Color Doppler Tissue Imaging to Evaluate Left Atrial Appendage Function in Patients with Mitral Stenosis in Sinus Rhythm

Azza El-Feky, Hebatalla Attia, Hani Awadallah, Gamal Abdelhady, Mohamed Bordy, Ahmed Emam

ABSTRACT

Tissue Doppler echocardiography has increasingly been used since its introduction in1989. Regional systolic functions can be measured by recording regional average systolic myocardial velocity with real-time Color Doppler Tissue Imaging (CDTI). In this study, the left atrial appendage (LAA) tissue velocity was measured by CDTI. LAA function in 40 patients with mitral stenosis in sinus rhythm (SR) and 40 healthy subjects undergoing transesophageal echocardiography were examined by CDTI. Systolic tissue appendage velocity (SaV, m/s) was measured at the tip of the LAA. Left atrial emptying and filling flow velocities (LAAEV, LAAFV, respectively) were also recorded with pulsed wave Doppler where as the sample volume was about 1cm inside the left atrial appendage. Patients with mitral stenosis in sinus rhythm had significantly decreased left atrial appendage filling velocity (LAAFV) (cm/s), left atrial appendage emptying velocity (LAAEV) (cm/s), SaV (cm/s), E(cm/s) and A (cm/s) waves compared to controls (28.9±6.6 vs 72.7±6, 23.6±6.2 vs 81.1±6.3, 4.6±1.5vs 10.7±3, 5.7±1.5 vs 13.1±3.1, 3.5±1 vs 9.8±3.4 respectively, P<0.01). Patients with mitral stenosis in sinus rhythm had significantly reduced left atrial appendage ejection fraction (LAA EF %) compared with the control subjects (32.9±8.1% vs 75.7±5.3 P <0.01). In conclusion, these results suggest that the LAA dysfunction may occur in patients with mitral stenosis in SR and CDTI can successfully be used for the quantification of contraction at the tip of the LAA.

Keywords: Doppler tissue imaging, left atrial appendage function, mitral stenosis, sinus rhythm

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INTRODUCTION

Thrombus and or spontaneous echo contrast develop in LAA in patients with LAA dysfunction. Decrease in LAA empty velocity shows LAA dysfunction. LAA is usually considered to be source for embolisation in patients with mitral stenosis (both in atrial fibrillation and sinus rhythm) tissue Doppler echocardiography has increasingly been used to evaluate regional

systolic and diastolic functions. Regional systolic and diastolic functions can be measured by recording regional average systolic and diastolic myocardial velocity with real time color Doppler tissue imaging (CDTI). Colour coded tissue Doppler rendered a qualitative assessment of LAA wall, depicting both the timing and the sequence of LAA contraction. With pulsed Doppler interrogation a triphasic signal was recorded in all patients, consisting of a positive wave followed by a biphasic wave[1].Evaluation of LAA wall using tissue Doppler is feasible and reproducible. While colour tissue Doppler analysis allows a qualitative assessment, pulsed Doppler gives new quantitative insights for the comprehensive assessment of LAA wall dynamics, which complements the information obtained with flow interrogation[2].

PATIENTS AND METHODS

The study group consisted of 40 patients (13 males, 27 females, age 30.9±8.6 years) with rheumatic mitral stenosis in sinus rhythm. Patients were carefully examined to ensure that the patients had mitral stenosis and in sinus rhythm. All patients gave written informed consent. Patients with moderate or severe mitral and aortic regurgitation, moderate or severe aortic stenosis, atrial fibrillation, prosthetic valves, a history of myocardial infarction, cardiomyopathy, and connective tissue disease were excluded from the study. 40 healthy people (17 males, 23 females, age 27.9±8.3) were also enrolled in this study as a control group. The control group was free as regard history of cardiac problems; the cardiac examination was also free.

Transthoracic echocardiography:

ECG gated Transthoracic echocardiographic study (ATL system HDI 5000), using phased array 3-2 MHZ prope, were done to patients and controls as well, to fulfill the inclusion and exclusion criteria of the cases and exclude any cardiac lesions of the controls. The transthoracic echocardiography was done to appropriate patients and control subjects for calculation of mitral valve area both by planimetry and Doppler, measurement of left atrial diameter, estimation of left ventricular ejection fraction. The examination was done while the subjects in the left lateral position.

Transesophageal echocardiography:

All patients and control subjects were studied with multiplane transesophageal echocardiography (ATL system HDI 5000) using phased array 7-4 MHZ prope, for evaluation of left atrium and left atrial appendage for the presence of thrombi or spontaneous echo contrast, left atrial appendage ejection fraction, left atrial emptying and filling flow velocities with pulsed wave Doppler. Color Doppler tissue imaging was used for assessment of the systolic and diastolic functions of the left atrial appendage (SaV, E and A waves).

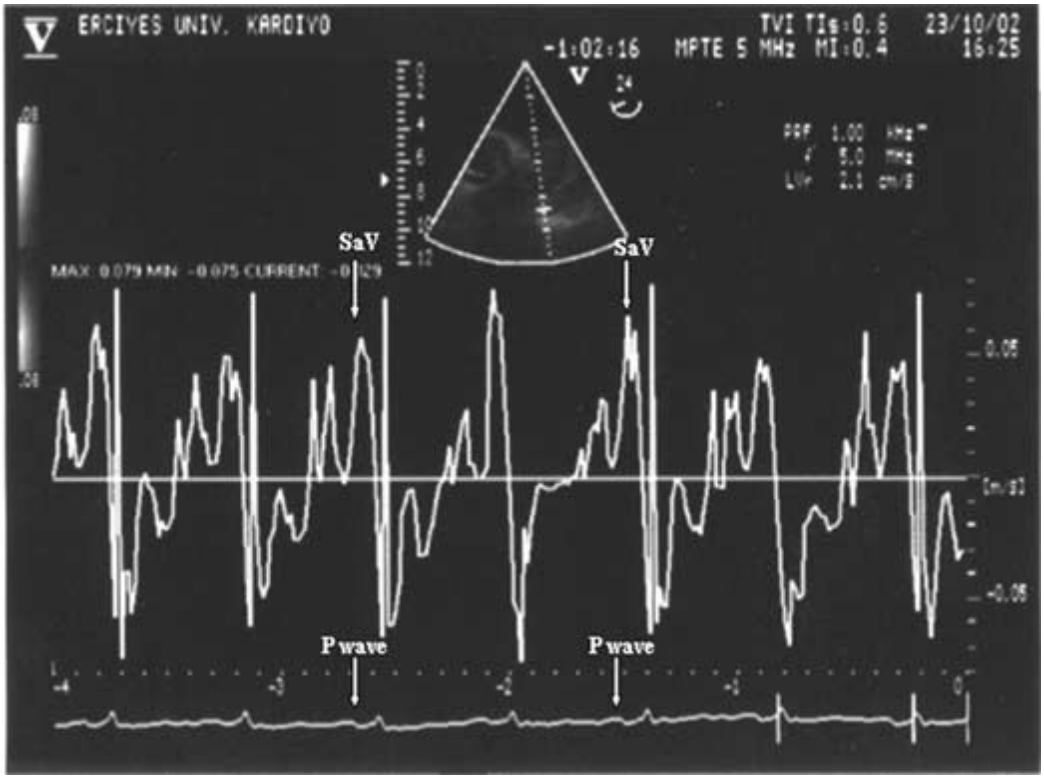

Figure 1. The velocity profile at the tip of left atrial appendage extracted from the color Doppler tissue imaging (black and white print). SaV: systolic appendage velocity.

Statistical analysis:

All calculations were performed with an IBM compatible SPSS (version 10.0) program. All data are presented as mean values with standard deviations. Differences were considered significant when $P<0.01$.

RESULTS

Patients with mitral stenosis did not differ significantly from the control group as regarding sex and age as shown in the tables below.

Table (1): Comparison between cases and controls as regards gender

	Males		Females		p
	No.	%	No.	%	
Cases	13	32.5	27	67.5	>0.05
Controls	17	42.5	23	57.5	>0.05

X2=0.8 P>0.05 not significant

Table (2): Comparison between cases and controls as regards gender

	Cases		Controls		P
	Mean	SD	mean	SD	
Age	30.9	8.6	27.9	8.3	>0.05

P>0.05 not significant

Left atrial appendage SEC was detected in 20 (50%) of the 40 patients with mitral stenosis.8 (20%) of the 40 patients who had SEC had also thrombus in left atrial appendage of patients with mitral stenosis.

Table (3): Distribution of SEC and Thrombi among cases

	No.	%
SEC		
with	20	50
without	20	50
Thrombi		
with	8	20
without	32	80

Patients with mitral stenosis in sinus rhythm had significantly decreased left atrial appendage filling velocity (LAAFV) (cm/s), left atrial appendage emptying velocity (LAAEV) (cm/s), SaV (cm/s), E(cm/s) and A (cm/s) waves compared to controls (28.9±6.6 vs 72.7±6, 23.6±6.2 vs 81.1±6.3 , 4.6±1.5 vs 10.7±3, 5.7±1.5 vs 13.1±3.1, 3.5±1 vs 9.8±3.4 respectively, P<0.01).Patients with mitral stenosis in sinus rhythm had significantly reduced left atrial appendage ejection fraction (LAA EF %) compared with the control subjects (32.9±8.1% vs 75.7±5.3 P <0.01).Left atrium diameter (cm) in patients with mitral stenosis in sinus rhythm were also larger than those of control groups (4.6±0.5 vs 3.5±0.6 respectively, P <0.01).

Table (4): Comparison between the two studied groups (cases and controls as regards the LA diameter, MVA, LAA filling, LAA emptying, LAA EF%, SAV, E wave, A wave, LVEDV, LVESV, LV EF%.

	Cases *n=40* Mean SD	Controls *n=40* Mean SD	t	P
Left atrial diameter (cm)	4.6±0.5	3.5±0.6	10.9	<0.01
MVA (planimetry) (cm^2)	1.23±0.2	4.5±0.5	34.7	<0.01
MVA (P½ t) (cm^2)	1.23±0.2	4.47±0.4	35.9	<0.01
LAA filling velocity(cm/s)	28.9±6.6	72.7±6.0	30.8	<0.01
LAA Emptying velocity(cm/s)	23.6±6.2	81.1±6.3	40.5	<0.01
LAA EF%	32.9±8.1	75.7±5.3	27.7	<0.01
SaV (cm/s)	4.6±1.5	10.7±3.0	11.1	<0.01
E wave (cm/s)	5.7±1.5	13.1±3.1	13.3	<0.01
A wave (cm/s)	3.5±1.0	9.8±3.4	11.0	<0.01
LVEDV(mm)	88±9.2	87±3.7	2.7	>0.05
LVESV(mm)	30±4.2	30.8±1.6	6.2	>0.05
LV EF%	67.6±5.5	66.2±2.0	1.7	>0.05

DISCUSSION

In this prospective study we assess the systolic and diastolic functions of the left atrial appendage, we found that the patients with mitral valve stenosis in sinus rhythm had a low left atrial appendage ejection fraction in comparison to the control group. There is a significant decrease in SaV which represent the systolic function of the appendage in patients compared to the control. Diastolic function of the appendage is also affected in patients. E and A waves which are a reflection of the diastolic function of the appendage are decreased in patients in comparison to control.

Our results showed that SEC may be a useful indicator to identify a subset of MS patients in either sinus rhythm or atrial fibrillation at a high risk for thromboembolic complication. Patients with SEC had a marked left atrial appendage dysfunction compared to patients without SEC.

Patients with mitral valve disease tend to have larger left atrial appendage size and left atrial appendage contractile dysfunction ; all these promote the formation of the left atrial appendage SEC and thrombus especially in patients with left atrial appendage dysfunction[3]. Hemodynamically significant mitral stenosis is associated with significant left atrial appendage stasis, which can lead to left atrial appendage SEC or thrombus formation even in presence of sinus rhythm[4].

Left atrial appendage dysfunction leads to stasis in cavity, which presents itself as a reduction in left atrial appendage emptying and filling velocities[5]. In this study we found that the emptying and filling velocities are markedly affected in patients with mitral valve disease in sinus rhythm in comparison to control.

Color Doppler tissue imaging is a new method that allows pulsed wave velocity measurement. Wilkinhoff et al.[6], have determined that regional mean systolic velocities in the left ventricle can be evaluated through this mode and showed that their data have high reproductively. Kerut[7] reported several applications of tissue Doppler imaging. Our study is to examine the left atrial appendage in sinus rhythm through color Doppler tissue imaging. Decreased peak systolic appendage velocity may be predictive poor left atrial appendage function in patients with mitral stenosis in atrial fibrillation and sinus rhythm. We showed that the left atrial appendage functions in patients with mitral stenosis can be evaluating quantitatively[8].

CONCLUSION

Evaluation of left atrial appendage dysfunction may be important for prediction of occurrence of spontaneous echo contrast (SEC) and thrombus in the left atrial appendage in patients with mitral stenosis in sinus rhythm. Color Doppler tissue imaging provides a method for quantification of contraction of the left atrial appendage .decreased systolic and diastolic left atrial appendage functions presented as decreased SaV, E and A waves taken from the left atrial appendage by color Doppler tissue imaging is one of the indicators of left atrial appendage dysfunctions in patients with mitral stenosis in sinus rhythm. Evaluation of left atrial appendage function by

color Doppler tissue imaging appears to be clinically reliable and applicable imaging technique that allows quantitative assessment of left atrial appendage dysfunction.

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