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

Mustafa Akcakoyun[1], Hekim Karapınar[1], Ozlem Esen[2], Ramazan Kargın[1], Selcuk Pala[1], Yunus Emıroglu[1], Zekeriya Kaya[1], Cihan Dundar[1], Akın Izgi Associate Prof.[1], Cevat Kirma Associate Prof[1], Ali Metin Esen Associate Prof[1]

[1]Kartal Kosuyolu Yuksek Ihtisas Heart-Education and Research Hospital, Department of Cardiology, Istanbul, Turkey
[2]İstanbul Memorial Hospital, Department of Cardiology, Istanbul, Turkey

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 successfull 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

Amaç: Sol ventrikül (SV) sistolik fonksiyonları mitral darlığı hastalarında genellikle bozulmuştur. Başarılı mitral balon valvuloplasti (MBV) ile SV sistolik fonksiyonlarının bazı hastalarda düzeldiği konvansiyonel yöntemlerle tespit edilmiştir. Doku doppler (DD) ile mitral anulusdan elde edilen sistolik dalga (S')'nın SV sistolik fonksiyonu ile oluştuğu ve hızının SV fonksiyonları ile korele olduğu gösterilmiştir. Bizde MBV ile SV sistolik fonksiyonlarındaki değişimi DD ile değerlendirmeyi amaçladık.

Metod: Ardışık 48 hasta (39 kadın, 36±10 yıl) çalışmaya alındı. Tüm hastalara işlemden önceki 24 saat içinde teicholz yöntemiyle SV ejeksiyon fraksiyonu (EF) ve renkli DD ile elde edilen mitral lateral anulusu S' dalga hızı ölçümünün dahil olduğu ayrıntılı transtorasik ekokardiyografik (TTE) inceleme yapıldı. MBV İnoue tekniği ile TTE kılavuzluğunda yapıldı. TTE MBV'den 24 saat sonra tekrarlandı. Veriler paired sample t-test ile değerlendirildi.

Bulgular: MBV 43 hastada başarılı (A grubu) olurken, 5 hastada ileri mitral yetersizliği (B grubu) gelişti. Her iki gruptaki hastaların kapak alanları anlamlı olarak arttı. A grubu hastaların ortalama ve maksimum mitral gradyentleri, sol atriyum çapı, 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, $=0.046$, sırasıyla). B grubu hastalarda ise kapak alanı artışı dışında hiçbir değişkende anlamlı değişiklik olmadı. Her iki grubun EF'lerinde de anlamlı değişiklik olmadı.

Sonuç: Başarılı MBV ile SV fonksiyonlarında düzelmenin olduğu, konvansiyonel yöntemlerle belirgin olarak tespit edilemese de, DD ile tespit edilebilmiştir. Ancak aynı düzelme ileri MY gelişen grupta izlenmemiştir.

Anahtar Kelimeler: Mitral darlığı, mitral balon valvuloplasti, sol ventrikül fonksiyonu, doku doppler görüntüleme

İletişim Adresi
Mustafa Akçakoyun, MD
Kartal Kosuyolu Yuksek Ihtisas Heart-Education and Research Hospital, Department of Cardiology, Istanbul, Turkey
Telefon: 90 505 770 5915 **Faks:** 90 216 459 4040 **e-posta:** makcakoyun@yahoo.com

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 cieangiography, 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.

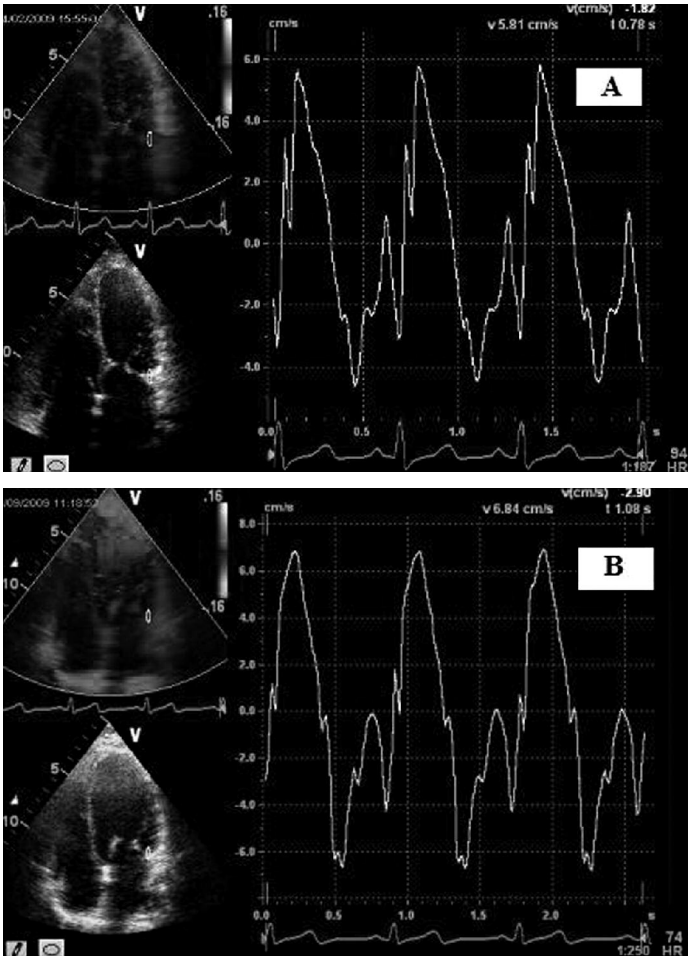

Figure 1: Lateral mitral annulus Color-coded tissue Doppler systolic velocities before (A) and after (B) percutaneous mitral balloon valvuloplasty

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, Illionis, 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).

Table 1: Echocardiographic parameters of the patients before and after mitral balloon valvuloplasty

	Group A (43)			Group B (5)		
	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

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 significanlty 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

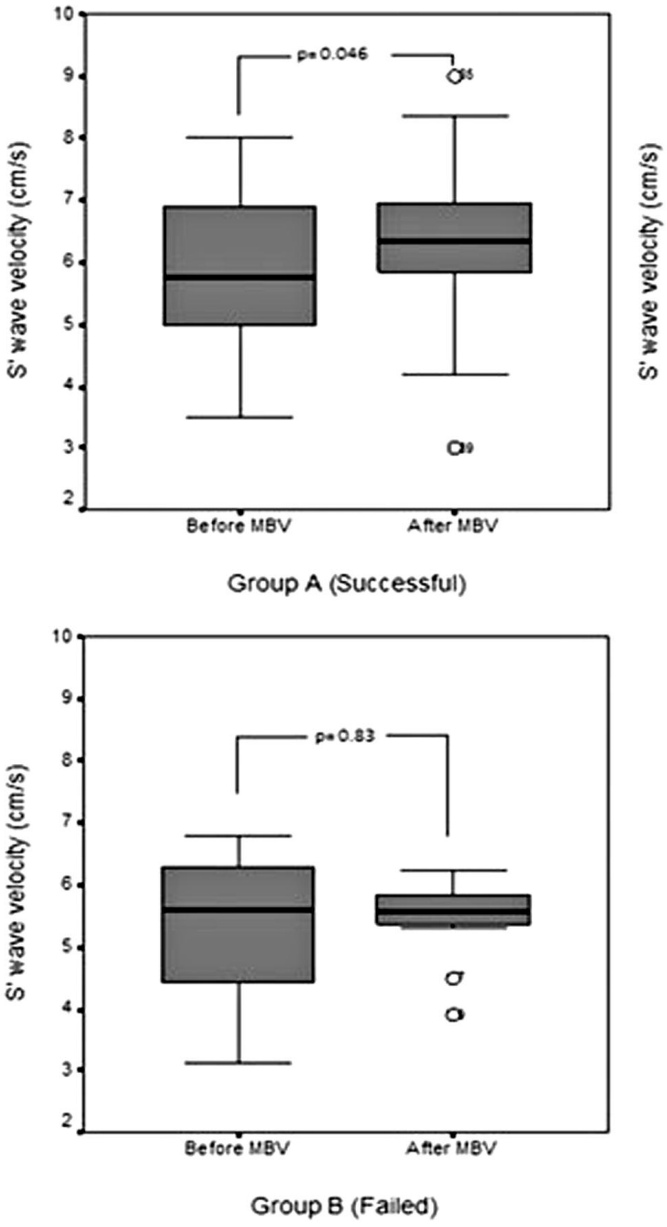

Figure 2: Comparison of left ventricular tissue Doppler systolic (S') velocities before and after percutaneous mitral balloon valvuloplasty in Group A (successfull) and Group B (Failed)

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 funciton in patients with PBMV.

REFERENCES

1. Mohan JC, Khalilullah M, Arora R. Left ventricular intrinsic contractility in pure rheumatic mitral stenosis. Am J Cardiol 1989; 64: 240-242.

2. Gash AK, Carabello BA, Cepin D, Spaan JF. Left ventricular ejection performance and systolic muscle function in patients with mitral stenosis. Circulation 1983; 67:148-154.

3. Heller SJ, Carleton RA. Abnormal left ventricular contraction in patients with mitral stenosis. Circulation 1970; 42: 1099-l 110.

4. Curry GC, Elliot EP, Ramsey HW. Quantitative left ventricular angiographic findings in mitral stenosis. Am J Cardiol 1972; 29: 621-627.

5. Bolen JL, Lopes MG, Harrison DC, Alderman EL. Analysis of left ventricular function in response to afterload change in patients with mitral stenosis. Circulation 1975; 52: 894-900.

6. Mohan JC, Nair M, Arora R. Left ventricular volumes and function immediately after balloon mitral valvuloplasty. Int J Cardiol 1991; 33: 275-280.

7. Goto S, Handa S, Akaishi M, Abe S, Ogawa S. Left vcntricular ejection performance in mitral stenosis and effects of successful percutaneous transvenous mitral commissurotomy. Am J Cardiol 1992; 69: 233-237.

8. Tischler MD, St John Sutton M, Bittl JA, Parker JD. Effects of percutaneous mitral valvuloplasty on left ventricular mass and volume. Am J Cardiol 1991; 68: 940-944.

9. Wisenbaugh T, Essop R, Middlemost S, Skoularigis J, Sareli P. Excessive vasoconstriction in rheumatic mitral stenosis with modestly reduced ejection fraction. J Am Col1 Cardiol 1992; 20: 1339-1344.

10. Bonow RO, Carabello BA, Kanu C, de Leon AC Jr, Faxon DP, Freed MD, et al. ACC/AHA 2006 guidelines for the management of patients with valvular heart disease: a report of the American College of Cardiology/American Heart Association Task Force on Practice Guidelines (writing committee to revise the 1998 Guidelines for the Management of Patients With Valvular Heart Disease): developed in collaboration with the Society of Cardiovascular Anesthesiologists. Circulation. 2006;114:e84–e231.

11. Vahanian A, Baumgartner H, Bax J, Butchart E, Dion R, Filippatos G, et al. Guidelines on the management of valvular heart disease: the Task Force on the Management of Valvular Heart Disease of the European Society of Cardiology. Eur Heart J. 2007;28:230 –268.

12. Sahn DJ, DeMaria A, Kisslo J, Weyman A. Recommendations regarding quantitation in M-mode echocardiography: results of a survey of echocardiographic measurements. Circulation. 1978; 58: 1072–1083.

13. Henry WL, DeMaria A, Gramiak R, King DL, Kisslo JA, Popp RL, et al. Report of the American Society of Echocardiography Committee on nomenclature and standards in two-dimensional echocardiography. Circulation. 1980; 62: 212–217.

14. Inoue K. Percutaneous transvenous mitral commissurotomy using the Inoue balloon. Eur Heart J. 1991;12(suppl B):99 –108.

15. Iwanaga S, Handa S, Abe S, Nakamura Y, Kunieda E, Ogawa K, et al. Left ventricular function in right ventricular overload asymmetry of the left ventricular ejection. Am J Cardiol 1989; 19: 487-498.

16. Pamir G, Ertaş F, Oral D, Gümüş H, Omürlü K, Karaoguz R. Left ventricular filling and ejection fraction after successful percutaneous balloon mitral valvuloplasty. Int J Cardiol. 1997 May 23;59(3):243-6.

17. Mohan JC, Bhargava M, Agrawal R, Arora R. Effects of balloon mitral valvuloplasty on left ventricular muscle function. Int J Cardiol. 1995 Mar 24;49(1):17-24.

18. Chetboul V, Escriou C, Tessier D, Richard V, Pouchelon JL, Thibault H, et al. Tissue Doppler imaging detects early asymptomatic myocardial abnormalities in a dog model of Duchenne's cardiomyopathy. Eur Heart J. 2004 Nov;25(21):1934-9.

19. Jassal DS, Othman RA, Ahmadie R, Fang T, Zieroth S, Fischer G, et al. The role of Tissue Doppler imaging in the noninvasive detection of chronic rejection after heterotopic cardiac transplantation in rats. Echocardiography. 2009 Jan;26(1):37-43.