The index of myocardial performance and aortic regurgitation: the influence of a volume overload lesion

Miyokard performans indeksi ve aort yetersizliği: hacim yüklenmesi lezyonun etkisi

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ABSTRACT

Objective: The index of myocardial performance (IMP) is a global cardiac function index with prognostic utility in patients with myocardial infarction and dilated cardiomyopathy but is preload dependent. We hypothesized that a volume overload lesion prolonging LV ejection time (LVET) may reduce IMP despite LV dysfunction (LVD).

Methods: The study groups consisted of 35 normals, 26 with LV dysfunction, and 60 with aortic regurgitation (AR): 40 with ejection fraction (EF) >50% (AR+Normal EF) and 20 with ejection fraction ≥50% (AR+Reduced EF). We evaluated consecutive patients in each group with technically adequate 2D and Doppler echocardiography.

Results: When compared to normal subjects (0.357±0.122), IMP was increased with LVD (0.604±0.278 p<0.001) but was similar in AR+Normal EF patients due to isovolumic relaxation time (IRT) and LVET prolongation. The IMP was lower in AR+Reduced EF group (0.346±0.172, p<0.001) as compared to the LVD group due to a prolonged LVET and a reduced IRT and isovolumic contraction time (ICT).

Conclusions: The IMP in AR+Normal EF patients was similar to normals due to IRT and LVET prolongation. The IMP was reduced in AR+Reduced EF patients compared to LVD patients due to IRT and ICT shortening and LVET prolongation. The index of myocardial performance in AR patients should be applied with caution. *(Anadolu Kardiyol Derg 2006; 6: 115-20)*

Key words: Aortic regurgitation, index of myocardial performance, left ventricular dysfunction

ÖZET

Amaç: Miyokard performans indeksi (MPİ) miyokard infarktüslü ve dilate kardiyomiyopatili hastalarda prognostik değeri olan bir global kardiyak fonksiyon indeksidir, ancak önyüke bağlıdır. Biz, sol ventrikül ejeksiyon zamanını (SVEZ) uzatan volüm yüklenmesine bağlı lezyonun sol ventrikül disfonksiyonuna (SVD) rağmen MPİ'ni azaltacağını varsaydık.

Yöntemler: Çalışma gruplarını 35 normal, SVD'lu 26 hasta ve aort yetersizliği (AY) olan 60 hasta (40'ı ejeksiyon fraksiyonu (EF) ≥50% (AY+Normal EF grubu) ve 20'si ejeksiyon fraksiyonu <50% (AY+düşük EF grubu)) oluşturuyordu. Hastalar her grupta ardışık olarak 2 boyutlu ve Doppler ekokardiyografi ile tarafımızdan incelendi.

Bulgular: Normal bireyler (0.357±0.122) ile karşılaştırıldığında MPİ, SVD'lu (0.604±0.278 p<0.001) hastalarda daha yüksek idi, ancak izovolümik relaksasyon zamanının (IRZ) ve SVEZ'nın uzamasına bağlı olarak AY+Normal EF hasta grubu ve normal grup arasında fark yok idi. Aynı zamanda SVD'lu gruba göre AY+düşük EF grubunda MPİ (0.346±0.172, p<0.001), SVEZ uzaması, IRZ ve isovolümik kontraksiyon zamanının (IKZ) azalmasına bağlı olarak kısaldığı tespit edilmiştir.

Sonuç: Miyokardiyal performans indeksi, IRZ ve SVEZ uzamasına bağlı olarak AY+normal EF'lu hastalarda ve normal bireylerde benzer idi. Sol ventrikül ejeksiyon zamanın uzaması, IRZ ve İKZ kısalmasına bağlı olarak MPİ AY+düşük EF grubunda SVD grubuna göre daha azalmıştı. Aort yetersizliği olan hastalarda MPİ'nin dikkatle kullanılması gerekir. *(Anadolu Kardiyol Derg 2006; 6: 115-20)*

Anahtar kelimeler: Aort yetersizliği, miyokard performans indeksi, sol ventrikül disfonksiyonu

Introduction

The index of myocardial performance (IMP) is a global left ventricular (LV) performance index that has prognostic significance in patients with cardiomyopathy, congestive heart failure, and following a myocardial infarction (1-3). The IMP is calculated as the Doppler derived sum of the isovolumic contraction time (ICT) and isovolumic relaxation time (IRT) divided by the left ventricular ejection time (LVET) (3). The IMP has been noted to be contractility dependent in clinical studies (4). However, IMP was also preload and afterload dependent in a canine model of normal and reduced LV systolic function (5,6). Specifically, volume loading in a canine model of normal and reduced LV function resulted in a lower IMP by prolonging LVET (5).

Clinically, LV volume overload produced by chronic aortic regurgitation (AR) results in a prolonged LVET (7-11) and may the-

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oretically reduce IMP. As patients with LV dysfunction due to dilated cardiomyopathy or following myocardial infarction have an increased IMP (1-3), the effect of concomitant chronic AR accompanying LV dysfunction has not been well clarified. The purpose of our study was to characterize IMP in patients with chronic AR with both normal LV and reduced LV ejection fractions.

Methods

Patients

This study was approved by the Wayne State University Human Investigation Committee. From 1994 to 1999, we reviewed the echocardiographic database of all the studies that were coded for isolated moderate or greater aortic regurgitation. Patients imaged during an acute illness (pneumonia, gastrointestinal bleeding, endocarditis, sepsis, etc) were excluded in order to avoid any influence on LV function. Consequently, we limited our evaluation to only outpatient imaging. From 1994-1999, approximately 5000 outpatient echocardiograms were performed (25% of all studies). Each study was reviewed for adequacy of echocardiographic images (for evaluation of wall motion and wall thickening and endocardial border detection for assessment of LV volumes). Each study was also evaluated for adequate transmitral and transaortic pulsed, continuous wave, and color flow Doppler. Patient records were reviewed to exclude patients with coronary artery disease (on the basis of history, electrocardiographic (ECG) evidence of Q waves > 30 msec in 2 consecutive ECG leads, or evidence of ischemic disease by stress test, myocardial perfusion, or cardiac catheterization). Patients with significant valvular regurgitation other than AR (greater than mild valvular regurgitation of another valve), any systolic gradient >10 mm Hg across the aortic or pulmonic valve, evidence of any degree of mitral or tricuspid stenosis, congenital heart disease, or non sinus rhythm were excluded.

We encountered the diagnosis of isolated moderate or greater aortic regurgitation (Doppler echocardiographic criteria: see below) in 98 patients. On further review of the echocardiogram and patient records, we excluded 24 patients for image quality, 5 patients for coexisting aortic stenosis, and akinetic segments in 9 patients. There were 60 patients that fulfilled the criteria. Forty had normal left ventricular ejection fraction (EF) defined as LV ejection fraction ≥50%. Twenty patients had a LV ejection fraction <50%. As comparison groups, from the same time period, we selected all echocardiograms deemed to be normal. We selected an age, sex, and date of study matched group consisting of 35 patients as a comparison for the 40 patients with AR and normal LV ejection fraction (AR+Normal EF) derived from the same 1994-1999 outpatient database. As a comparison group for aortic regurgitation with reduced LV ejection fraction (AR+Reduced EF), we reviewed all the studies with a LV ejection fraction <50% without evidence of valve disease other than mild regurgitation, without a gradient >10 mm Hg across the pulmonic or aortic valve, or any evidence of mitral or tricuspid stenosis, congenital heart disease, or non sinus rhythm. Patients with a remote history of ischemic etiology of LV dysfunction were included as long as their reason for their present evaluation was not ischemic symptoms. We selected an age, sex, and date of study matched group resulting in 26 patients fulfilling the criteria from 1994-1999 outpatient database.

For each patient included, we reviewed patient records and echocardiographic records to determine the presence of hypertension, diabetes, and medication history, which was recorded into a database. Hypertension was defined as a systolic blood pressure ≥140 mm Hg, diastolic blood pressure ≥90 mm Hg, or hypertension treatment. The blood pressure obtained at the time of the echocardiographic study was recorded or if not available, an outpatient blood pressure within 1 month of the study. Diabetes was defined as a fasting blood glucose >125 mg% or diabetes medication or diet treatment.

Echocardiographic Measurements

Echocardiographic images of the left and right ventricles, left and right atria and heart valves were obtained using a Hewlett-Packard Sonos 2500 (Hewlett Packard, Andover, MA), echocardiograph from multiple parasternal, apical and subcostal views of the heart. Transmitral flow was obtained using an apical four-chamber view with the sample volume at the tips of the mitral leaflets. Transaortic flow was measured from a sample volume in the LV outflow tract just below the aortic valve in the apical three chamber view. Pulsed and continuous wave Doppler and color flow imaging was acquired from all valves to assess regurgitation and presence of a gradient across each of the valves. The degree of aortic regurgitation was determined from the ratio of the color jet height to the LV outflow tract diameter in diastole. A ratio ≥ 25% was required for a diagnosis of moderate and ≥ 65% for severe aortic regurgitation (12).

Parameters Measured

All of the parameters measured were the average of 3 determinations from consecutive cardiac cycles. The following parameters were obtained using the American Society of Echocardiography standards of measurement for posterior wall dimension, septal wall dimension, end-diastolic dimension, and end-systolic dimension. Left ventricular end-diastolic and end-systolic volumes were obtained from 2 orthogonal apical views using the modified Simpson's rule. Left ventricular ejection fraction was calculated as the difference between end-diastolic and end systolic volume divided by end-diastolic volume (13).

Using transmitral pulsed Doppler, the following indices were obtained: peak rapid filling velocity, peak atrial filling velocity, and their ratio. The rapid deceleration time defined as the time interval from the peak rapid filling velocity to the time the descending segment of the peak rapid filling velocity spectrum crossed the zero baseline (using linear interpolation) was obtained. Transaortic Doppler was used to obtain LVET, which was measured from the onset to the end of the aortic velocity spectrum. The IRT was calculated as the interval from the R wave to the onset of transmitral filling spectrum minus the interval from the R wave to the end of transaortic velocity spectrum (1,2).

The IMP (3) was calculated by the following formula:

IMP=a-b/b

where a= time interval between the end of transmitral velocity spectrum of 1 cardiac cycle to the onset of transmitral mitral velocity spectrum of the next cardiac cycle; and b=LVET.

The ICT was determined by subtracting LVET and IRT from "a". Isovolumic contraction time, IRT, and LVET were divided by the square root of the RR interval to normalize for heart rate and expressed as the respective index (1-3). Index of myocardial performance and IRT calculations involved non-simultaneous measurements of transaortic and transmitral spectral tracings. These spectral tracings are acquired within 1-2 minutes routinely. Heart rate was within 3 beats/minute.

Statistics

Categorical variable were compared using Chi Square or Fisher Exact test depending on cell size. All continuous data were expressed as mean ± SD. Differences between a variable among stages were assessed using a 1 way analysis of variance. If the F statistic indicated a significant difference existed (P<0.05), then Turkey's test was used to determine where the significant differences existed. A P value <0.05 was considered to be significant. The relationship between variables was determined using least squares linear regression. Forward stepwise multiple linear regression was used to determine the predictors of IMP using all variables with a linear correlation with a P value<0.1.

Results

Table 1 summarizes patient characteristics in the 4 groups. The distribution of New York Heart Association functional class was similar between LV dysfunction and the AR+Reduced EF groups. Both groups had more patients who were functional class II than the normal group. The AR+Normal EF had significantly more patients as functional class II than the normal group. Hypertension (and the use of calcium channel blockers and diuretics) was more common among AR+Normal EF patients than normals. Systolic blood pressures were higher among both AR groups and LVD groups as compared to normals. Both hypertension and diabetes were more common among LV dysfunction patients than AR+Reduced EF patients. Consequently, angiotensin converting enzyme inhibitors, beta blockers, and diuretics were more commonly used with LV dysfunction patients. Two patients in the normal group were using beta blockers for arrhythmias. The etiology and severity of AR was similar in both AR groups.

Parameters of LV size, LV function, and transmitral Doppler are summarized in Table 2. Posterior wall thickness was greater in both groups of AR patients as compared to normals and patients with LVD. As expected, the end diastolic dimension and LV volumes were greater in both AR groups and the LVD group as compared to normals. Patients with AR+Reduced EF had larger LV sizes and volumes as compared to AR+Normal EF patients. Peak rapid filling velocity, E/A, and deceleration time were significantly reduced in the AR+Normal EF group as compared to normals. When compared to the LVD group, E/A was reduced in the AR+Reduced EF group. The cardiac cycle length (RR) was significantly shortened in the LVD and AR+Reduced EF groups as compared to normals and the AR+Normal EF group. The diastolic filling period was shorter in the LVD group as compared to normals and longer in the AR+Normal EF group as compared to AR+Reduced EF possibly reflecting heart rate differences. Patients with AR+Reduced EF demonstrated later ending of aortic flow and an earlier onset of mitral flow as compared to patients

Table 1. Patient Characteristics

Parameters	Normals	AR+Normal EF	AR+Reduced EF	LVD
Age, years	50.6±5.1	51.6± 7.2	53.2±6.5	51.7±8.6
Males/Females, n	20/15	22/18	11/9	15/11
NYHA Class, n				
I	35	27	7	13
II	0	13**	9	10
III	0	0	4	3
IV	0	0	0	0
Etiology of AR, n				
Bicuspid	-	4	4	-
Sclerosis	-	34	15	-
Prolapse	-	2	1	-
Severity of AR, n				
Moderate	-	23	9	-
Severe	-	17	11	-
Hypertension, n	0	8*	6*	12***^
Diabetes, n	0	5	4	9***^
Systolic BP, mm Hg	113±11	136±19**	141±20**	135±18**
Diastolic BP, mm Hg	68±12	74±14	78±18*	76±11*
ACEI, n	0	5	4	21***^^^
Beta blockers, n	2	3	2	8*
CCB's, n	0	6*	3	6*
Diuretics, n	0	6*	5*	19***^^
Digoxin, n	0	0	4	6*

*p<0.05, **p<0.01, ***p<0.001 vs Normal. ^=p<0.05, ^^p<0.01, ^^^p<0.001 vs AR+ Reduced EF

ACEI- angiotensin converting enzyme inhibitor, AR- aortic regurgitation, AR+Normal EF- aortic regurgitation with ejection fraction >50%, AR+Reduced EF- aortic regurgitation with reduced ejection fraction; systolic dysfunction, BP- blood pressure, CCB's- calcium channel blockers, LVD- left ventricular dysfunction, NYHA- New York Heart Association in the LVD group. Mitral valve opening was delayed in the AR+Normal EF group as compared to normals and the group with AR+Reduced EF. Similarly mitral valve opening was delayed in the LVD group as compared to normals.

Table 3 summarizes IMP and its components as heart rate adjusted indices. All the components of IMP were expressed as heart rate adjusted indexes. The ICT was prolonged in the LVD group as compared to normals and the AR+Reduced EF group. The IRT was prolonged in the AR+Normal EF group as compared to normals. The IRT was also prolonged in the LVD group as compared to AR+Reduced EF due to aortic flow ending later and mitral flow beginning earlier in the AR+Reduced EF group. Both AR groups demonstrated prolonged LVET's as compared to normals. The LVET in the LVD group was shorter than in normals and in both AR groups ($p<0.001$). As a consequence, IMP (Fig. 1) was similar to normals in the AR+Normal EF group primarily due to prolongation of both IRT and LVET. However, IMP in the AR+Reduced EF was markedly lower than the LVD group due to a longer LVET and a shorter IRT and ICT despite similar LV ejection fractions. The IMP in the LVD group was increased as compared to normals as expected.

Using forward stepwise multiple linear regression, in patients with normal LV systolic function, IMP could be predicted ($r=0.7612$, $p<0.0001$) from age ($r=0.616$, $p=0.0007$) and the diastolic filling period ($r= 0.471$, $p=0.0091$). The IMP could be predicted ($r=0.6415$, $p<0.001$) in patients with LVD from age ($r=0.489$, $p=0.0091$) and LV ejection fraction ($r=0.386$, $p=0.0412$). In patients with AR+Normal EF, IMP could be predicted ($r=0.6655$, $p<0.001$) from deceleration time ($r=0.418$, $p=0.005$) and ejection fraction ($r= 0.397$, $p=0.019$). In patients with AR+Reduced EF, IMP could be predicted ($r=0.7728$, $P<0.0001$) from end systolic volume ($r=0.450$, $p=0.0075$), E/A ($r=0.423$, $p=0.0086$), and LV ejection fraction ($r=0.368$, $p=0.0429$).

Discussion

The IMP has been used in the past as a prognostic indicator in patients with cardiomyopathy, congestive heart failure and following a myocardial infarction (1-2). However, IMP has been demonstrated to be preload, afterload, and contractility dependent in human and experimental studies (5,6,14). Chronic AR is both a volume and a pressure overload lesion as end systolic stress tends to be increased (15). We hypothesized that AR as a volume overload lesion would prolong LVET (8-10) and possibly

Table 2. Parameters of LV size, LV function, and transmitral Doppler

Parameters	Normals	AR+Normal EF	AR+Reduced EF	LVD
PWT, mm	8.3±1.5	11.2±3.9***	11.7±2.6*	9.2±1.5^^
EDD, mm	46.4±4.1	53.7±8.4*^	61.7±9.1**	63.5±10.2**
FS, %	39.6±6.3	39.2±7.2^^	26.1±3.1**	25.7±4.4***
EDV, ml	112±21	169±50**^	219±82***	229±81***
ESV, ml	38±14	55±31*^^^	111±29*	119±48***
EF, %	66±7	62.9±8.4^^	45±9***	42±10***
E, cm/s	83±17	68±19*	73±26	81±29
A, cm/s	61±10	69±18	73±26	64±22
E/A	1.4±0.3	1.1±0.4*	1.1±0.6	1.6±1.2^
DFP, msec	462±126	471±141^	368±184	382±118*
DCT, msec	224±52	398±199***	384±204**	235±82^^
R-AVC, msec	375±35	399±29	389±36	372±31^
R-MVO, msec	433±30	468±39*^	435±44	468±39^
RR, msec	882±157	870±163^	779±134*	759±109*

*p<0.05, **p<0.01, ***p<0.001 vs Normal. ^=p<0.05, ^^p<0.01, ^^^p<0.001 vs AR+Reduced EF

A- atrial filling velocity, AR- aortic regurgitation, AR+Normal EF- aortic regurgitation with ejection fraction >50%, AR+Reduced EF- aortic regurgitation with reduced ejection fraction, systolic dysfunction, DCT- deceleration time, DFP- diastolic filling period, E- peak filling velocity, EDD- end-diastolic dimension, EDV- end-diastolic volume, EF- ejection fraction ESV- end-systolic volume, ,FS- fractional shortening, LVD- left ventricular dysfunction, PWT- posterior wall thickness, R-AVC- R wave to end of aortic flow interval, R-MVO- R wave to onset of mitral flow interval, RR- cycle length

Table 3. Components of the Index of Myocardial Performance

Parameters	Normals	AR+Normal EF	AR+Reduced EF	LVD
ICT index, msec	48±23	45±21	58±33	87±27***^
IRT index, msec	59±34	70±32^	52±31	71±33^
LVET index, msec	301±29	344±43**	325±45*	269±50**^^^
IMP	0.357±0.122	0.342±0.188	0.346±0.172	0.604±0.278***^^^

*p<0.05, **p<0.01, ***p<0.001 compared to Normals. ^p<0.05, ^^p<0.01, ^^^p<0.001 compared to AR+Reduced EF

AR- aortic regurgitation, AR+Normal EF- aortic regurgitation with ejection fraction >50%, AR+Reduced EF- aortic regurgitation with reduced ejection fraction, systolic dysfunction, LVET- left ventricular ejection time, ICT- isovolumic contraction time, IMP- index of myocardial performance, IRT- isovolumic relaxation time reduce IMP. However, patients with AR also tend to have IRT prolongation (7), which may increase the IMP. The effect of a prolonged LVET and IRT may influence IMP and limit its prognostic value in AR patients. In this study we compared patients with chronic AR and normal LV ejection fraction with age, and sex matched normals. Furthermore, patients with AR+Reduced EF were compared to age and sex matched patients in the LVD group.

We demonstrated that AR+Normal EF patients had a prolonged LVET and IRT resulting in an IMP that did not differ from the normal group. In AR+Reduced EF patients, IMP was significantly lower than in LVD patients primarily due to increased LVET (56 msec longer) and smaller sum of IRT and ICT (58 msec shorter). The increased volume load in AR clearly influenced the IMP by prolonging the LVET. The pressure overload aspect does not appear to be operative, as LVET would be expected to be shorter while ICT and IRT would be longer (6). In patients with AR+Reduced EF, IRT and ICT were similar to normals but shorter than patients with LVD. The IRT was also shorter than in patients with AR+Normal EF. We believe the shortening of IRT in AR+Reduced EF was due to a delay in the end of aortic flow and earlier onset of mitral flow. This might suggest greater elevation of LV filling pressure in the AR+Reduced EF group, but only 4 of 20 patients were functional Class 3 and hemodynamics were not obtained. The ICT can be defined as the time interval from the end of mitral flow to the onset of aortic flow. The ICT shortening in the AR+Reduced EF group was due to an earlier onset of aortic flow as the time to end of aortic flow occurred 17 msec later in the AR+Reduced EF group and LVET was 60 msec longer (nonindexed values). The result would be that the onset of aortic flow occurred 43 msec earlier explaining a large percentage of 29 msec lower ICT index. The finding of an increased IMP in the LVD group may also be in part to the higher incidence of hypertension, coronary disease and diabetes (16,17).

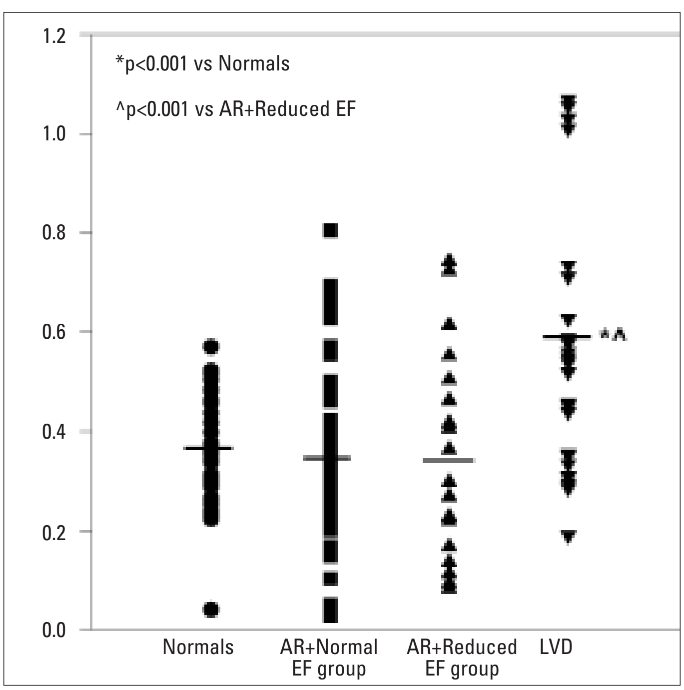

Figure 1. The distribution of Index of Myocardial Performance is demonstrated for each of the groups studied.

AR - aortic regurgitation, EF- ejection fraction, LVD- left ventricular dysfunction

As compared to the AR+Normal EF group, patients with AR+Reduced EF had faster heart rates, shorter diastolic filling periods and started mitral filling earlier resulting in a shorter IRT than patients with AR+Normal EF. Forward stepwise regression revealed that IMP could be predicted from ejection fraction in both AR groups and in the LVD group. Diastolic filling parameters (deceleration time and E/A) in the AR groups suggesting impaired relaxation were also independent predictors of IMP.

Previous Literature

There has been limited work on the influence of AR on IMP. A recent work described IMP in patients prior to and following cardiac surgery for AR (7). Their data differed considerably from the data in our patient group. They demonstrated increases in ICT and IRT and shortening of the LVET. These findings are more consistent with pressure loading with LV dysfunction or cardiomyopathy (1,6) or end stage AR where preload reserve has been exhausted and afterload excess is evident (18, 19). One might suspect that these patients were referred for surgery for congestive heart failure and/or LV dysfunction. Although the estimate of systolic function in their study (fractional shortening) was similar to the estimate of systolic function (ejection fraction) in the AR+Reduced EF group, our values for ICT and IRT were shorter with the LVET being longer. Furthermore, only 4 of 20 patients in our study were functional class III.

Previous data in the literature has noted that the LVET is prolonged in AR, which may have the effect of reducing IMP (8-10). However, previous literature including Haque's study (7) did not stratify patients based on LV systolic function. Our study differs in that we included patients with normal and reduced LV ejection fraction. Other lesions producing LV volume overload may affect IMP and its components differently. With chronic mitral regurgitation, LVET is shorter which may prolong the IMP. This is not surprising, as severe mitral regurgitation has been noted to shorten LVET (7,10,11).

The effect of volume loading on IMP has been demonstrated in canines with and without LV dysfunction and in humans in the operating room. The LVET increased with volume loading (5,20) in both human and experimental studies. However, other studies have not demonstrated preload dependence, but compared patients groups and related IMP to LV size (3).

Limitations

The study has a retrospective design. Consequently, we did not have a consecutive series of patients enrolled since some echocardiograms were not technically adequate. Of importance, the LVD and AR+Reduced EF groups were matched for age, sex, and LV ejection fractions. However, the incidence of coronary disease, hypertension, and diabetes mellitus was significantly higher in the LVD group, which may increase IMP. Consequently, patients in the LVD group had a higher incidence in the use of angiotensin converting enzyme inhibitors and diuretics, which may have an uncertain influence on IMP and its components. Also, patient numbers were small in the AR+Reduced EF group. Second, dichotomization of AR patients based on heart failure symptoms or based on LV ejection fraction is problematic. Symptoms of congestive heart failure may occur with preserved or reduced LV ejection fractions. In fact, the average LV ejection fraction in patients with heart failure and AR were noted to be 45-50% (21,22). We chose an LV ejection fraction of <50% to dichotomize the AR groups purely for comparison with a matched groups of patients with LVD. Although the LV ejection fractions are comparable, the degree of LV systolic dysfunction may not be similar due differing preload and afterload states. Finally, as this was a retrospective study, follow-up was difficult and not evaluated because many patients changed their health care provider.

Clinical Implications

The IMP is most useful as a predictive index when ICT and IRT increase and LVET decrease as in patients post myocardial infarction and with dilated cardiomyopathy (1,2). However, IMP is difficult to interpret in volume overload states as AR with LVET prolongation. In patients with volume overload lesions or patients who experience changes in loading conditions, 1 or more components of IMP may be impacted resulting in an index that may not reflect global cardiac functioning.

Conclusions

Index of myocardial performance had similar values in patients with AR+Normal EF as compared to normal individuals due to an increase in both IRT and LVET. However, in patients with AR+Reduced EF, IMP values were similar to normal patients due primarily to prolongation of LVET. In patients with AR+Reduced EF, IMP values were significantly lower than LVD patients matched for LV ejection fraction due to prolongation of LVET and shortening of the IRT and ICT.

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