Effects of Mitral Balloon Valvuloplasty on Left Ventricular Systolic Functions: Assessment with Color Tissue Doppler

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ABSTRACT

Objective: Left ventricular (LV) systolic functions are generally depressed in Mitral Stenosis (MS). Recovery of LV systolic functions demonstrated with 2D echocardiography in some patients by mitral balloon valvuloplasty (MBV). Systolic mitral annular velocity (S’) by Tissue Doppler Imaging (TDI) predicts LV systolic function. We aimed to evaluate early effects of MBV on LV systolic function by TDI.

Methods: Forty-eight consecutive patients included to the study (39 female, 36±10 years). A full transthoracic echocardiographic study (TTE) including left ventricular ejection fraction assessment by teicholz method and mitral annular color TDI assessment was performed 24 hours before and after MBV in all patients. MBV performed by İnoue technique under guidance of TTE. Analysis of mitral lateral annular S’ wave velocity was performed immediately after echocardiographic examination.

Results: MBV performed successfully in 43 patients (Group A), and severe mitral regurgitation developed in 5 patients (Group B). Mitral valve area, and S’ wave velocity increased, mean and maximum mitral gradient, and left atrial diameter, and systolic pulmonary artery pressure (PAP) were reduced significantly by MBV in group A patients (p<0.01, <0.046, <0.01, <0.01, <0.01, <0.01, respectively). But, only mitral valve area increased significantly in group B patients (p<0.01). LVEF by teicholz did not change significantly in both groups.

Conclusion: Improvements of LV systolic functions after successful MBV can easily showed by color TDI where 2D echocardiography could not indicate.

Key Words: Mitral stenosis, mitral balloon valvuloplasty, left ventricular function, tissue Doppler Imaging

ÖZET

Mitral Balon Valvuloplastinin Sol Ventrikül Sistolik Fonksiyonları Üzerine Etkisinin Renkli Doku Doppler ile Değerlendirilmesi


Metod: Ardışık 48 hasta (39 kadın, 36±10 yıl) çalışmaya alınmıştır. Tüm hastalara işlemden önceki 24 saat içinde teicholz yöntemile SV ejeksiyon fraksiyonu (EF) ve renkli DD ile elde edilen mitral lateral anulus S’ dalga hız ölçümünün dahil olduğu transtorasik ekokardiografik (TTE) inceleme yapıldı. MBV İnoue tekniği ile TTE kılavuzunda yapıldı. TTE MBV’den 24 saat sonra tekrarlandığı. Veriler paired sample t-test ile değerlendirildi.

Bulgular: MBV 43 hastada başarılı (A grubu) olurken, 5 hastada ieri mitral yetersizliği (B grubu) gelişti. Her iki grupta hastaların kapak alanları anlamlı olarak arttı. A grubu hastaların ortalaması ve maksimum mitral gradyentleri, sol atriyum çapi, sistolik pulmoner arter basıncı azalırken, mitral kapak alanı ve mitral anuler S’ dalga hızları anlamlı olarak arttı (p<0.01, <0.01, <0.01, <0.01, <0.01, <0.01, sırasıyla). B grubu hastalarda ise kapak alanı artışına karşı hıçbir değişik kende anlamlı değişiklik olmadığı, her iki grubun EF’lerinde de anlamlı değişiklik olmadığı, sonucu: Başarılı MBV ile SV fonksiyonlarında düzelmenin olduğu, konvansiyonel yöntemlerle belirgin olarak tespit edilememesi, ancak aynı düzneli ieri MY gelişen grupa izlenmemisti. Anahtar Kelimeler: Mitral darlığı, mitral balon valvuloplasti, sol ventrikül fonksiyonu, doku doppler görüntüleme
INTRODUCTION

Left ventricular systolic function is frequently deteriorated in mitral stenosis (1-3). On pathogenesis of mitral stenosis have been reported following causes; chronic preload insufficiency (2,4) afterload mismatch, (1,2) depressed contractility (2,3,5) and altered left ventricular geometry consequent upon right ventricular pressure overload.(6) Some investigators have reported conflicting data on the left ventricular load and ejection function following mitral valvuloplasty (7-9) is controversial.

Tissue Doppler Imaging (TDI) is a new and powerful method in evaluation of both regional and global systolic or diastolic ventricular function. Although the effect of percutaneous mitral balloon valvuloplasty (MBV) on left ventricular systolic function has been shown by two-dimensional echocardiography and biplane cineangiography, TDI has not been previously studied. In the present study, we evaluated early effects of MBV on left ventricular systolic function by color-coded TDI.

MATERIALS AND METHODS

Patients

Forty-eight consecutive patients included to the study (39 female, 36±10 years) in our institution. Inclusion criteria for balloon mitral valvuloplasty were mitral valve area ≤1.5 cm² (moderate to severe) and New York Heart Association functional class ≥II. These criteria were determined according to recommendations of recent guidelines published jointly by the American Heart Association and the American College of Cardiology(10) and in guidelines published by the European Society of Cardiology.(11) Exclusivity criteria were atrial fibrillation, mixed valvular disease, coronary artery disease, left atrial thrombus, mitral regurgitation (grade 2 or more) before PBMV. The study protocol was approved by the local ethics committee, and informed consent was obtained from all participants.

Echocardiographic methods

A full transthoracic echocardiographic study (TTE) including left ventricular ejection fraction assessment by teicholz method and color TDI assessment was performed 24 hours before and after MBV in all patients. The study patients underwent full echocardiographic examination including quantitative 2D color TDI using commercially available equipment (Vivid 7, GE Vingmed, Horten, Norway) equipped with 2.5-MHz phased-array transducers. The measurements were carried out and interpreted according to recommendations of the American Society of Echocardiography.(12,13) Color-coded tissue Doppler images were acquired over a predetermined two consecutive cardiac cycles from the apical four-chamber and were transferred to a workstation composed of a personal computer whose software package provides customized image visualization, processing, and analysis (Echopac, GE-Vingmed, Norway). The sample volume was placed at the junction of the LV wall with the mitral annulus of the lateral myocardial segments from the apical four-chamber. Peak velocities during systole (S’), early diastole (E’), and late diastole (A’) were measured (Figure 1). The final value represented the average of four sites.

Balloon mitral valvuloplasty

The valvuloplasty was performed with the Inoue monoballoon technique.(14) The success was defined as a decrease in mitral valve gradient >50% and an increase in MVA >0.5 cm² after MBV.

Statistical methods

Data are expressed as mean ± standard deviation. Using an SPSS package 11.0 (SPSS Inc., Chicago, Illinois, USA) the changes in parameters before and after mitral valvuloplasty were compared with paired t-tests. A p value of <0.05 was considered significant.

RESULTS

MBV performed successfully in 43 patients (Group A), and severe mitral regurgitation developed in 5 patients (Group B). Mitral valve area and S’ wave velocity increased, (Figure 2) however, mean and maximum mitral gradient, and left atrial diameter and systolic pulmonary artery pressure (PAP) were reduced significantly by MBV in group A patients (p<0.01, =0.046, <0.01, <0.01, <0.01, <0.01, respectively).
But, only mitral valve area increased significantly in group B patients \( (p<0.01) \). LV EF by teicholz did not change significantly in both groups (Table 1).

**DISCUSSION**

Left ventricular systolic function depends on preload, afterload, intrinsic contractility and right ventricular pressure dynamics.\(^{(15)}\) Contribution of altered loading conditions to depressed systolic function observed in some of patients with mitral stenosis is controversial. Left ventricular contractile function has been found normal\(^{(2,9)}\) or depressed\(^{(1,5)}\)

The main finding of this study is that LV regional systolic function was improved after successfull MBV. Previous studies have shown no change in ejection fraction\(^{(6,8,9,16)}\) except in two.\(^{(7,17)}\) We also demonstrated that LV EF did not change significantly after MBV. Mohan et al.\(^{(17)}\) suggested that improvement in ejection performance following valvuloplasty was not correlated to alteration in loading conditions. However, Pamir et al.\(^{(16)}\) also showed that LVEF does not change acutely after PBMV.

TDI has substantial spatial and temporal resolution. When evaluating global performance, the annular systolic velocity has shown a good correlation with the left ventricular ejection fraction. Several investigators have demonstrated that TDI is a more sensitive indicator than standard echocardiography parameters in detection of systolic dysfunction in cases with preserved EF.\(^{(18,19)}\) We also showed that systolic velocity is increased in lateral mitral annulus with TDI after MBV immediately, although left ventricle global ejection fraction did not change. The possible explanation why this increase was not observed in group B is persistence of increased left ventricular end diastolic pressure due to mitral regurgitation. In addition to improved LV systolic velocity, we suggested that systolic pulmonary pressure and left atrial diameters are decreased in patients with successfull valvuloplasty other than in patients with severe mitral regurgitation after valvuloplasty. It is

| Table 1: Echocardiographic parameters of the patients before and after mitral balloon valvuloplasty |
|---------------------------------------------------|---------------------------------------------------|-------------------------------------------------|---------------------------------------------------|
| **Group A (43)** | **Group B (5)** | **Group A (Successful)** | **Group B (Failed)** |
| **Before MBV** | **After MBV** | **p value** | **Before MBV** | **After MBV** | **p value** |
| MVA planimetry (cm\(^{2}\)) | 1.12±0.25 | 1.86±0.24 | <0.01 | 1.06±0.14 | 1.85±0.23 | <0.01 |
| MVA-PHT (cm\(^{2}\)) | 1.09±0.21 | 1.89±0.31 | <0.01 | 1.07±0.13 | 1.86±0.21 | <0.01 |
| Maximum gradient (mmHg) | 20.63±6.24 | 10.19±2.5 | <0.01 | 21.09±6.5 | 19.6±12.14 | 0.562 |
| Mean gradient (mmHg) | 11.65±4.58 | 4.89±1.81 | <0.01 | 12.64±4.7 | 9.13±5.63 | 0.221 |
| Systolic PAP (mmHg) | 48.71±11.9 | 32.2±8.4 | <0.01 | 46.65±8.1 | 43.56±11.7 | 0.572 |
| Left Atrial diameter (cm) | 4.38±0.58 | 3.94±0.57 | <0.01 | 4.32±0.47 | 4.03±0.51 | 0.293 |
| LVEF (%) | 61.8±4.3 | 62.8±4.6 | 0.892 | 62.4±5.3 | 62.3±4.6 | 0.954 |
| Mitral annular S’ vel. (cm/sn) | 5.84±1.24 | 6.32±1.33 | 0.046 | 5.78±1.42 | 5.67±0.64 | 0.830 |

MBV, mitral balloon valvuloplasty; MVA, Mitral valve area; PHT, pressure half time; LVEF, Left ventricular ejection fraction; PAP, Pulmonary artery pressure.
possible that a change in right ventricular hemodynamics was responsible for this increased left atrial pressure as a result of mitral regurgitation. A limitation of our study is the small number of patients who developed severe mitral regurgitation. In conclusion, our study showed that TDI is more sensitive than conventional echocardiography in detecting improved systolic function in patients with PBMV.

REFERENCES