Severity of Mitral Regurgitation Assessed by Echocardiography Reliability and Limitations

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SUMMARY

To assess whether echocardiography may represent a useful mean to evaluate the degree of mitral regurgitation (DR), left ventricular diastolic internal dimension (LVIDd), left atrial dimension (LAD), and velocity of circumferential fiber shortening (Vcf) were compared to DR assessed by left ventriculography in 48 patients with primary (n=21) and cardiomyopathic (n=27) valvular incompetence.

In patients with good left ventricular contractility, i.e. with Vcf values above 1.02, a significant positive linear correlation was found between LVIDd and DR ($\text{LVIDd} = 5.38 + 0.45\text{DR}$; $r = 0.72$; $p < 0.001$). In contrast, in patients with depressed left ventricular function, i.e. with Vcf values below 1.02, LVIDd did not correlate to DR. In either group LAD and Vcf did not correlate to DR.

Thus, echocardiography may provide useful semiquantitative information concerning DR only in patients with preserved left ventricular performance.

Additional Indexing Words:

LVIDd LAD Vcf Left ventricular contractility

THE clinical evaluation of patients with mitral regurgitation offers several difficulties. Actually, although mitral valve incompetence increases left ventricular volume load it is unclear, as yet, how the resulting cardiac enlargement can relate to the severity of valvular insufficiency and how the myocardial inotropic state may influence this relationship.

Previous angiographic studies¹⁾⁻⁴⁾ in patients with mitral regurgitation (MR) of various origin grouped together, showed that the degree of valvular regurgitation correlated to the severity of clinical symptoms, the extent of left ventricular enlargement and the impairment of left ventricular function.

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In contrast, Bolen and Alderman,⁵⁾ reviewing angiographic data of patients with mitral valve disease, divided into different groups according to the origin of the disease (either combined rheumatic stenosis and regurgitation or cardiomyopathic mitral insufficiency) and found a significant correlation between left ventricular end-diastolic volume and degree of regurgitation in patients with primary valve disease, in whom a ejection fraction was generally preserved. However, a normal value of ejection fraction on angiography does not necessarily indicate the absence of impaired left ventricular performance in acute^{6),7)} or in chronic⁸⁾ volume overloading.

The aim of this study was to establish how myocardial contractility may influence the relation between the severity of MR and the degree of cardiac enlargement in patients with isolated MR either primary or secondary to cardiomyopathy. The mean rate of circumferential fiber shortening (Vcf), showed to reflect the intrinsic inotropic state of the myocardium at rest⁹⁾⁻¹¹⁾ even in the presence of chronic volume overload,^{8),12)} was utilized to establish left ventricular contractile state.

MATERIALS AND METHODS

A retrospective study was performed in 48 patients (pts) with MR who underwent echocardiographic examination within 48 hours from the diagnostic heart catheterization. On the basis of the hemodynamic data, these pts were divided into 3 groups: pts in group 1 (n=3) had prolapse of the posterior leaflet of the mitral

FIG. 1. Echocardiogram of the left ventricle of a patient in group 2 with a simultaneous recording of the ECG and carotid pulse tracing.

FIG. 2. Record from a patient in group 3 with cardiomyopathic mitral insufficiency. Simultaneous ECG and carotidogram are registered.

valve; those in group 2 ($n=18$) presented rheumatic MR (Fig. 1); pts in group 3 ($n=27$) had cardiomyopathic MR (coronary artery disease, congestive idiopathic cardiomyopathy) (Fig. 2). Acute MR and combined mitral valve stenosis and insufficiency were excluded from the study. Echocardiograms had been obtained by standard methods¹³⁾ using an Aloka SSD 110 ultrasonoscope with a 2.25 MHz transducer; recordings were made using a Honeywell 1856 strip chart recorder, with the high sensitive paper (Kodak Linograph 1895) running at the speed of 50 mm/sec.

The following echocardiographic measurements were done: left ventricular end-diastolic internal dimension (LVIDd) at the level of the chordae tendineae, using the R wave of the ECG tracing as reference; left ventricular end-systolic dimension (LVIDs), considered as the smallest dimension between the left septal endocardium and the posterior wall endocardium during systole; left atrial diameter (LAD), as the greatest vertical distance between the anterior side of the posterior aortic wall and the posterior left atrial wall during ventricular systole; velocity of circumferential fiber shortening (Vcf) calculated as: $LVIDd - LVIDs / LVIDd \times ET$, where ET is the left ventricular ejection time measured on a simultaneously recorded carotid pulse tracing. Measurements were performed by 2 different observers on 5 consecutive cycles and then averaged; differences in measurements were arbitrated by a third observer. Echocardiographic data were correlated by simple linear regression with the angiographic degree of observable radiopacity of the regurgitant fraction (DR), classified as degree 1 to 4, according to the AHA "ad hoc Committee" classification.^{14), 15)}

RESULTS

Table I shows the mean values $\pm$ standard error of the mean for LAD, LVIDd, and Vcf. LAD and LVIDd were within normal limits in pts in group 1, while they were elevated in groups 2 and 3; in contrast, only pts in group 3 had clearly depressed Vcf. The distribution of the single values of Vcf in the 3 groups showed that all of the patients in groups 1 and 2 had normal Vcf, while all but 3 pts in group 3 exhibited depressed Vcf values (Fig. 3).

According to their inotropic state pts were divided in 2 additional groups: in group A were included 24 pts with normal Vcf (above 1.02 circ/sec),¹¹⁾ while in group B were 24 pts with depressed Vcf. In group A a

Table I. Echocardiographic Parameters Measured in 3 Groups of Patients with Mitral Regurgitation

	LVIDd (mm)	LAD (mm)	Vcf (circ/sec)
Gr 1 (n= 3)	52 $\pm$ 3.3	42 $\pm$ 3.4	1.54 $\pm$ 0.07
Gr 2 (n=18)	63 $\pm$ 1.4	57 $\pm$ 2.2	1.29 $\pm$ 0.02
Gr 3 (n=27)	67 $\pm$ 1.3	54 $\pm$ 1.3	0.60 $\pm$ 0.04

Gr 1=group 1; Gr 2=group 2; Gr 3=group 3; LVIDd=left ventricular internal dimension in diastole; LAD=left atrial diameter; Vcf=mean rate of circumferential fiber shortening; All numbers are expressed as mean $\pm$ SEM.

FIG. 3. Distribution of Vcf values in all of the patients studied, divided into 3 groups according to etiology. On the abscissa the degree of mitral regurgitation (DR) is reported. All values underneath the broken line can be considered abnormal. Note the absence of the significant relation between Vcf and degree of MR. Gr 1=group 1; Gr 2=group 2; Gr 3=group 3.

positive linear correlation was found between LVIDd and DR (LVIDd = $5.38 + 0.45\text{DR}$; $r = 0.72$; $p < 0.001$) (Fig. 4). In contrast, in group B, i.e. in pts with depressed inotropism, no correlation was present between the degree of MR and LVIDd; in particular LVIDd appeared disproportionately large in patients with relatively small DR (grades 1 and 2) (Fig. 5). When patients were divided according to etiology of MR, i.e. primary mitral in-

FIG. 4. Relationship between LVIDd and degree of regurgitation in patients with normal Vcf.

FIG. 5. Distribution of LVIDd values, plotted against the relative DR in patients with depressed Vcf.

FIG. 6. Relation between LVIDd and DR in patients of groups 1 and 2.

FIG. 7. Distribution of left atrial dimension (LAD) values in all patients divided according to etiology. No correlation was found between LAD and DR.

sufficiency (groups 1 and 2) and cardiomyopathic mitral regurgitation (group 3), the linear regression equation showed a significant correlation, similar to that observed in group A ($LVIDd = 4.97 + 0.52DR$; $r = 0.75$; $p < 0.001$) (Fig. 6).

Finally, a significant correlation between LAD and DR could not be found in these MR pts, never when they were considered together, nor when they were divided into 3 groups according to the etiology of the disease (Fig. 7); the distribution of LAD values being similar in the 3 groups. Eventually, in patients with severe regurgitation grading 3 or 4, a normal LAD was never encountered.

DISCUSSION

Data here reported seem to support previous results showing that, in patients with primary mitral regurgitation, left ventricular function is generally well preserved, in spite of the chronic volume overload. In contrast, when mitral insufficiency is secondary to cardiomyopathy, the altered inotropism of the myocardium induces an impairment of cardiac performance, reflected by depressed velocity of contractile elements. Under this condition, left ventricular enlargement and degree of regurgitation are not linked by a linear correlation, this suggesting that the diastolic left ventricular dimension can not be utilized as a reliable indicator of the severity of MR. Actually, in these patients, the heart works on a depressed force-velocity curve and maintains a normal forward flow, in spite of a severe impairment of the intrinsic contractile state, at the expense of further and disproportionate increase in end-diastolic volume. Thus, regurgitant volume and myocardial contrac-

tility are the two determinants of the relation between severity of regurgitation and left ventricular enlargement. As supported by others^{3),17),18)} the inotropic state of the left ventricle appears the prevailing factor in the relation between LVIDd and DR.

In patients with primary MR, on the contrary, LVIDd values can offer a semiquantitative estimation of the DR; thereby, under this condition, the noninvasive evaluation of the left chamber size can be helpful to identify patients with severe valvular incompetence. However, the possibility can not be overlooked that in patients with primary valve insufficiency, an intervening cardiomyopathy eventually may affect ventricular dimension and, therefore, inhibit the evaluation of DR by echocardiography.

Finally, as shown previously by angiography¹⁹⁾ no significant correlation exists between left atrial enlargement and severity of regurgitation, independently from the etiology of MR, this suggesting that several factors other than the severity of valve incompetence may play a role in inducing an increase in left atrial dimension, such as among these factors, an increase in left atrial pressure, either stable or temporary, as sometime observed in chronic heart disease,²⁰⁾ the atrial wall involvement by the disease, the duration of disease, the myocardial inotropism.

In conclusion, echocardiography appears to be useful in the evaluation of patients with MR, in particular in those with a well preserved left ventricular function, in whom, this noninvasive method appears capable to give a semiquantitative estimation of the severity of valvular incompetence.

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