Study on the Mitral Valve Prolapse I. Incidence in Kobe University Students

II. Follow Up Study

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Incidence of mitral valve prolapse (MVP) in 4517 students of Kobe University, and clinical features in cases with MVP were studied. MVP was detected in 42 cases by two-dimensional echocardiography, and the prevalence of MVP was 0.93 percent (42 of 4517 cases). Among 42 cases with MVP, apparent mitral regurgitation (MR) was noted in one case with severe MVP, ventricular tachycardia was detected in one and ST-T wave abnormalities were detected in 10 respectively. In another follow up study of our hospital, 14 of 85 patients followed more than one year were noted to be deterioration in echocardiographic parameters. Eight of 14 patients had severe prolapse with severe MR, but remaining 6 had mild or moderate prolapse with mild or absent of MR. However, ST-T wave abnormalities, serious arrhythmias, and low response of %FS increase on exercise were found in high incidence in 6 of mild or moderate prolapse as well as in severe prolapse. So these follow up results suggested that not only students with severe MVP but also students with mild or moderate MVP with ST-T wave changes or VPC found in university medical examination must be followed up carefully.

IDIOPATHIC mitral valve prolapse (MVP) is one of the most frequently observed abnormalities as the base of heart murmurs or ECG abnormalities found in school medical examinations. MVP is generally thought to be a benign disease, but some cases with MVP were reported to fall into more serious conditions such as congestive heart failure, sudden death due to arrhythmias, and complication of infective endocarditis in the long term follow up study.¹⁻⁵ In this study we report (I) the incidence of MVP in student's medical examination of Kobe University using echocardiography and the clinical features in

students with MVP, and (II) the results of follow up study of the patients with MVP in our hospital.

MATERIALS AND METHODS

Medical examination was performed in 4517 students (consisting of 3569 males and 948 females) of Kobe University. Out of 4517 students 99 cases, who had been pointed out to be abnormal in auscultation and/or in ECG, were examined by M-mode echocardiography, and out of the 99 cases 49 cases with abnormal findings in M-mode echocardiography were further examined by two-dimensional echocardiography (2-DE). M-mode echocardiography was performed using Fukuda echocardiography

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SSD-110S, and 2-DE was performed using Toshiba ultrasonoscope SSH-11A and SSH-40A. Mitral regurgitation (MR) was detected by pulsed doppler echocardiography (PDE) using Toshiba pulse doppler unit SDS-10A and SDS-21A. The left ventricular short axis dimension in end-diastole (LVDD) and in end-systole (LVDs) and left atrial dimension (LAD) were measured by M-mode echocardiograms. Left ventricular percent fractional shortening (%FS) was calculated as follows. $\%FS = [(LVDD - LVDs)/LVDD] \times 100$.

MVP was diagnosed on the 2-DE image of

TABLE I ECHOCARDIOGRAPHIC FINDINGS IN THE MEDICAL EXAMINATION OF KOBE UNIVERSITY

<i>M-mode (n = 99)</i>		
MVP susp.	45 cases
VSD susp.	2	
LV dilatation	1	
IVS hypertrophy	1	
normal	50	
<i>2-DE (n = 49)</i>		
MVP	42	40
TVP	1	1
VSD	2	2
ruptured aneurysm of sinus of Valsalva	1	1
normal	3	3

2-DE = two-dimensional echocardiography; MVP = mitral valve prolapse; VSD = ventricular septal defect; LV = left ventricle; IVS = interventricular septum; TVP = tricuspid valve prolapse

long axis view of the left ventricle in accordance with the criteria we reported previously,⁶ — grade 1: mitral leaflets showed slightly convex to the left atrium in systole but the leaflets had not exceeded over the mitral annular level, grade 2: mitral leaflet prolapse showed exceeding over the mitral annular level for only short period in systole but not for pansystolic period, grade 3: mitral leaflet was prolapsed exceeding over the mitral annular level throughout the systole, and grade 4: mitral leaflet showed marked pansystolic prolapse. For the follow up study 85 patients (consisting of 44 males and 41 females whose mean age was 29 years old; from 9 to 76 years old) were subjected. The follow up study was made for more than one year (mean follow up period 3.1 years). Among these 85 patients 14 patients were noted to be aggravated in echocardiographic parameters ($\Delta LVDD \geq 5$ mm, $\Delta LAD \geq 5$ mm or $\Delta \%FS \leq -5\%$ beyond normal range). Of these 14 patients, MR was detected by PDE in 11 cases and 24-hour ambulatory ECG monitoring was performed in 9 cases. Six cases were examined by echocardiography before and during exercise using by supine ergometer (50 watt 9 min) to evaluate the left ventricular response to exercise. When increase of %FS during exercise was less than 5%, left ventricular response was evaluated abnormal (in 10 normal controls increase of %FS during exercise was $11 \pm 3\%$, mean $\pm$ S.D.).

RESULTS

(I) Medical examination in Kobe University students

TABLE II MVP GRADE AND ECHOCARDIOGRAPHIC PARAMETERS IN STUDENTS WITH MVP OF KOBE UNIVERSITY

MVP Grade	I°	II°	III°	IV°	total
No. of Cases	4 cases	22	15	1	42
MR (Doppler)	0	5	5	1	11
<i>UCG parameter</i>					
LVDD (mm)	49.5 $\pm$ 1.5	46.4 $\pm$ 4.8	46.7 $\pm$ 3.4	57	46.9 $\pm$ 4.4
LVDs (mm)	32.3 $\pm$ 1.1	3.03 $\pm$ 4.0	30.5 $\pm$ 3.3	38	30.0 $\pm$ 3.9
LAD (mm)	30.3 $\pm$ 2.0	28.1 $\pm$ 4.0	26.8 $\pm$ 3.2	30	27.9 $\pm$ 3.7
%FS (%)	35.9 $\pm$ 4.6	36.6 $\pm$ 4.8	34.6 $\pm$ 4.9	33	35.7 $\pm$ 4.9

MVP = mitral valve prolapse; MR = mitral regurgitation; LVDD = left ventricular end-diastolic dimension; LVDs = left ventricular end-systolic dimension; LAD = left atrial dimension; %FS = %fractional shortening

TABLE III CLINICAL FINDINGS AND ECG ABNORMALITIES IN STUDENTS WITH MVP OF KOBE UNIVERSITY

MVP Grade	I° (n = 4)	II° (n = 22)	III° (n = 15)	IV° (n = 1)	total (n = 42)
symptom		2	5		7 cases (17%)
click	1	6	7		14 (33)
systolic murmur	4	18	9	1	32 (76)
ECG abnormality					
ST-T change		5	5		10 (24)
VPC			2 (VT 1)		2 (5)
SVPC		1			1 (2)
sinus brady cardia			1		1 (2)
incomplete RBBB	1	2	2		5 (12)
abnormal Q		1			1 (2)

MVP = mitral valve prolapse; VPC = ventricular premature contraction; SVPC = supra-ventricular premature contraction; RBBB = right bundle branch block; VT = ventricular tachycardia

1) Echocardiographic findings (Table I)

In M-mode echocardiography abnormal findings were detected in 49 of 99 cases, whom consisting of 45 cases with suspicion of MVP, 2 cases with suspicion of ventricular septal defect (VSD), and one case each with left ventricular dilatation and interventricular septal hypertrophy.

Of 49 cases, MVP was detected in 42 cases, tricuspid valve prolapse (TVP) in one, VSD in 2 cases, and ruptured aneurysm of the sinus of Valsalva in one respectively, and 3 cases were normal in 2-DE.

2) MVP grade and echocardiographic parameters (Table II)

Of the 42 cases with MVP by 2-DE, number of cases in each grade was as followed, — 4 cases in grade 1, 22 cases in grade 2, 15 cases in grade 3, and one case in grade 4, respectively. MR was detected in 11 of the 42 cases (26%) by PDE, but MR was in mild degree (MR signal was localized near the mitral orifice in the left atrium) in all cases except for the case of grade 4 (MR signal was detected over the middle part in the left atrium). Echocardiographic parameters (LVDD, LVDs, LAD and %FS) were all within normal ranges in all cases of less than grade 3, but only one case of grade 4 had left ventricular dilatation.

3) Clinical findings (Table III)

Seven cases (2 cases in grade 2 and 5 cases in

grade 3) presented with symptoms (chest pain or palpitation). Fourteen cases were noted to have systolic click and 32 cases had systolic murmur. ST-T wave changes were detected in 10 cases (5 cases each in grade 2 and in grade 3) and ventricular premature contractions (VPC) were detected in 2 cases, in one of whom ventricular tachycardia (VT) was found in 24-hour ambulatory ECG monitoring.

(II) Follow up study

Among 85 followed up patients with MVP 14 patients were noted to be aggravated in echocardiographic parameters. The clinical findings of these patients are shown in Table IV.

Eight (Case 1–8) of the 14 patients had severe prolapse of grade 4 and most of them were accompanied by severe MR, but the remaining 6 cases (Case 9–14) had mild or moderate prolapse and mild degree or absent of MR. Seven of the 14 cases (50%) had ST-T wave abnormalities in 12 lead ECG, and 4 (44%) of 9 cases monitored by 24-hour ambulatory ECG presented with serious arrhythmias of more than grade 3 by Lown's classification.⁷ On exercise echocardiography all of 6 cases were noted with low response of %FS increase during exercise. The findings such as ST-T wave abnormalities, serious arrhythmias and low response of %FS change on exercise were detected in high incidence not only in severe prolapse group but also in mild or moderate prolapse group.

TABLE IV CLINICAL FINDINGS OF 14 AGGRAVATING PATIENTS AMONG 85 PATIENTS WITH MVP FOLLOWED MORE THAN ONE YEAR

	Age	Sex	MVP grade	MR	symptom	murmur	ECG at rest			Holter ECG	Ex. UCT
							ST-T change	arrhythmia			
Case 1	55	M	IV°→IV°	(++)	palpitation	holo-systole	(+)	SVPC	PSVT	—	—
2	39	M	IV°→IV°	(++)	chest pain	holo-systole	(+)	SVPC	VPC	abnormal	—
3	57	F	IV°→IV°	—	(—)	holo-systole	(—)	(—)	—	—	—
4	26	M	IV°→IV°	(++)	palpitation	holo-systole	(+)	(—)	VPC	—	—
5	18	M	IV°→IV°	(++)	palpitation	mid ~ late systole	(—)	—	—	—	—
6	30	M	III°→IV°	(+)	palpitation	holo-systole	(—)	(—)	(—)	abnormal	—
7	25	F	III°→IV°	—	(—)	holo-systole	(—)	(—)	—	—	—
8	43	F	III°→IV°	(++)	dyspnea	holo-systole	(+)	(—)	(—)	—	—
9	56	F	III°→III°	(+)	chest pain	ejection type	(+)	(—)	(—)	abnormal	—
10	40	F	III°→III°	(+)	chest pain	(—)	(+)	(—)	transient Af	abnormal	—
11	39	F	III°→III°	(+)	palpitation	holo-systole	(+)	VPC	VPC	—	—
12	23	M	III°→II°	(—)	(—)	late systole	(—)	(—)	VPC	abnormal	—
13	22	M	II°→III°	(—)	(—)	(—)	(—)	(—)	—	abnormal	—
14	23	M	II°→II°	—	(—)	ejection type	(—)	(—)	—	—	—

MVP = mitral valve prolapse; MR = mitral regurgitation; (++) = severe; (+) = mild; SVPC = supra-ventricular premature contraction;
VPC = ventricular premature contraction; PSVT = paroxysmal supra-ventricular tachycardia; Af = atrial fibrillation; VPC in Holter ECG =
VPC more than grade 3 by Low's classification; Ex UCT = exercise echocardiography

DISCUSSION

Mitral valve prolapse (MVP) is frequently encountered in young people and important as the basic disease of auscultatory and ECG abnormalities in school medical examination. The prevalence of MVP is reported to be 4–17% in mass medical examination and tends to be higher in females by several investigators.^{8–11} In this study MVP was detected in 42 of 4517 cases (0.93%), and the incidence was lower than other reports. One of its cause is thought that our study include males about 4 times as many as females, and another cause may be that in our study MVP is diagnosed by 2-DE and other investigators by M-mode echocardiography. Pansystolic bowing is well known to be one of the important signs of MVP in M-mode echocardiography, but this sign may include false positive cases.¹² In fact MVP was not detected by 2-DE in 5 of 45 cases who were suspected to have MVP by M-mode echocardiography in our study. MVP is generally thought to be a benign disease, but some of them were reported to fall into more serious conditions, which are not well investigated yet.

In our follow up study (3.1 years of mean follow up period), MR is considered the main factor for the deterioration in 8 cases (Case 1–8) with severe prolapse out of 14 cases whose echocardiographic parameters were changed for the worse, as all of them showed grade 4 prolapse and 5 of 6 cases performed PDE revealed severe MR at last examination. In the remaining 6 cases (Case 9–14) with mild or moderate prolapse MR was in mild degree or not detected, however findings of ST-T wave abnormalities, serious arrhythmias in ECG, and low response of %FS that myocardial change as reported by Mason¹³ may play a role in the worsening of left ventricular function. From these follow up results it is suggested that not only one student with grade 4 MVP but also other students with low grade MVP especially with ST-T change and VPC found in medical examination must be carefully followed up and left ventricular

function test is necessary for the students with MVP.

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