Elevated Cardiac Enzymes in Hypertrophic Cardiomyopathy Patients With Heart Failure
– A 20-Year Prospective Follow-up Study –

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**Background:** To better understand the evolution of typical hypertrophic cardiomyopathy (HCM) to heart failure (HF), we investigated the relationship between serum biochemical abnormalities and changes in left ventricular (LV) remodeling.

**Methods and Results:** Seventy-seven HCM patients were followed for 20 years. Creatine kinase (CK), CK-MB, lactate dehydrogenase (LDH), LDH-1, troponin T and myosin light chain-1 (MLC-1) were measured. Abnormal CK-MB elevation was observed in 64% of HCM patients. LDH-1 was not significantly different compared with the control subjects. Troponin T elevation was observed in 3 HCM patients and MLC-1 elevation was not observed. According to median CK-MB, HCM patients were divided into 2 groups: group H (CK-MB ≥2.5%, n=33) and group L (CK-MB <2.5%, n=44). During the follow-up period in group H, LV end-diastolic dimension increased (P<0.0001), fractional shortening decreased (P<0.0004), and left atrial dimension increased (P<0.0001). The markers reflecting LV hypertrophy were significantly decreased. In group L, LV end-diastolic dimension increased (P<0.02) and left atrial dimension increased (P<0.0001). HF was observed in 18 patients in group H and in 4 in group L. There were 14 HF deaths in group H and 2 in group L, and 3 sudden cardiac deaths in group H.

**Conclusions:** Persistent elevation of cardiac enzymes in HCM patients indicates ongoing myocardial injury, ultimately resulting in death by HF. (Circ J 2016; 80: 218–226)

**Key Words:** Cardiac enzyme; Heart failure; Hypertrophic cardiomyopathy; Left ventricular remodeling; Sudden cardiac death
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Cardiac Enzymes and HF in HCM

Table 1. Baseline Subject Characteristics

<table>
<thead>
<tr>
<th></th>
<th>n</th>
<th>Age (years)</th>
<th>HR (beats/min)</th>
<th>SBP (mmHg)</th>
<th>DBP (mmHg)</th>
<th>LVDd (mm)</th>
<th>FS (%)</th>
<th>LAD (mm)</th>
<th>IVST (mm)</th>
</tr>
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<tbody>
<tr>
<td>Normal control subjects (I)</td>
<td>12</td>
<td>56±7</td>
<td>70±4</td>
<td>119±10</td>
<td>74±11</td>
<td>46.74±2.60</td>
<td>38.99±2.46</td>
<td>32.48±2.66</td>
<td>7.29±0.93</td>
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<td>Patients with hypertension (II)</td>
<td>14</td>
<td>55±14</td>
<td>65±9</td>
<td>176±19</td>
<td>106±10</td>
<td>48.90±4.07</td>
<td>37.83±4.25</td>
<td>34.55±5.74</td>
<td>11.72±2.59</td>
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<tr>
<td>Patients with HCM (III)</td>
<td>77</td>
<td>56±12</td>
<td>67±7</td>
<td>130±18</td>
<td>78±11</td>
<td>43.78±4.46</td>
<td>44.09±7.69</td>
<td>36.29±5.90</td>
<td>17.67±5.12</td>
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P-value

<table>
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<tr>
<th></th>
<th>I vs. II</th>
<th>NS</th>
<th>NS</th>
<th>&lt;0.0001</th>
<th>&lt;0.0001</th>
<th>NS</th>
<th>NS</th>
<th>NS</th>
<th>&lt;0.005</th>
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<tr>
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<td>I vs. III</td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
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<td>NS</td>
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<td>&lt;0.0001</td>
</tr>
<tr>
<td></td>
<td>II vs. III</td>
<td>NS</td>
<td>NS</td>
<td>&lt;0.0001</td>
<td>&lt;0.0001</td>
<td>&lt;0.005</td>
<td>&lt;0.005</td>
<td>NS</td>
<td>&lt;0.0001</td>
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</table>

Data given as mean±SD. †Raw data for 3 patients. CK, creatine kinase; DBP, diastolic blood pressure; FS, fractional shortening; HCM, hypertrophic cardiomyopathy; HR, heart rate; IVST, interventricular septal wall thickness; LAD, left atrial dimension; LDH, lactate dehydrogenase; LVDd, left ventricular end-diastolic dimension; MLC, myosin light chain; PWT, posterior wall thickness; SBP, systolic blood pressure.

patients with HCM (13 women and 64 men) participated in this study after providing informed consent. Diagnosis of HCM was made according to the World Health Organization/International Society and Federation of Cardiology definition of cardiomyopathies. Mean age at the start of the study was 54±12 years. Of 77 patients with HCM, 28 had hypertrophic obstructive cardiomyopathy (HOCM) and 49 had hypertrophic non-obstructive cardiomyopathy (HNMC). HOCM was diagnosed when the LV pressure gradient (LVPG) was ≥30mmHg without provocation. Cardiac catheterization was performed in 62 patients (81%) to exclude the combination of coronary artery disease. Patients who had a history of HF, LV end-diastolic dimension ≥50mm, LV fractional shortening <30%, notched R wave on electrocardiography (ECG), atrial fibrillation, or plasma creatinine ≥1.2mg/dl at the start of the study were excluded.

Fifty-five patients (71%) had been receiving β-blockers and 58 (75%) had been receiving calcium antagonists at the start of the study. Since 1997, 7 patients had been receiving cibenzoline to attenuate LVPG. Four women and 8 men who had no abnormalities on history, physical examination, ECG or echocardiogram were selected as normal control subjects (NCS). Four women and 10 men who had diastolic blood pressure ≥95mmHg, symmetric LV hypertrophy on echocardiogram and serum creatinine ≤1.4mg were selected as the essential hypertension (EHT) group. Both groups served as controls.

Study Protocol

To detect cardiac biochemical abnormalities, creatine kinase (CK), CK-MB, lactate dehydrogenase (LDH), LDH-1, myosin light chain-1 (MLC-1), and troponin T were measured between 1987 and 1988 in all subjects. To confirm the reproducibility of CK, CK-MB, LDH, and LDH-1 measurements, these biochemical indexes were measured at the start of the study and 6 months later in patients with HCM. Echocardiography, which was used to determine LV and left atrial function and dimension, and ECG, which was used to determine SV1+RV5, were performed every 4–6 months.

During the follow-up period, all deaths due to cardiovascular events, cancers and other causes were annotated. Cardiovascular complications, HF, atrial fibrillation, apoplexy, myocardial infarction, and valvular heart disease, among others were assessed. HF was defined according to clinical symptoms of the New York Heart Association functional classification class III or IV, and the confirmation of pleural effusion associated with HF on chest radiography. The end-point was the time of death, but deceased patients >85 years were excluded from the analysis in this study.

Biochemistry Markers

Venous blood was drawn in the morning after overnight fasting in the outpatient clinic, and sera for CK, CK-MB, troponin T, and MLC-1 measurement were stored at −80°C until the time of assay. The serum for LDH and LDH-1 measurements was kept at room temperature, and total LDH activity and LDH-1 were measured on the day of blood sampling.

Total CK activity was assayed using the reagent Merckautore (Cellogel; Chemetron, Milano, Italy) and fluorescence. Total LDH activity was determined using the reagent Merchauto (Merck, Darmstadt, Germany). CK-MB was measured on cellulose acetate electrophoresis (Cellogel; Chemetron, Milano, Italy) and fluorescence. Total LDH activity was determined using the reagent Merchauto (Merck, Darmstadt, Germany).
ECG and Echocardiography Parameters

Twelve-lead ECG was recorded and SV1+RV5 was measured as an index of myocardial hypertrophy. Echocardiography was performed using an SSD-870 or an SSD-9000 echocardiograph with a 3.5-MHz transducer (Aloka, Tokyo, Japan). LV end-diastolic and end-systolic dimensions, interventricular septal wall thickness (IVST), LV posterior wall thickness (LVPWT), LV fractional shortening and left atrial dimension were measured.

Statistical Analysis

All data are expressed as mean±SD. Data obtained before and after the determination of the sample were compared using Student’s t-test for paired samples. Cumulative survival curves were determined by actuarial methods, and results were analyzed using chi-squared test. Groups were compared on both univariate and multivariate analysis using the Cox regression model. Kaplan-Meier curves were constructed to compare cardiovascular events and prognosis in Group H and Group L, and were compared using log-rank test. P<0.05 was considered statistically significant.

Follow-up Period

The mean follow-up period in all patients with HCM was 17.8±4.0 years.

Baseline Characteristics

As shown in Table 1, patient age and heart rate were not significantly different among the NCS, EHT, and HCM. Both systolic and diastolic blood pressure were higher in patients with EHT than in the other 2 groups. LV end-diastolic dimension was smaller in patients with HCM than in those with EHT. Fractional shortening was greater in patients with HCM than in the other 2 groups. Left atrial dimension was not significantly different among the 3 groups. Both IVST and LVPWT were greater in patients with EHT and with HCM than in NCS. IVST was greater in HCM patients than in those
Table 2. Baseline Characteristics vs. High CK-MB†

<table>
<thead>
<tr>
<th>Group</th>
<th>n</th>
<th>Mean ± SD</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group H</td>
<td>33</td>
<td>56.9 ± 13.4</td>
<td>NS</td>
</tr>
<tr>
<td>Group L</td>
<td>44</td>
<td>55.0 ± 10.9</td>
<td>NS</td>
</tr>
<tr>
<td>Age (years)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Female/Male</td>
<td>5/28</td>
<td>8/36</td>
<td>NS</td>
</tr>
<tr>
<td>HOCM</td>
<td>13 (39)</td>
<td>15 (34)</td>
<td>NS</td>
</tr>
<tr>
<td>CK (IU/L)</td>
<td>104.3±48.7</td>
<td>85.5±32.8</td>
<td>&lt;0.05</td>
</tr>
<tr>
<td>CK-MB (%)</td>
<td>5.27±2.14</td>
<td>0.63±1.02</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>LDH (IU/L)</td>
<td>103.9±47.7</td>
<td>78.9±22.7</td>
<td>&lt;0.005</td>
</tr>
<tr>
<td>LDH–1 (%)</td>
<td>32.6±8.2</td>
<td>27.8±6.2</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>HR (beats/min)</td>
<td>66±5</td>
<td>68±7</td>
<td>NS</td>
</tr>
<tr>
<td>LV Dd (mm)</td>
<td>43.48±5.26</td>
<td>44.02±3.78</td>
<td>NS</td>
</tr>
<tr>
<td>LV end-systolic dimension (mm)</td>
<td>24.76±5.80</td>
<td>24.41±3.43</td>
<td>NS</td>
</tr>
<tr>
<td>FS (%)</td>
<td>43.45±4.7</td>
<td>44.9±6.06</td>
<td>NS</td>
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<td>LAD (mm)</td>
<td>36.57±6.40</td>
<td>36.08±5.56</td>
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<tr>
<td>IVST (mm)</td>
<td>19.74±7.7</td>
<td>16.08±4.94</td>
<td>&lt;0.002</td>
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<tr>
<td>LVPWT (mm)</td>
<td>13.57±3.30</td>
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<tr>
<td>IVST/LVPWT</td>
<td>1.49±0.38</td>
<td>1.34±0.37</td>
<td>NS</td>
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<tr>
<td>SV1+RV5 (mV)</td>
<td>5.61±1.94</td>
<td>4.45±1.47</td>
<td>&lt;0.005</td>
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</table>

Data given as mean ± SD or n (%). †Group H, CK-MB ≥2.5%; group L, CK-MB <2.5%. HOCM, hypertrophic obstructive cardiomyopathy; LV, left ventricular. Other abbreviations as in Table 1.

Figure 3. Change in left ventricular end-diastolic dimension, fractional shortening, and left atrial dimension from the initial recording to the last recording of the study in (A–C) group H and (D–F) group L. (A,C,D,F) Red line, decrease; (B,E), increase.
with EHT. SV1+RV5 was higher in patients with EHT and with HCM than in NCS.

Biochemistry Markers
As shown in Table 1, CK and CK-MB were higher in patients with HCM than in NCS or in EHT. As shown in Figure 1A, abnormal elevation of the serum CK-MB was observed only in patients with HCM. There were, however, no significant differences in LDH and LDH-1 between the 3 groups (Table 1; Figure 1B). As shown in Table 1, abnormal elevation of troponin T was observed in 3 patients with HCM. Abnormal elevation of MLC-1 was not observed in any subjects in the 3 groups.

Reproducibility of Serum Cardiac Enzyme Level
Reproducibility of the serum levels of CK-MB and LDH-1 was examined. A good correlation in both markers was confirmed (CK-MB: r=0.793, P<0.0001; LDH-1: r=0.847, P<0.0001). Of both biochemical markers, only serum CK-MB was significantly elevated in patients with HCM (Figure 1), therefore the CK-MB data were analyzed in this study. As shown in Figure 2, there was a good correlation between CK-MB at the 2 time points. According to median CK-MB, patients with HCM were divided into 2 groups: group H, both values of CK-MB ≥2.5% (n=33); and group L, 1 or both values of CK-MB <2.5% (n=44).

Groups H and L Baseline Characteristics
Table 2 lists the baseline characteristics of groups H and L. Age, female/male ratio, and HOCM/HNMC ratio were not significantly different between the groups. CK, CK-MB, LDH, and LDH-1 were higher in group H than in group L. Heart rate, LV end-diastolic and end-systolic dimensions, fractional shortening, and left atrial dimension were not significantly different. IVST and SV1+RV5 were greater in group H than in group L.

Changes in Echocardiographic and ECG Parameters During Follow-up
Figure 3 shows changes in LV end-diastolic dimension, fractional shortening and left atrial dimension in the 2 groups. In group H, LV end-diastolic dimension increased from 43.48±5.26 mm to 50.23±6.21 mm, fractional shortening decreased from 43.45±9.47% to 36.66±10.85% and left atrial dimension increased from 36.57±6.4 mm to 43.53±7.91 mm. In group L, LV end-diastolic dimension significantly increased from 44.02±3.78 mm to 46.08±9.2 mm, fractional shortening showed no significant change, and left atrial dimension increased from
Cardiac Enzymes and HF in HCM

L. All patients had been perfectly followed up till the finish of the study. The mean follow-up period was 15.8 ± 5.3 years in group H and 19.4 ± 1.4 years in group L.

Discussion

The present study has shown that the elevation of serum cardiac enzymes is closely related to the incidence of cardiovascular events and prognosis in patients with HCM. In patients with high serum cardiac enzymes, the level of markers indicating LV hypertrophy gradually decreased, LV end-diastolic dimension increased, and fractional shortening deteriorated over time. In addition, an increase in left atrial dimension was observed in almost all patients. Thus, these findings indicated that the elevation of serum cardiac enzymes reflects ongoing myocardial injury. HF was the most common cause of death among patients with HCM, with its incidence being approximately 5-fold higher than that of SCD.

Selection of HCM Patients

In this study, to calculate the exact time to HF in patients with HCM, we strictly selected patients whose LV function did not suffer obvious myocardial damage. Among the 6 points defined for patient selection, notched R wave on ECG is important. This usually appears as the first finding of myocardial injury and progresses to more leads as the myocardial injury advances, along with a decrease in SV1+RV5. Recently, the clinical significance of notched R wave in patients with HCM was confirmed. Late gadolinium enhancement on cardiac magnetic resonance is known to be related to the cardiovascular

Cardiovascular Events and Prognosis During Follow-up

Figure 5A shows the comparisons of cardiovascular complications during the follow-up period between groups H and L. Incidence of death was higher in group H (58%) than in group L (18%). The incidence of HF was also higher in group H (55%) than in group L (9%). Of 22 HCM patients with HF, 8 had HOCM and 14 had HNCM. The mean follow-up period in HCM patients with HF from the first visit to hospital and to the occurrence of HF was 15.3 ± 3.1 years, and mean age at the occurrence of HF was 68.7 ± 13.4 years. Atrial fibrillation was observed in many patients in both groups, and its incidence was greater in group H than in group L. Twenty-seven patients (35%) died during follow-up. Figure 5B shows the causes of death for these 27 patients. As shown in Figure 5B, HF was the most common cause of death, and its incidence in group H was much higher than in group L. SCD was also higher in group H than in group L. Two patients with SCD had HOCM. Cancer was another important cause of death.

Figure 6A shows the cumulative event-free rate and Figure 6B, the cumulative survival rate in groups H and L. Both rates were significantly lower in group H than in group L. All patients had been perfectly followed up till the finish of the study. The mean follow-up period was 15.8 ± 5.3 years in group H and 19.4 ± 1.4 years in group L.

Cardiovascular Events and Prognosis During Follow-up

Figure 4 shows changes in IVST, LVPWT, IVST/LVPWT ratio, and SV1+RV5 in groups H and L. In group H, IVST significantly decreased from 19.74 ± 4.77 to 13.07 ± 4.42 mm, LVPWT from 13.57 ± 3.30 to 11.30 ± 2.32 mm, IVST/LVPWT ratio from 1.49 ± 0.36 to 1.16 ± 0.31, and SV1+RV5 from 5.61 ± 1.94 to 3.76 ± 1.59. In group L, these parameters had no significant changes.

Figure 5.

(A) Complications and (B) causes of death in (blue) group H and (red) group L. (A) The incidence of all-cause death, heart failure and atrial fibrillation was higher in group H than in group L. (B) The incidence of death due to heart failure and sudden cardiac death was higher in group H than in group L.
Complications and prognosis in patients with HCM.

Harris et al. reported, however, that the duration from the onset of HCM symptoms to end-stage disease was $14 \pm 10$ years, and that transplantation or death occurred rapidly after development of end-stage disease in HCM patients. Additionally, Thaman et al. reported that only the follow-up duration was significantly related to LV wall thinning, suggesting that the remodeling process is a time-related phenomenon. Therefore, to confirm the prognosis of HCM, a follow-up of at least 150 months seems to be necessary.

Clinical Significance of Serum Elevation of Biochemical Markers

In the present study, CK, CK-MB, LDH, LDH-1, troponin T, and MLC-1 were measured to evaluate whether cardiac biochemical abnormalities existed in patients with HCM. Abnormal elevation of serum CK-MB was observed in $\geq 60\%$ of patients with HCM, and serum LDH-1 was higher in group H than in group L. CK and LDH are cytosolic proteins, and CK-MB and LDH-1 are most abundant in the heart. Thus, the persistent elevation of serum CK-MB and LDH1 strongly suggests the existence of ongoing myocardial injury, and this may ultimately result in myocardial cell death. The progression of complications and prognosis in patients with HCM.

Duration of Follow-up

A short follow-up period may result in the missing of major cardiovascular events. The time from first visit to hospital to the occurrence of HF was the key in predicting the real prognosis in patients with HCM. In this study, the mean follow-up period from the first visit to the occurrence of HF in 22 patients was approximately 15 years. Indeed, in the present study the incidence of HF death increased rapidly over 10 years of the follow-up. The mean follow-up period in most studies focusing on the clinical course of HCM was between 5.1 years and 11 years, and thus, in these studies, the incidence of SCD was greater than the incidence of death due to HF. Harris et al. reported, however, that the duration from the onset of HCM symptoms to end-stage disease was $14 \pm 10$ years, and that transplantation or death occurred rapidly after development of end-stage disease in HCM patients. Additionally, Thaman et al. reported that only the follow-up duration was significantly related to LV wall thinning, suggesting that the remodeling process is a time-related phenomenon. Therefore, to confirm the prognosis of HCM, a follow-up of at least 150 months seems to be necessary.

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LV remodeling was more rapid and severe in group H than in group L. Thus, considering these points, we may be able to predict the progression of LV remodeling in patients with HCM in the future.

Elevation of serum troponin T was observed in only 3 patients with HCM, and the extent of the elevation was very slight. Of these 3 patients, 1 died of colon cancer, 1 died of HF, and 1 had HF but is still alive. In myocytes, troponin T is compartmentalized into a minor cytosolic fraction (5%) and a major myofibrillarbound fraction (95%). Therefore, we believe that the troponin T level in these 3 patients may correspond to cytosolic fraction.

Elevation of MLC-1 was not observed in patients with HCM. MLC-1 is an important structural protein, and thus the release of MLC-1 is highly specific for irreversible myocardial injury. Unlike CK-MB and LDH-1, elevation of serum troponin T and MLC-1 was seldom or never observed in patients with HCM. The dissociation of serum levels of cardiac enzymes and structural proteins may indicate that the process of changes from typical HCM to HF advances slowly.

Cardiovascular Complications and Cardiac Death
During the follow-up period in group H, LV end-diastolic dimension increased, and fractional shortening and all markers indicating LV hypertrophy decreased. As a result, HF was observed in >50% of patients. In group L, LV end-diastolic dimension increased, and fractional shortening and all markers indicating LV hypertrophy remained unchanged. Fractional shortening, however, decreased in >50% of patients, and thus HF will be realized in the near future in group L. It is reported that most patients with HNCM do not develop severe progressive HF during their clinical course. In the present study, however, there was no significant difference in the incidence of HF between HOCM (29%) and HNCM (29%) as observed by Biagini et al. It is reasonable that myocardial hypertrophy may be related to the serum elevation of cardiac enzymes that reflect ongoing myocardial injury. Thus, the present data indicate that LV remodeling in patients with greater LV hypertrophy advances more quickly.

LV hypertrophy and LV diastolic dysfunction, which are essential cardiac disorders in patients with HCM, are highly associated with the mechanisms of LV remodeling. Severe LV hypertrophy and LV diastolic dysfunction cause myocardial ischemia. An inappropriate myocardial mass in relation to coronary artery size, abnormal intramural coronary arteries, low stroke volume due to small LV dimension, and high LV diastolic pressure may result in severe myocardial ischemia.

The high incidence of increased left atrial dimension and atrial fibrillation was another important characteristic of cardiovascular complications in this study. This is the manifestation of LV diastolic dysfunction in patients with HCM. Thus, the increase in left atrial dimension is not necessarily related to the deterioration of LV systolic dysfunction.

In the current study, the incidence of HF death was approximately 5-fold higher than that of SCD. The difference in the incidence of cardiac death between previously reported studies and the present study must be mainly due to the difference in the duration of follow-up.

Pharmacological and Interventional Therapies and Perspectives
In this study, β-blockers were used in 23 patients in group H (70%) and in 32 patients in group L (73%), and calcium antagonists were used in 23 patients in group H (70%) and in 35 patients in group L (80%). The frequency of use of both drugs was not significantly different between groups H and L, but the progression of LV remodeling was much more rapid in group H than in group L. Thus, both β-blockers and calcium antagonists seem to be of little use for preventing the change from typical HCM to end-stage HF.

As an interventional therapy for the reduction of LVPG, surgical septal myotomy, dual chamber pacing and percutaneous transluminal septal myocardial ablation (PTSMA) are utilized. All treatments are effective for the reduction of LVPG. In 1987 when we started the present study, PTSMA had not yet been developed. PTSMA was developed at the same time that we reported the usefulness of cibenzoline for the reduction of LVPG. In the present study, both surgical septal myotomy and PTSMA were not utilized.

An important finding of the present study is that there is no intervention capable of inducing the regression of LV wall thickness in patients with HCM. Recently, we reported for the first time that drug therapy with cibenzoline can induce the regression of LV hypertrophy and improve LV diastolic dysfunction in patients with HCM. A recent study by Maron et al indicated that cardiovascular mortality in patients with HCM was lowered with the use of contemporary management strategies such as implantable cardioverter defibrillator, septal myectomy and alcohol septal ablation, and heart transplantation. These treatments do not cause regression of LV hypertrophy or improvement in LV diastolic dysfunction. Further studies on the relationship between change of LV remodeling and prognosis in patients with HCM are expected.

Study Limitations
In this study, CK isozymes were measured using cellulose acetate electrophoresis and fluorescence. Using this method, CK-MB was not detected in the NCS or EHT groups. This method, however, stopped being used at Ehime University Hospital in 1989. Therefore, we could not collect sufficient patients with HCM for the study. Nonetheless, we believe that the present results would not have changed even if the number of HCM patients had increased. When we started the present study, high-sensitivity troponin T was not utilized. Currently, high-sensitivity troponin T is a useful marker of myocardial injury in HCM patients. Previous results using high-sensitivity troponin T seem to match the patterns of the present results using CK-MB.

Conclusions
The persistent elevation of cardiac enzymes in HCM patients indicated ongoing myocardial injury, ultimately resulting in death by HF. The progression of LV remodeling was more rapid and more severe in HCM patients with higher plasma cardiac enzyme level and greater LV hypertrophy. To predict outcome of HCM, at least 15 years of follow-up seems to be necessary. The prognosis of HCM without SCD can be estimated by measuring serum cardiac enzyme level.

Disclosures
None of the authors have any conflict of interest or financial relationship to declare.

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