disease, gallop rhythm and large CTR more often as compared with the CRBBB group (Table 1).

On the polygraphic findings the a-wave ratio was significantly increased ($p < 0.001$), and PEPi and IRT were prolonged ($P < 0.001$, $p < 0.001$) respectively, and ICT was also delayed ($0.05 < p < 0.1$) in the former group. However, in the values of Q-IIi, ETi, and Q-C there was no significant difference between the two groups (Table 2, Fig. 2). On observing individual cases Q-C was within the normal range (20-47 msec) in all CRBBB cases, but in CRBBB+LAD group there was recognized a prolongation of 50 msec or more in 4 of the ten cases whose ACG could be recorded.

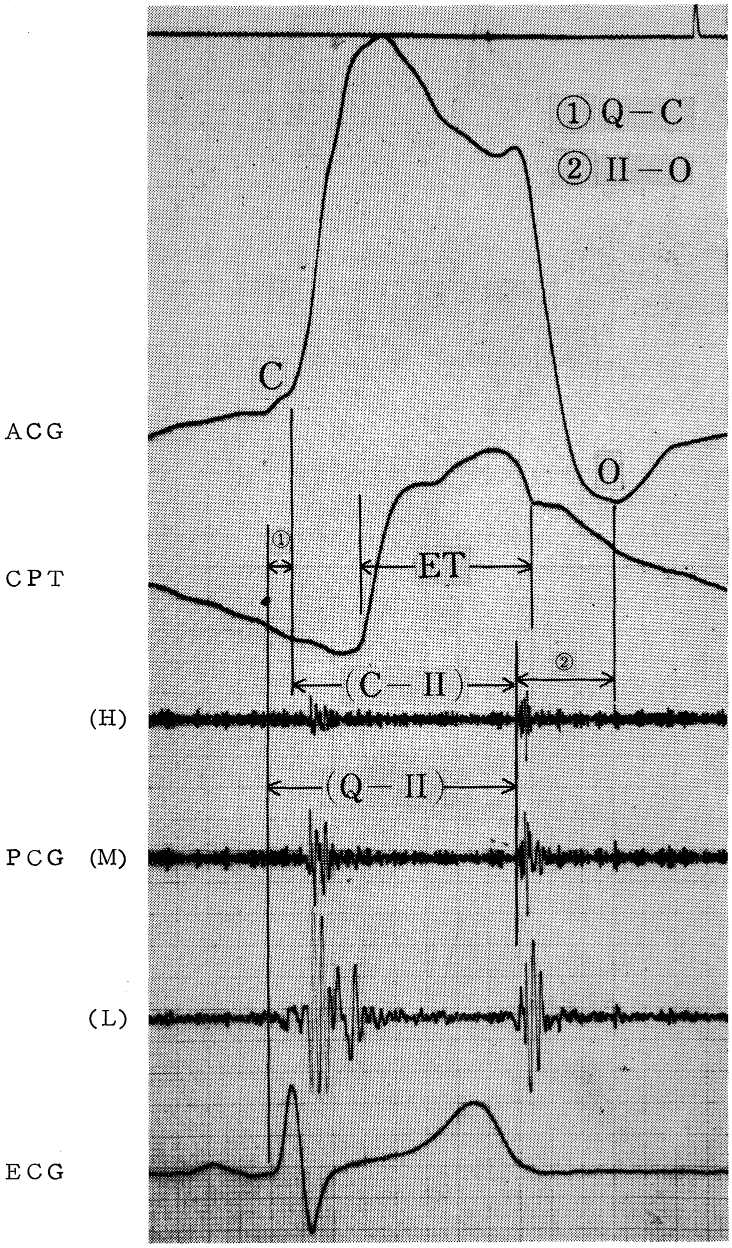

Fig. 1. Diagram of polygraphic parameters
Q–II = total systole, ET = ejection time,
PEP (preejection period) = (Q–II) − ET, Q-C = electromechanical interval,
ICT (isovolumic contraction time) = (C-II) − ET,
II–O = isovolumic relaxation time,
ACG = apexcardiogram, CPT = carotid pulse tracing,
PCG = phonocardiogram

TABLE 2

Measurements of polygraphic parameters in the three groups.

	1) CRBBB	2) CRBBB +LAD	3) CLBBB	P value 1 vs 2	P value 1 vs 3	P value 2 vs 3
Q-IIi	491±8.8	500±11.8	535±14.8	NS	●	※
ETi	344±6.0	336±14.0	319±11.3	NS	●	△
PEPi	148±4.9	163± 9.9	211±17.1	※	●	●
Q-C	34.0±3.0	39.0± 6.8	55.0± 9.2	NS	●	×
ICT	72.0±6.9	87.0±11.0	116±16.5	△	●	×
IRT	107±6.0	123± 8.4	121±11.5	●	●	NS
a wave ratio	5.5±1.4	11.5± 3.6	10.9± 2.6	●	●	NS

P values: △: 0.05 < P < 0.1, ×: P < 0.05, ※: P < 0.01, ●: P < 0.001 NS: nonsignificant

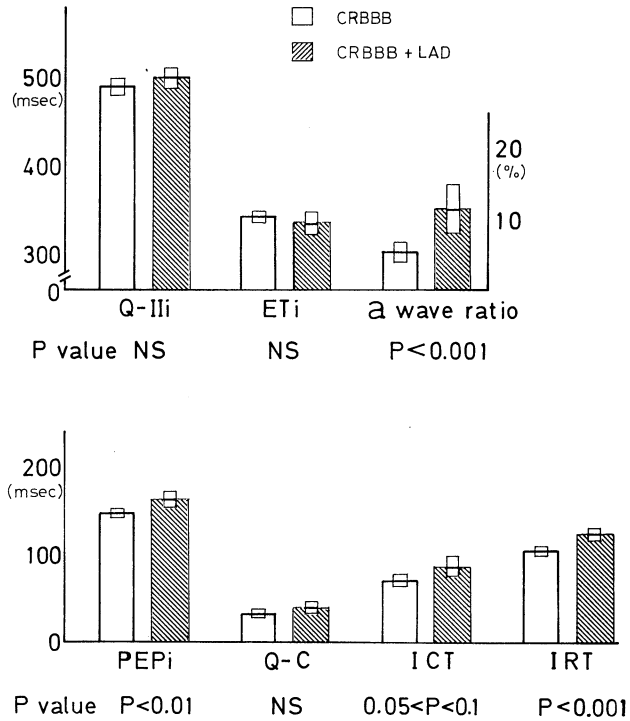

Fig. 2. Mean values and their 95 % confidence limits of the various parameters between complete right bundle branch block (CRBBB) and complete right bundle branch block with left axis deviation (CRBBB+LAD).
Q-IIi=Q-II index, ETi=ET index, PEPi=PEP index

2. CLBBB as against CRBBB

As for the clinical findings most of CLBBB group revealed organic heart disease and many of them had audible gallop rhythm, as well as the increment of CTR, but in the CRBBB group organic heart disease and gallop rhythm were only a few in number and their CTR also was within the normal range (Table 1).

The polygraphic findings showed a significant difference between the two in all the seven items; in the CLBBB group there was a significant prolongation of Q-IIi, PEPi, Q-C, ICT, IRT ($p < 0.001$ in all) and a shortening of ETi ($p < 0.001$) as well as increase ($p < 0.001$) of the a-wave ratio (Table 2, Fig. 3). There was observed a delayed Q-C of 50 msec or more in 10 out of the 14 cases whose ACG was available.

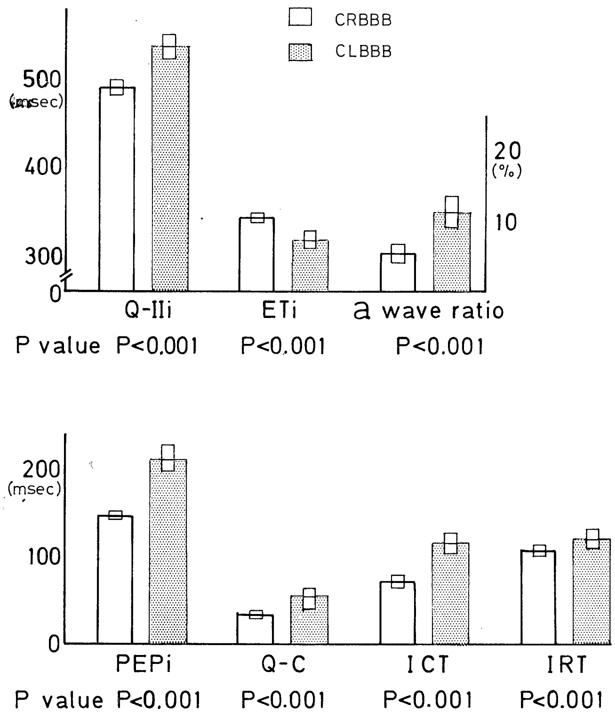

Fig. 3. Mean values and their 95% confidence limits between complete right bundle branch block (CRBBB) and complete left bundle branch block (CLBBB).

3. CLBBB as against CRBBB+LAD

CLBBB group had a greater number of organic heart disease, audible gallop rhythm and an increase of CTR when compared with CRBBB+LAD group (Table 1).

Polygraphic findings in CLBBB group showed a significant prolongation of Q-IIi ($p < 0.01$), PEPi ($p < 0.001$), Q-C ($p < 0.05$), and ICT ($p < 0.05$) and a shortening of ETi ($0.05 < p < 0.1$) as compared with CRBBB+LAD group. However, there could be observed no significant difference in the a-wave ratio and ICT (Table 2, Fig. 4).

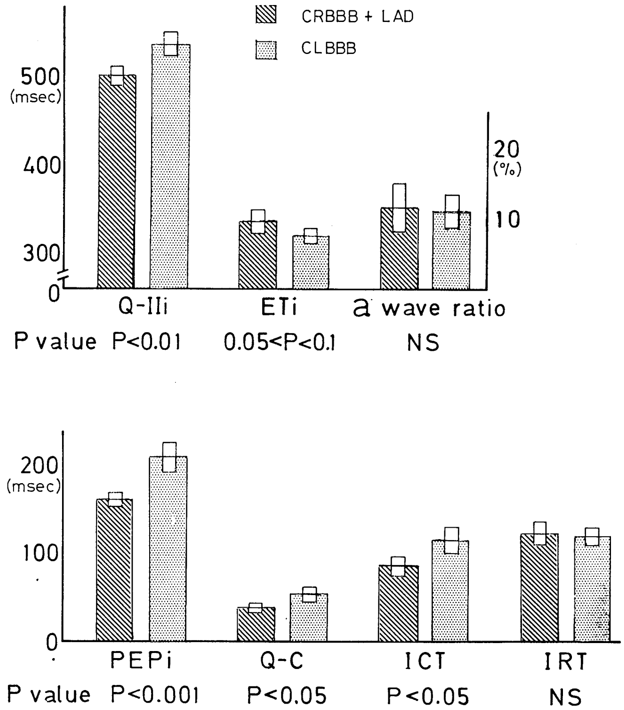

Fig. 4. Mean values and their 95% confidence limits between complete right bundle branch block+left axis deviation (CRBBB+LAD) and complete left bundle branch block (CLBBB).

4. Intermittent CRBBB (Table 3)

For the purpose of elucidating whether or not CRBBB itself gives any effect on the left ventricular function and STI we studied 2 cases (Case 1, a 52 year-old male with chronic renal failure, and Case 2, a 64 year-old male with atrial fibrillation).

As seen in Table 3, 6 items of the ventricular function in both cases there could be seen no significant difference between the two occasions (at normal conduction and CRBBB, respectively) nor was there any marked change in the tracings of PCG, CAP and ACG.

TABLE 3

Measurements of polygraphic parameters in two cases of intermittent right bundle branch block.

		HR	Q-IIi	ETi	PEPi	Q-C	ICT	IRT
Case 1	NC	65	460 ±15.4	296 ± 6.6	164 ±14.8	34.0 ± 1.3	95.5 ±11.2	123 ± 4.2
	CRBBB	80	478 ± 8.9※	307 ±11.0※	172 ± 6.5※	34.5 ± 1.7※	97.0 ± 8.6※	127 ± 3.6※
Case 2	NC	78	518 ±10.7	359 ± 5.3	168 ± 8.0	36.5 ± 2.9	81.0 ± 5.2	100 ± 6.2
	CRBBB	88	528 ±12.2※	353 ± 5.1※	174 ± 5.2※	38.0 ± 7.5※	85.0 ± 4.6※	102 ± 5.1※

NC=normal conduction
CRBBB=complete right bundle branch block
P values: ※: nonsignificant

DISCUSSION

1. CRBBB+LAD as against CRBBB

In comparing the left ventricular function of the two groups it was found that CRBBB+LAD group showed a significant increase in the a-wave ratio and also a significant prolongation of IRT as compared with CRBBB group. It is well known that the increase of the a-wave ratio has a close correlation with the decrease in the left ventricular compliance and the rise in the left ventricular end-diastolic pressure[5]. While significance of the IRT prolongation is not well understood, it is considered as to be also related to the decrease in the left ventricular compliance[6,7]. Moreover, PEPi showed a significant prolongation in the CRBBB+LAD group. By dividing structural components of PEP into two parts (Q-C and ICT), Q-C did not show any significant difference between the two groups, but ICT revealed a significant prolongation in the former group. Consequently, the prolongation of PEP seems to be mainly due to the prolongation of ICT, and this fact appears to be correlated to the fall in the left ventricular contractility[8,9]. These results suggest that there are more cases that show a fall in the left ventricular function both at systolic and diastolic phases in CRBBB+LAD group than in CRBBB group.

It is said that in the case with CRBBB+LAD, there occurs the conduction disturbance in both right bundle-branch and left anterior hemi-branch[10,11], and this can be interpreted as due to the fall in left ventricular function resulting from an extensive myocardial lesion in the left ventricle[12,13]. In contrast, in the case with uncomplicated CRBBB the left ventricular function is said to be normal[14].

Our present polygraphic observation gave the results that support such opinions, and this fact can also be understood from the fact that there were more cases with organic heart disease as well as a higher incidence of gallop rhythm and with a greater CTR in the CRBBB+LAD group than in the CRBBB group.

As the conduction disturbance of the left bundle-branch itself results in the fall of the left ventricular function in the presence of CLBBB[1,15,16], the left anterior hemiblock itself can be expected to influence the left ventricular function. However, since the distribution and communication of Purkinje fibers are dense, the left anterior hemiblock alone could induce only a slight left intraventricular conduction disturbance[17], hence it is not clear just how much the left anterior hemiblock itself would influence on the left ventricular function.

On the other hand, CRBBB alone did not affect the left ventricular function or STI (Table 3), hence it is understandable that the left ventricular function in CRBBB group is dependent upon the presence or absence and the extent of the basic lesion that accompanies it.

Baragan et al. state that in CRBBB+LAD group in comparison to CRBBB group the beginning of left ventricular ejection is significantly delayed, and such a delay is induced by the delay in both the beginning of left ventricular contraction and ICT[18]. Our results also reveal that in the former as compared to the latter PEP was significantly prolonged and it was due to delay in the beginning of left ventricular ejection. The ICT (the second component of PEP) was delayed significantly in the former but there was no significant difference of Q-C (the first component of PEP) between the two, hence the delay in the beginning of the left ventricular ejection seems to be mainly due to the delay in ICT. However, in individual cases it was demonstrated that 4 out of 10 cases showed a significant prolongation of 50 msec or more in Q-C.

2. CLBBB as against CRBBB

Since CLBBB group, as compared with CRBBB group, showed abnormal deviations in all polygraphic items, the left ventricular functions both at systolic and diastolic phases in the former group seem to be depressed than those in the latter group (Table 2, Fig. 3). Likewise abnormalities such as gallop rhythm and large CTR were higher in the former (Table 1), and these findings lead us to conclude that there are a greater number of cases with organic heart disease in the former group (Table 1) and the severity of basic disease[19] is greater in addition to the abnormality secondary to the conduction disturbance of the left bundle-branch itself[1,15,16].

3. CLBBB as against CRBBB+LAD

Since there were more cases with organic heart disease, audible gallop and a greater CTR in CLBBB group than in CRBBB+LAD group, it is suggested that the former group may have a greater number of cases with myocardial lesion of higher severity than in the latter.

On the polygraphic measurements there could be seen abnormal ETi ($0.05 < p < 0.1$) and ICT ($p < 0.05$) so that the left ventricular functions seem to have been depressed to a greater degree in the former than in the latter group.

The PEPi in the former was prolonged significantly, and this indicates that the beginning of left ventricular ejection is delayed in the former group. Both Q-C and ICT that are the components of PEP were significantly delayed in CLBBB group. It was already mentioned that the delay of Q-C could be observed also in the CRBBB+LAD group but in CLBBB group such a delay was far longer, indicating that the start of the left ventricular contraction was more delayed in a great number of cases. The ICT in CLBBB group was also delayed to a greater extent, and this seems to be due to the severity of left ventricular function in the basic lesion as well as due to a greater left intraventricular conduction disturbance in CLBBB group.

SUMMARY

By means of the polygraphic method we noninvasively studied the left ventricular function and STI in three types of bundle-branch blocks (CRBBB, CRBBB+LAD, and CLBBB) and obtained the following results.

It was shown that among the three groups studied the left ventricular function was decreased in the order of CLBBB (greatest), CRBBB+LAD and CRBBB. In the first two groups, in addition to the basic lesion, the left intraventricular conduction disturbance itself seems to affect the left ventricular function. In contrast, it was demonstrated that CRBBB alone did not affect the left ventricular function which was dependent upon the underlying lesion.

Furthermore, in the first two groups a delay in the left ventricular ejection was observed, and such a delay was especially marked in CLBBB group. As the causes of the delay in left ventricular ejection the prolongation of ICT was mainly responsible in CRBBB+LAD group, while the prolongation in both electromechanical interval (Q-C) and ICT proved to be responsible in CLBBB group in most cases.

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