DIAGNOSTIC SIGNIFICANCE OF EARLY DIASTOLIC TIME INTERVALS IN PATIENTS WITH HYPERTROPHIC CARDIOMYOPATHY AND MYOCARDIAL HYPERTROPHY DUE TO ESSENTIAL HYPERTENSION

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In order to differentiate hypertrophic cardiomyopathy (HCM) from myocardial hypertrophy due to essential hypertension (HT), echocardiogram, apex-cardiogram and phonocardiogram were simultaneously recorded in patients with HCM (n = 22), HT (n = 34) and normal subjects (N) (n = 22). The following early diastolic time intervals were measured: 1) II_A -O time, 2) II_A -MVO time (IRT) and 3) MVO-O time.

The II_A -O time was 119 ± 9 msec in N, 159 ± 31 in HT ($p < 0.001$, vs N) and 228 ± 57 in HCM ($p < 0.001$, vs N and HT, respectively). The II_A -MVO time was 66 ± 11 msec in N, 95 ± 18 in HT ($p < 0.001$, vs N) and 102 ± 24 in HCM ($p < 0.001$, vs N). The MVO-O time was 53 ± 9 msec in N, 66 ± 21 in HT and 126 ± 48 in HCM ($p < 0.001$, vs N and HT, respectively). These results showed that among the early diastolic time intervals HT was abnormal only in the II_A -MVO time. On the other hand, HCM had abnormalities not only in the II_A -MVO time but also in the MVO-O time. Both the II_A -MVO and the MVO-O times in hypertrophic non-obstructive cardiomyopathy were prolonged significantly as compared to those in obstructive one.

Analysis of early diastolic time intervals may be very useful to differentiate HCM, especially of the non-obstructive type, from HT.

BOTH hypertrophic cardiomyopathy and hypertensive heart disease are considered to have myocardial hypertrophy as a common morphological phenomenon. Furthermore, hypertrophic cardiomyopathy often coexists with systemic hypertension, but their prognoses are quite different. Especially in some patients

with hypertrophic cardiomyopathy, sudden death is the first manifestation of the disease. Therefore, it is very important to differentiate hypertrophic cardiomyopathy from myocardial hypertrophy due to essential hypertension hemodynamically.

There have been some reports^{1,2} on their differentiation using echocardiography, but Goodwin et al^{1,3,4} have reported that it was very difficult to differentiate non-obstructive cardiomyopathy from hypertensive heart disease by this method.

We analysed the early diastolic time intervals

Key Words:

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Fig.1. Diagram of a simultaneous recording of an echocardiogram, an apexcardiogram and a phonocardiogram and the early diastolic phase intervals employed in this study.

using echocardiogram, apexcardiogram and phonocardiogram recorded simultaneously.

MATERIALS AND METHODS

Subjects

Seventy-eight subjects were divided into the following 3 groups:

Group I (normal subjects, N): This group consisted of 22 healthy subjects. There were no abnormalities in history, physical examination, electrocardiogram, chest X-ray and echocardiogram.

Fig.2. Comparison of the II_A-O time in normal subject, essential hypertension (HT) and hypertrophic cardiomyopathy (HCM).

Interventricular septal thickness (IVST) and posterior wall thickness of the left ventricle (PWT) measured using M-mode echocardiography

TABLE I MEASUREMENTS OF EARLY DIASTOLIC TIME INTERVALS

	Age (years)	MBP (mmHg)	HR (beat/min)	II _A -O (msec)	II _A -MVO (msec)	MVO-O (msec)	MVO-ME (msec)	ME-O (msec)
Group I (Normal) n = 22	43 ± 11	98 ± 6	65 ± 10	119 ± 9	66 ± 11	53 ± 9	59 ± 9	-6 ± 12
Group II (HT) n = 34	45 ± 10	132 ± 18	65 ± 9	159 ± 31	95 ± 18	66 ± 21	60 ± 11	3 ± 23
Group III (HCM) n = 22	47 ± 13	99 ± 11	60 ± 9	228 ± 57	102 ± 24	126 ± 48	63 ± 12	64 ± 45
<i>p</i> values								
I vs II	ns	<0.001	ns	<0.001	<0.001	ns	ns	ns
I vs III	ns	ns	ns	<0.001	<0.001	<0.001	ns	<0.001
II vs III	ns	<0.001	ns	<0.001	ns	<0.001	ns	<0.001

Values are given as mean ± SD.

Abbreviations: HT = essential hypertension; HCM = hypertrophic cardiomyopathy; MBP = mean blood pressure; HR = heart rate; II_A = aortic component of the second heart sound; O = O-point of apex-cardiogram; MVO = point of mitral valve opening; ME = point of maximal excursion of the anterior mitral leaflet.

Fig.3. Comparison of the II_A-MVO time (left) and MVO-O time (right) in normal subject, essential hypertension and hypertrophic cardiomyopathy.

Fig.4. The MVO-ME time (left) and the ME-O time (right) in normal subject, essential hypertension and hypertrophic cardiomyopathy.

were 7.5 ± 1.2 and 7.9 ± 1.0 mm, respectively.

Group II (essential hypertension, HT): This group consisted of 34 patients who had systemic hypertension with a diastolic blood pressure above 95 mmHg. Patients who have coronary artery disease or valvular heart disease were not included in this group. Patients in this group corresponded to stage II or III of the WHO classification. IVST and PWT measured using M-mode echocardiography were 13.4 ± 3.5 and 13.0 ± 2.8 mm, respectively.

Group III (hypertrophic cardiomyopathy, HCM): Twenty-two patients were included in this group. The diagnosis of HCM was made by cardiac catheterization and echocardiographic studies. Four patients of this group were the obstructive type and 5 were the so-called apical hypertrophic type.⁵ The obstructive type was diagnosed, when patient had a pressure gradient above 20 mmHg in the left ventricular outflow

Fig.5. Simultaneous records of an echocardiogram, an apex cardiogram and a phonocardiogram in a normal subject (A), a patient with essential hypertension (B) and that with hypertrophic cardiomyopathy (C).

tract and showed systolic anterior movement of the mitral valve and mid-systolic closure of the aortic valve on an echocardiogram. Asymmetrical septal hypertrophy (ASH)⁶ was seen in 12 patients. Patients who have systemic hypertension, valvular heart disease and significant coronary artery stenosis were excluded from this group.

Groups II and III were examined without medication for at least 2 weeks. Age and heart rate were matched in each group (Table I).

Procedures

Echocardiogram, apexcardiogram and phonocardiogram were recorded simultaneously. Echocardiogram was recorded using Aloka SSD-800 with 2.25 MHz transducer. Apexcardiogram was recorded using a TY-303 transducer (Fukuda Denshi Co., Ltd) with a time constant of 4 sec, and phonocardiogram was

Fig. 6. Comparison of the II_A-MVO time (left) and the MVO-O time (right) in patients with hypertrophic obstructive cardiomyopathy and hypertrophic non-obstructive cardiomyopathy.

Fig. 7. The II_A-MVO time and the MVO-O time in normal subjects, essential hypertension (HT) and hypertrophic cardiomyopathy (HCM). As compared with a normal subject, the II_A-MVO time was prolonged significantly with little change in the MVO-O time in HT, while in HCM both the MVO-O time and the II_A-MVO time were prolonged significantly.

recorded using a MA-250 (Fukuda Denshi Co., Ltd). All patients were placed in the left lateral decubitus position for recording the apexcardiogram and the echocardiogram. The output was recorded using a Honeywell strip chart recorder at a paper speed of 100 mm per sec.

The following early diastolic time intervals were measured as shown in Fig. 1:

II_A-O time: The interval from the onset of the aortic component of the second heart sound to the O-point on the apexcardiogram. The II_A-O time was subdivided into the II_A-MVO time and the MVO-O time.

II_A-MVO time: The interval from the onset

of the aortic component of the second heart sound to the mitral valve opening (MVO). This phase corresponds to the isovolumic relaxation time.

MVO-O time: The interval from MVO to the O-point on the apexcardiogram.

MVO-ME time: The interval from MVO to the maximal excursion (ME) point of the anterior mitral leaflet.

ME-O time: The interval from ME to the O-point on the apexcardiogram. When the O-point appeared before the ME-point, the ME-O time was expressed as a negative value and when the O-point appeared after the ME-point, ME-O time was expressed as a positive value.

Statistical Analysis: Comparison of the data among groups was made using Student's *t*-test for unpaired data.

RESULTS

The results are summarized in Table I.

The II_A-O time was 119 ± 9 msec in N, 159 ± 3 in HT ($p < 0.001$, vs N) and 228 ± 57 in HCM ($p < 0.001$, vs N and HT, respectively) (Fig. 2).

The II_A-MVO time was 66 ± 11 msec in N, 95 ± 18 in HT ($p < 0.001$, vs N) and 102 ± 24 in HCM ($p < 0.001$, vs N) (Fig. 3, left). There was no significant difference between HT and HCM.

The MVO-O time was 53 ± 9 msec in N, 66 ± 21 in HT and 126 ± 48 in HCM ($p < 0.001$, vs N and HT, respectively) (Fig. 3, right). This phase is very important to differentiate HCM from HT.

The MVO-ME time was not significantly different among 3 groups (Fig. 4, left).

The ME-O time (Fig. 4, right): The position of the O-point on the apexcardiogram in N and HT closely corresponded to that of the ME-point of the mitral valve. However, the position of the O-point in HCM was markedly delayed as compared to that of the ME-point of the mitral valve (Fig. 5). This is a good indicator for differentiating HCM from HT at a glance.

Comparison between hypertrophic obstructive cardiomyopathy and hypertrophic non-obstructive cardiomyopathy (Fig. 6): The II_A-MVO time was 77 ± 10 msec in obstructive type and 108 ± 20 in non-obstructive type. The MVO-O time was 79 ± 19 msec in obstructive type and 133 ± 47 in non-obstructive type. Both the II_A-MVO and the MVO-O time in non-obstructive type was significantly prolonged as compared to those in obstructive one.

DISCUSSION

It is well-known that echocardiography has been very useful to diagnose HCM. Asymmetric septal hypertrophy⁶⁻⁸ systolic anterior motion of mitral valve⁹ and mid-systolic closure of the aortic valve^{10,11} are very important echocardiographic features to diagnose HCM. However, these echocardiographic findings are not necessarily seen in all the patients with HCM. These are rather specific findings in obstructive type^{12,13} than in non-obstructive type. In addition, these echocardiographic findings are rarely seen in some types of non-obstructive hypertrophic cardiomyopathy such as apical hypertrophy.⁵ Therefore, there is a limitation in differentiating HCM from HT echocardiographically.

Thus, in this report, we tried to differentiate HCM from HT on a functional basis using the diastolic time intervals.

The II_A -O time in HCM was obviously prolonged as compared to that in HT. Hemodynamic significance of the O-point has not been clarified sufficiently. If the O-point corresponds approximately to the nadir of the left ventricular pressure,¹⁴⁻¹⁶ it will take more time to reach its nadir in HCM. The prolongation of the II_A -O time seems to be one of the indicators reflecting an impaired diastolic relaxation.

In this study a common abnormality in both HCM and HT was the prolongation of the II_A -MVO time. There have been some reports concerning the prolongation of isovolumic relaxation time (the II_A -MVO time) in patients with various heart diseases including HCM and HT.¹⁷⁻²² Isovolumic relaxation time depends on the aortic closing pressure, rate of pressure fall of the left ventricle and the height of left atrial pressure.¹⁹ It seems that an increased wall thickness itself, which is a common characteristic of HCM and HT, affects the rate of pressure fall, and this is the main factor responsible for the prolongation of the isovolumic relaxation time.

On the other hand, a difference in the MVO-O time was observed between HCM and HT in this study. Differing from the II_A -MVO time, the MVO-O time begins with the blood inflow from the left atrium to the left ventricle. Prolongation of the MVO-O time indicates a diastolic abnormality in the early filling stage. Marked prolongation of the MVO-O time was seen in only HCM. Therefore, the MVO-O time seems to be a specific abnormality in the early diastolic phase

of HCM.

In summary, in HT abnormalities in early diastolic time intervals were observed almost exclusively in the prolongation of the II_A -MVO time, while in HCM abnormalities were seen not only in the II_A -MVO time but also in the MVO-O time (Fig. 7). It seems that the prolongation of the II_A -MVO time indicates the extent of myocardial hypertrophy of the left ventricle, but the prolongation of the MVO-O time is a manifestation of the difference of myocardial characteristics between HCM and HT.

Both the II_A -MVO time and the MVO-O time in the non-obstructive type were prolonged significantly as compared to those in the obstructive type. The reason for this is not clear at present. These 2 intervals may depend upon the extent of myocardial involvement. The elevation of left atrial pressure may be another factor, being responsible for the shorter II_A -MVO time in the obstructive type as compared to that in the non-obstructive type.

Finally, our results showed that the early diastolic time intervals obtained from the simultaneous recording of the echocardiogram, apexcardiogram and phonocardiogram were very useful for differentiating HCM, especially of the non-obstructive type, from HT.

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