Left Ventricular Function in Patients with Stable Systemic Lupus Erythematosus

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SUMMARY

Echocardiography was used to compare the left ventricular function of 43 female patients with stable systemic lupus erythematosus with 93 healthy females in 3 age groups. Left ventricular systolic function was evaluated by the left ventricular ejection fraction and left ventricular diastolic function was evaluated by the diastolic descent rate of the anterior mitral leaflet (DDR), the ratio of mean systolic velocity to mean diastolic velocity in the left ventricular posterior wall (D/S ratio) and the ratio of peak mitral inflow velocity during the atrial filling period to that in the early filling period (A/E ratio). The left ventricular ejection fraction was not significantly different between patients and normal subjects. However, left ventricular diastolic function evaluated by these indexes in patients was different from normal subjects. These data suggest that left ventricular diastolic function is lower in patients with stable systemic lupus erythematosus than in normal subjects. It appears to deteriorate progressively with age. However, left ventricular systolic function remains normal.

Additional Indexing Words:
Cardiac function    DDR    D/S ratio    A/E ratio

CARDIOVASCULAR manifestations are frequently associated with systemic lupus erythematosus (SLE). Previous reports showed abnormal cardiac function in patients with SLE. Several reports described cardiac function in patients with SLE after corticosteroid therapy. However, neither detailed studies of cardiac function nor change in cardiac function with age have been reported for patients with stable SLE. Since the development and use of the therapy for patients with SLE has led to prolong-
ed longevity, cardiac abnormalities and cardiac function may be significant factors which influence the prognosis of patients with SLE. In this study, we evaluated left ventricular systolic and diastolic function of patients with stable SLE by M-mode and Doppler echocardiography.

**Methods**

**Patients**

Forty-three female patients with stable SLE (18–29 years: n=14, 30–39 years: n=13, 40–49 years: n=16) were studied. All fulfilled the 1982 American Rheumatism Association criteria for the diagnosis of SLE. Their erythrocyte sedimentation rates and complements were normal or had not changed for a few months and their clinical symptoms had not deteriorated. They underwent echocardiography, chest x ray, standard 12 lead electrocardiography, blood analysis, serum chemistry and urinalysis. Normal subjects consisted of 93 women (18–29 years: n=23, 30–39 years: n=43, 40–49 years: n=27), who had no history of heart disease, hypertension or other medical problems; they underwent urinalysis, chest x ray and electrocardiography.

**Equipment and methods**

M-mode, 2-dimensional and Doppler echocardiographic studies were performed with a SSH160A (Toshiba, Tokyo, Japan) using a 2-dimensional transducer (3.75 MHz) and a Doppler transducer (2.5 MHz). Echocardiography was performed on both patients and normal subjects in the partial left lateral decubitus position. M-mode measurements were recorded by moving an M-mode cursor on the 2-dimensional scan at the parasternal long axis view. The apical four chamber view was used for measurements of mitral valve inflow velocity, obtained with the Doppler beam aligned perpendicular to the plane of the mitral anulus by the continuous wave Doppler method. Minor adjustments of the transducer angulation were made to obtain the highest velocity.

**Statistical analysis**

Data are expressed as means±SD. Student's t-test was used for comparisons of paired samples.
RESULTS

Clinical findings

The duration of disease and the duration of steroid therapy were positively correlated with age (Table I). The values of ESR and CH₅₀ are given in Table I. Table II shows the clinical characteristics and echocardiographic values of the patients and normal subjects. The body surface area did not differ between patients and normal subjects. Diastolic pressure was higher in patients than in normal subjects in the 4th decade of life. In other age groups, there was no significant difference in blood pressure between patients and normal subjects.

Cardiac function

Left ventricular systolic function was evaluated by the left ventricular ejection fraction (LVEF). There were no significant differences in the

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<th>Table I. Clinical Characteristics of Patients</th>
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<td><strong>Age</strong> (years)</td>
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ESR = erythrocyte sedimentation rate.

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<th>Table II. Clinical Characteristics and Echocardiographic Findings in SLE and Control Subjects</th>
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<td>Control 1.56±0.10</td>
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<td>30-39</td>
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<td>Control 1.52±0.10</td>
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BSA = body surface area; SBP = systolic blood pressure; DBP = diastolic blood pressure; LAD = left atrial dimension; LVDd = left ventricular end-diastolic dimension; LVEF = left ventricular ejection fraction.

* p < 0.05 patients vs. control.
left atrial dimension (LAD), left ventricular end-diastolic dimension (LVDd) and LVEF between patients and normal subjects in each age group. The left ventricular diastolic function was evaluated by the diastolic descent rate of the anterior mitral leaflet (DDR), the ratio of mean systolic velocity to mean diastolic velocity in left ventricular posterior wall (D/S ratio) (Fig. 1), and the ratio of peak mitral inflow velocity during the atrial filling period to that in the early filling period (A/E ratio). The DDR was significantly lower in patients than in normal subjects in each age group and declined with age.
Fig. 2. The diastolic descent rate of the anterior mitral leaflet (DDR).
*p<0.001 patients vs. control.

Fig. 3. The ratio of mean systolic velocity to mean diastolic velocity of the left ventricular posterior wall (D/S ratio). *p<0.01, **p<0.001 patients vs. control, respectively.

(Fig. 2, Table III). The D/S ratio was significantly higher in patients than in normal subjects and increased with age (Fig. 3, Table III). The A/E ratio was also higher in patients than in normal subjects, although it was not significantly different in the 2 groups in the 4th decade of life (Fig. 4, Table III).

The diastolic dysfunction in the patients in the 4th decade of life may
have resulted from hypertension, because those patients showed significantly higher diastolic pressure than normal subjects. Therefore, left ventricular diastolic function in the 4th decade of life was compared between 9 patients with normal blood pressure and normal subjects. In the 9 patients, blood pressure was $115\pm6.6/72\pm5.6\text{mmHg}$ and was not significantly different from that in normal subjects. The DDR was significantly lower in the 9 patients than in normal subjects ($66\pm11.6\text{mm/s}$ vs. $95\pm16.5\text{mm/s}$, $p<0.001$) and the D/S ratio was significantly higher in the 9 patients than in normal subjects ($0.49\pm0.12$ vs. $0.34\pm0.04$, $p<0.01$). However, the A/E ratio did not differ in the 2 groups ($0.63\pm0.08$ vs. $0.63\pm0.11$, $p=\text{NS}$).

**DISCUSSION**

The prognosis of the patients with SLE has improved since the introduction of corticosteroid therapy. Therefore, in SLE as well as normal subjects, cardiovascular function has become an important factor for the prognosis. Several reports of cardiac function in SLE have been published. Strauer et al.\(^6\) reported that cardiac function evaluated by cardiac catheterization was impaired during the active stage of SLE. We also presented echocardiographic and phonocardiographic evidence that cardiac function deteriorated during the active stage, and improved after corticosteroid therapy.\(^8\) Murai et al.\(^9\) further reported that left ventricular systolic and diastolic
functions during the inactive stage were not significantly different from those in normal subjects. However, cardiac function in stable SLE has not yet been reported for a range of age groups.

This study used echocardiography to evaluate left ventricular systolic and diastolic functions in different age groups of stable SLE patients. The left ventricular systolic function was not significantly different from normal subjects in each age group. This confirms our previous report\(^8\) and the report of Murai et al.\(^9\) On the other hand, left ventricular diastolic function in patients with SLE was apparently different from that in normal subjects.

Many reports document the clinical utility of the indices of left ventricular diastolic function used in this study.\(^14\)–\(^21\) However, since the DDR can be affected by mitral valve abnormalities, it does not always accurately reflect left ventricular diastolic function. Doherty et al.\(^5\) reported the incidence of Libman-Sacks endocarditis in the mitral valve was 26% in autopsies of patients with SLE. Since mitral valve prolapse was present in 7% and mitral valve thickening in 7% in the patients of this study, the decrease of DDR might be partially caused by such mitral valve abnormalities.

The ratio of peak late mitral inflow velocity to peak early mitral inflow velocity (A/E ratio) also increases with age and in various diseases.\(^18,19\) Fujii et al.\(^20\) pointed out that left ventricular diastolic wall motion and the diastolic velocity of the left ventricular posterior wall by M-mode echocardiography were indices of left ventricular diastolic function. However, the diastolic velocity of the posterior wall depends on the direction of the echo beam. Therefore, to exclude the influence of the direction of the echo beam, we previously adopted the D/S ratio (ratio of mean systolic velocity to mean diastolic velocity in the left ventricular posterior wall) as an indicator of left ventricular diastolic function. When left ventricular diastolic function is reduced, the mean diastolic velocity of the left ventricular posterior wall decreases, resulting in an increase in the D/S ratio. We reported that the D/S ratio increased in hypertrophic obstructive cardiomyopathy, hypertensive heart disease and angina pectoris and that the D/S ratio showed a positive correlation with the isometric relaxation time.\(^15,21\) Since all of these indices showed abnormal findings, the results indicate a reduced diastolic function in stable SLE patients across the age groups.

Diastolic dysfunction may be induced by hypertension\(^22\) and corticosteroids,\(^23\) as well as the cardiac effect of SLE itself. However, young patients with both normal blood pressure and a short duration of steroid therapy showed diastolic dysfunction. Therefore, this study suggests that cardiac abnormalities due to SLE are responsible for the reduction of left ventricular
diastolic function. Borenstein et al\textsuperscript{24} reported that myocardial cell atrophy, fatty infiltration and small areas of necrosis were found in the myocardium of patients with SLE at autopsy. In addition, Bidani et al\textsuperscript{25} showed that areas of immune deposits were present in the walls of the blood vessels. Abnormalities in the myocardium and myocardial blood vessels may cause a reduction in diastolic function.

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