VALUE OF VECTORCARDIOGRAPHY IN PREDICTING PROGRESS IN DILATED CARDIOMYOPATHY

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Sixteen of 75 patients with dilated cardiomyopathy (DCM) died during a mean follow-up period of 39.7 months. In non-survivors, the cardiothoracic ratio and the left ventricular end-diastolic dimensions were greater, the left ventricular end-diastolic pressures were more elevated, and the cardiac index was lower than in the survivors at the time of initial diagnosis. There were no significant differences between survivors and non-survivors in the magnitude of the maximum QRS and T vectors or in the maximum T angle. In the non-survivors, the maximum QRS vector was directed more posteriorly and the width/length ratio of the loop in the horizontal plane was smaller than in survivors. The QRS loop in the horizontal plane was often distorted in non-survivors or showed a bizarre figure-of-eight configuration.

It appears that in DCM a marked posterior displacement of a QRS loop that is narrow and distorted or is in a bizarre figure-of-eight configuration in the horizontal plane indicates an unfavorable prognosis.

IT is well known that the prognosis in dilated cardiomyopathy (DCM) is poor. According to a Japanese committee report,¹ the 5 year survival is only 53%. Although it has been suggested that various clinical variables are useful in the prediction of DCM, the value of electrocardiograms (ECG) and vectorcardiograms (VCG) as predictors of outcome in this disease has not been widely investigated. In the present study, vectorcardiograms of DCM patients were analyzed qualitatively and quantitatively to determine their prognostic value.

MATERIALS AND METHODS

We retrospectively reviewed the ECGs and

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VCGs of 75 patients with DCM who were referred to the Second Department of Internal Medicine, Gunma University Hospital between January 1979 and December 1987. There were 61 males and 14 females ranging in age from 22 to 76 years. The patients were monitored until either death or June 30th 1988. The mean follow-up period was 39.7 months.

The diagnosis of DCM was based on physical findings, electrocardiography, M-mode and two-dimensional echocardiography, left ventricular angiography, coronary angiography and endomyocardial biopsy.

Sixteen of the original 75 patients died from 1 to 78 months after the first examination (non-survivors), 5 from congestive heart failure and 11 suddenly. The remaining 59 patients were still alive (survivors). The mean follow-up period for non-survivors was 22.7 months and most deaths occurred within the first 2 years. The base lines of radiographic, echocardiographic and hemo-

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TABLE I THE BASE LINE OF RADIOGRAPHIC, ECHOCARDIOGRAPHIC AND HEMODYNAMIC FINDINGS OF SURVIVORS AND NON-SURVIVORS

	Non-survivor		Survivor
Age (years)	48.2 ± 12.5		47.2 ± 10.3
Cardiothoracic ratio (%)	61.6 ± 5.9	**	56.6 ± 5.1
<i>Echocardiography</i>			
LVDD (mm)	64.7 ± 10.1	**	57.7 ± 7.0
LVEDV (ml)	227.4 ± 57.9	**	176.6 ± 42.5
EF	0.40 ± 0.12		0.38 ± 0.13
<i>Cardiac catheterization</i>			
LVSP (mmHg)	118.1 ± 16.3		125.8 ± 17.5
LVEDP (mmHg)	11.2 ± 5.8	*	7.9 ± 4.9
CI (l/min/m ²)	2.42 ± 0.63	**	3.08 ± 0.70

p* < 0.05, *p* < 0.01

LVDD: left ventricular end-diastolic dimension, LVEDV: left ventricular end-diastolic volume, EF: ejection fraction, LVSP: left ventricular systolic pressure, LVEDP: left ventricular end-diastolic pressure, CI: cardiac index

TABLE II THE RESULTS OF MEASUREMENTS OF THE VECTORCARDIOGRAPHY OF NON-SURVIVORS AND SURVIVORS

	Non-Survivor		Survivor
<i>Magnitude of Max QRS vector (mV)</i>			
Horizontal	1.44 ± 0.61		1.85 ± 0.69
Frontal	1.25 ± 0.66		1.66 ± 0.67
Sagittal	1.38 ± 0.62		1.35 ± 0.65
Spatial	2.79 ± 0.78		3.14 ± 1.03
<i>Direction of Max QRS vector (degree)</i>			
Horizontal	-59.0 ± 32.9	**	-22.7 ± 40.1
Frontal	16.3 ± 45.7		17.9 ± 24.0
Sagittal	3.1 ± 21.2	**	42.3 ± 51.9
<i>Magnitude of Max T vector (mV)</i>			
Horizontal	0.27 ± 0.17		0.30 ± 0.20
Frontal	0.20 ± 0.10		0.22 ± 0.14
Sagittal	0.26 ± 0.17		0.27 ± 0.20
Spatial	0.43 ± 0.25		0.47 ± 0.29
<i>Direction of Max T vector (degree)</i>			
Horizontal	87.2 ± 34.7		57.2 ± 66.9
Frontal	-34.6 ± 100.6		-37.1 ± 96.1
Sagittal	5.0 ± 136.8		6.9 ± 141.5

***p* < 0.001

Fig.1. The direction of the maximum QRS vector in survivors and non-survivors. The maximum QRS vectors in non-survivors was directed more posteriorly than in survivors.

Fig.2. The width/length ratios of the QRS loop in the horizontal plane. The non-survivors had significantly smaller ratios than the survivors ($p < 0.001$).

dynamic findings of survivors and non-survivors are shown in Table I. In non-survivors as compared with survivors, the cardiothoracic ratio, left ventricular end-diastolic dimension and left ventricular end-diastolic volume were large, and the left ventricular end-diastolic pressure was high, while the cardiac index was low. The Frank lead VCGs were recorded with a Fukuda Vectorcardiograph VA-3G. The sagittal plane was viewed from the left. The measurements were made on the magnitude of the maximum QRS and T vectors, the width of the QRS loop, and the direction of the maximum QRS and T vectors in three planar projections. Vectorcardiographic measurements were not made in 5 cases in which electrocardiogram showed right bundle branch block.

The unpaired Student's *t* test and the chi square test were used for statistical analysis and a *p* value of less than 0.05 was considered indicative of a significant difference.

RESULTS

Table II shows the measurements of the VCGs. There was no significant difference between survivors and non-survivors in the magnitude of the maximum QRS vector. However, the maximum QRS vector was directed

Fig.3. The ECG and VCG of a non-survivor. The QRS loop is narrowly elongated and distorted, and the maximum QRS vector is directed to posteriorly.

TABLE III COMPARISON OF THE INCIDENCE OF PROLONGATION OF QRS INTERVAL (> 0.12 sec) AND BUNCHING OF QRS LOOP, LEFT VENTRICULAR END-DIASTOLIC DIMENSION (LVDd), LEFT VENTRICULAR END-DIASTOLIC VOLUME (LVEDV) AND LEFT VENTRICULAR END-DIASTOLIC PRESSURE (LVEDP) BETWEEN THE PATIENTS WITH SMOOTHLY OVAL QRS LOOP AND THOSE WITH NARROWLY ELONGATED QRS LOOP

	Smoothly oval QRS loop		Narrowly elongated QRS loop
Case number	54		16
non-survivor	6 (11%)	**	9 (56%)
Prolongation of QRS interval	7 (13%)	**	12 (75%)
Bunching of QRS loop	9 (17%)	**	12 (75%)
LVDd (mm)	56.9 ± 7.3	**	64.6 ± 10.5
LVEDV (ml)	177.8 ± 45.3	**	214.5 ± 63.7
LVEDP (mmHg)	7.4 ± 4.6	*	11.0 ± 6.5

** $p < 0.001$, * $p < 0.02$

more posteriorly and superiorly in non-survivors. As shown in Fig. 1, the maximum QRS angle ranged between -10° and -95° in the horizontal plane in non-survivors, while a more anterior direction of the vector in this plane appeared in 36 survivors (65%). Among 48 cases in which the maximum QRS was directed more posteriorly

than -10° in the horizontal plane, 15 (31%) died during the follow up period, and 7 of 14 cases (50%) with marked posterior displacement of the maximum QRS vector of more than -60° in the horizontal plane were also non-survivors. In the sagittal plane, the maximum QRS angle ranged between 25° and -53° in non-survivors, while

the orientation of the maximum QRS vector outside this range appeared in 30 survivors (55%). Thus, 15 of 40 patients (38%) whose maximum QRS angle was between 25° and -53° in the sagittal plane died during the follow-up period.

The width/length ratio of the QRS loop was significantly smaller in non-survivors than in survivors (Fig. 2). The ratio was less than 0.4 in 10 of 15 non-survivors (67%) and in 12 of 55 survivors (22%). The difference was statistically significant ($p < 0.01$). While the QRS loop was smoothly oval in most survivors (48 cases, 87%), it was usually narrowly elongated in non-survivors (9 cases, 60%) and frequently showed a distorted or figure-of-eight configuration. A representative VCG of a non-survivor is shown in Fig. 3.

Left ventricular end-diastolic dimension and end-diastolic volume were larger, and end-diastolic pressure was higher in patients with narrowly elongated QRS loop than in those with smoothly oval QRS loop. The prolongation of QRS interval (> 0.12 sec) and bunching of QRS loop were more frequently seen in patients with narrowly elongated QRS loop than those with smoothly oval QRS loop (Table III).

There was no significant difference in the maximum T angle between survivors and non-survivors (Table II).

In routine 12 lead electrocardiograms, abnormal Q waves occurred more frequently in non-survivors (6 cases, 38%) than in survivors (2 cases, 3%), and the prolongation of QRS interval (> 0.12 sec) was seen more frequently in non-survivors (8 cases, 50%) than in survivors (11 cases, 17%). These differences were statistically significant ($p < 0.01$). There were no other significant differences in routine ECGs between the 2 groups.

Atrial fibrillation occurred in 24 survivors (41%) and in 6 non-survivors (38%). Right bundle branch block occurred in 4 survivors (7%) and in 1 non-survivor (6%).

DISCUSSION

The prognosis in DCM is generally poor. According to the committee report in Japan,¹ the 5- and 10-year survival rates are 54% and 36%, respectively. Fuster and associates² reported that two-thirds of the deaths occurred within 2 years after diagnosis. Sixteen of 75 patients in our series died during the mean follow-up period of 39.7 months.

Several clinical and hemodynamic variables

have been pointed out as useful for prediction of prognosis, although some controversies remain. Old age,¹⁻³ increased cardiothoracic ratio,² presence of ventricular arrhythmias^{3,4} and elevated left ventricular end-diastolic pressure⁴ at the time of initial diagnosis are considered to be indicative of unfavorable prognosis. The present study showed significant increases in the cardiothoracic ratio and the echocardiographically determined left ventricular end-diastolic dimension in non-survivors and in the elevation of left ventricular end-diastolic pressure, but the prognosis was not related to age.

There are few reports on the vectorcardiographic aspects of DCM. Hamby and Raia⁵ reported that a posteriorly directed and relatively narrow QRS loop was characteristic of primary myocardial disease. A posterior displacement of the QRS loop in DCM was also pointed out by Motomura and associates.⁶ Goldberger and associates⁷ reported that the frontal plane QRS voltage was decreased in DCM despite an increase in the horizontal plane QRS voltage, indicating that the orientation of the QRS loop was relatively perpendicular to the frontal plane. That is, the QRS loop was displaced posteriorly in DCM.

In the present study, there were no significant differences between survivors and non-survivors in the magnitude of the maximum QRS and T vectors or in the maximum T angle. However, the maximum QRS vector was directed more posteriorly and the width/length ratio of the loop was smaller in non-survivors than in survivors. In addition, in non-survivors, the QRS loop frequently showed a narrow and distorted pattern or a bizarre figure-of-eight configuration in the horizontal plane. Thus, we think that a posteriorly displaced narrow QRS loop, which is distorted or in a figure-of-eight configuration in the horizontal plane, indicates a poor prognosis in DCM. An opinion similar to ours has been suggested by Sekiguchi and Sato.⁸

A figure-of-eight configuration of the QRS loop in the horizontal plane similar to our non-survivors occasionally occurs in chronic aortic valve disease. According to Recke,⁹ such a QRS loop appeared in patients with aortic stenosis or combined aortic stenosis and aortic insufficiency and large left ventricular end-diastolic volume. That report postulated a left ventricular conduction delay as the underlying mechanism. Our results demonstrated that a narrow and distorted or figure-of-eight QRS loop in the horizontal plane in DCM was associated with marked left

ventricular dilation, marked elevation of left ventricular end-diastolic pressure and possibly left ventricular conduction delay. A relatively low R wave with initial slurring, a frequent finding in advanced cases of DCM, may be the electrocardiographic counterpart of the above vectorcardiographic change.

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