ORIGINAL REPORT

Correlation between Anterior Mitral Leaflet Concavity Area and Ischemic Induced Mitral Regurgitation Severity by Echocardiography

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Abstract- Functional mitral regurgitation (MR) results from left ventricular remodeling, leaflet tethering or tenting. Coronary artery disease is one of the important causes of functional MR due to tethering. Detection of functional MR and its severity are important factors in patient prognosis. There are different methods for detection of functional MR and its severity, including anterior mitral leaflet concavity area (AMLCA). In this cross sectional study 32 patients, 19 male with three vessel disease (3VD) who were candidate for coronary artery bypass grafting (CABG) with or without mitral valve replacement were selected. The patients had functional MR in ventriculography. AMLCA was determined by long axis view of transthorasic echocardiography (TTE). In this study 32 patients with 3VD and MR were selected (15 mild, 15 moderate and 2 cases with severe MR). The mean age was 62 ± 12 years. In these patients AMLCA were 0.1- 0.43 cm^2 in transthorasic echocardiography. The findings of this study showed strong association between anterior mitral leaflet concavity area and functional MR severity (r=0.89) in parasternal long axis (LAX) view of TTE. According to these findings the relation between functional MR and AMLCA was a linear relationship and increase in severity of functional MR was in concordance with increasing of anterior mitral leaflet concavity area (*P*=0.001). Mitral leaflet concavity area in the parasternal LAX view provides rapid and reliable recognition of functional MR due to coronary artery disease and is quantitatively related to the degree of such MR. We recommend further study with more subjects and ischemic functional MR and AMLCA.

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Introduction

Ischemic heart disease (IHD) and the resultant mitral regurgitation (MR) has been a major concern during the recent years. These mentioned entities constitute one of the leading causes of death (1). At the current time the best tool for recognizing of MR is echocardiography (2). Current methods of MR severity evaluation are not efficacious in some instances. For example in cases where the direction of regurgitant flow is toward the left atrial wall, appropriate and rapid determination of the severity of MR is troublesome. Delayed or inappropriate diagnosis may result in failure of medical or surgical measures (2, 3). Anterior mitral leaflet concavity area (AMLCA) which results from ventricular wall tethering may be a useful measure in determining the severity of MR (4). This approach has not been conclusive yet and few researches are performed on this field and also in our country there is no research on this topic by this time. Previous research on this topic had apparent limitations. In order to determine the relationship between AMLCA and the severity of MR with two-dimensional echocardiography, this research was performed on candidates of coronary artery bypass grafting (CABG) with or without mitral valve replacement (MVR) in cardiac center of Taleghani Hospital, Tehran, Iran.

Materials and Methods

A cross-sectional research was designed as descriptive method for correlation. 32 patients 19 male with definite diagnosis of ischemic MR who were candidate for CABG were included.

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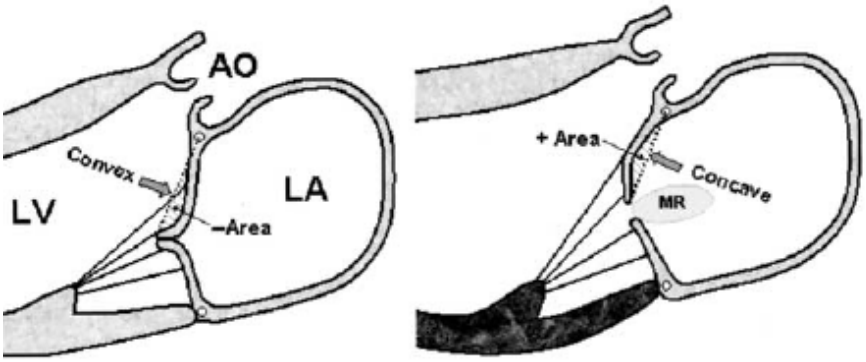

Figure 1. Leaflet configuration in long-axis view. Tethering of mitral valve leaflets is expressed by concave leaflet configuration toward left atrium and by positive area bounded by anterior leaflet and line connecting its insertion and coaptation point

The requirement for CABG was defined according to current guidelines (5).

Patients were included after clear explanation of the procedure and written consent. Patients were categorized according to age, sex and the severity of MR. Severity of the MR, according to the current guidelines(5), was determined by ventriculography in the catheterization laboratory using a Zimens unit. All patients underwent transthoracic echocardiography (TTE) using a ViViD 3 unit and AMLCA was determined according to the figure 1. Surface area were measured in centimeter square. Concavity area (CA) percentiles and the best cut of point of the CA was determined using the Roc Curve statistical analysis. Thereafter sensitivity of the CA in diagnosing of severity of the ischemic induced MR was defined. Relationship between ischemic MR and AMLCA was determined with Spearman correlation coefficient. Finally the correlation degree and P values were calculated.

Results

This study was performed on 32 patients with ischemic MR. Patient's mean age was 62+/- 10 years, ranging from 45 to 80 years. 19 patients (59.4%) were male and 13 patients (40.6%) were female. In male patients, 37% had mild MR and 63% had moderate to severe MR. 61.5% of female patients had mild MR versus 38.5% who had moderate to severe MR. The incidence of moderate to severe MR in male patients were 2.7 times of their female counterparts. MR severity was mild in 15 patients (46.9%), moderate in 15 patients (46.9%) and severe in 2 patients (6.2%). Patient distribution according to ischemic MR severity in percentile and AMLCA is summarized in table 1. In patients with mild MR, 5-50 percentile of the AMLCA was 0.1 to 0.26 cm^2. Patients with moderate MR, 50-95 percentile of the AMLCA was 0.26-0.43 cm^2 and finally patients with severe MR, 95 percentile and more of the AMLCA was 0.43 cm^2 or more. Correlation degree of the AMLCA and severity of the ischemic MR was 0.89 which was statistically significant ($P< 0.001$ and r=0.89). There is a linear equation between the AMLCA and the severity of the MR, the formula is FMR= 0.158 + (6.028*CA).

According to the Roc Curve analysis it was determined that if the cut point is more than 0.1 cm^2, the patient has ischemic MR and sensitivity is 88%.

Table 1. Persentile and relation between AMLCA with severity of ischemic MR

AMLCA / MR severity	Percentile	Centimeter square
Mild (N=15)	5-50	0.1- 0.26
Moderate (N=15)	50-95	0.26-0.43
Severe (N=2)	95 and more	0/43 and more

Discussion

The research showed that use of AMLCA for determination of the MR severity due to ischemia has a good correlation with MR severity and this approach has an appropriate sensitivity. Kenneth and colleagues in their research mentioned that MR is usually silent in early myocardial infarction and is more common in anterior wall infarction. This ischemic MR is accompanied by regional wall motion abnormality and has vast importance in determining cardiovascular mortality (6). It seems this is a valuable finding and has been used. Trichon *et al.* evaluated the relation of frequency and severity of mitral regurgitation to survival among patients with left ventricular systolic dysfunction and heart failure. They showed that diagnosis of MR in ischemic heart disease patients and also nonischemic patients is very important, and also insisted on the cause of MR and recommended measuring it (7). It seems that method is a good recommendation. Grigioni *et al.* in the article "ischemic mitral regurgitation, long term outcome and prognostic implications with quantitative doppler assessment" found that in the long term follow up of myocardial infarction patients, existence of MR is an independent risk factor of mortality (apart from severity of heart failure). Consequently measurement of MR is an important issue in clinical decision making of post MI patients for both therapeutic measures and risk stratification (8). Nesta *et al.* in their research "leaflet concavity: a rapid visual clue to the presence and mechanism of functional mitral regurgitation" which evaluates leaflet concavity as a fast method of determining functional MR, conclude that MR repair is dependent on the understanding of its primary cause. They also insist that the preferred method of functional MR evaluation is controversial. Ischemic mitral leaflet concavity (IMLC) area is a method of determining severity of MR which its method of measurement is not universally accepted but AMLCA in the long axis view of the heart can reliably and rapidly recognize the functional MR. Leaflet disfiguration is due to tethering through the intermediate chords. Measurement of AMLCA could have an important role in clinical decision (4). We believe that it is a good recommendation and it was our theoric basis.

Otsuji *et al.* in their article "Restricted diastolic opening of the mitral leaflets in patients with left ventricular dysfunction: evidence for increased valve tethering" found that patients who have ischemic induced left ventricular systolic dysfunction and IMLC also have diastolic limitation of mitral valve leaflet opening and this issue is independent of blood volume entering the ventricle. In other words due to tethering there is systolic impairment of valve closure and diastolic impairment of valve opening (9).

In the above-mentioned researches the importance of functional MR is clarified but as Nesta *et al.* mentions (4) method of evaluation of ischemic induced functional MR is controversial. They concluded that AMLCA in the long axis view can reliably recognize the functional MR but they did not give any method of determining the severity of MR using AMLCA. In this research we determined and measured the severity of MR in the long axis view using AMLCA. We found that there is simple linear correlation between the severity of MR and AMLCA. It seems that a linear equation between severity of MR and AMLCA was not reported in the literature. The negative measure of this research were first it was done in one center with limited number of samples second it was not double blind. Positive measures include independency of any third party institute and avoidance of any harm to the participants. Another positive measure was the use of Roc Curve analysis. A promising finding in this research is the introduction of a cut of point for determining ischemic MR severity which its use is recommended to all colleagues. This noninvasive tool would be determining or at least helpful in evaluation of ischemic MR severity. In our proposed equation by the use of 2 constant numbers and determination of CA, operator can define the MR severity. Finally it seems that AMLCA in the long axis view may be an appropriate method of determining severity of ischemic induced MR. In this research correlation between AMLCA and ischemic MR severity was strong ($r=0.89$, $P<0.001$) and a simple linear equation (FMR= 0.158+ (6.028* CA)) exists which was explained beforehand.

In conclusion it seems that AMLCA in long axis could be a promising tool in determining ischemic MR but due to mentioned limitations and increased frequency of ischemic heart disease and the resultant MR, further research to elaborate this issue is recommended.

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