

Evaluation of early alterations in transmitral diastolic flow and tissue Doppler imaging findings of the septal and lateral segments of the left ventricle in the early period after coronary angioplasty

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Abstract

BACKGROUND: We aimed to evaluate subepicardial and subendocardial left ventricular (LV) functions in patients with single coronary artery lesion at an early stage after percutaneous coronary intervention (PCI).

METHODS: Patients with left anterior descending (LAD) lesion (n = 40) were evaluated. Subjects underwent PCI and at least one coronary stent was placed. Before and one month after PCI, patients underwent echocardiography. The ordinary Doppler indicators including E wave deceleration time, A velocity and E velocity as well as the pulsed-wave tissue Doppler imaging (PW-TDI) parameters (Aa, Ea and Sa velocity) were measured. The findings before and after intervention were compared.

RESULTS: E wave deceleration time was the only factor that significantly improved in ordinary Doppler and other parameters such as A velocity and E velocity did not show any changes. Among TDI parameters, Aa velocity and Ea velocity in septum area improved significantly but despite an increase in Sa velocity in septum, it was not statistically significant. Ea velocity significantly improved in lateral area but Aa and Sa velocity insignificantly increased.

CONCLUSION: In patients with coronary artery disease, the systolic and diastolic function is impaired. It is simply diagnosable by TDI. Although the systolic function impairment is remained after PCI, the diastolic function considerable improved after angioplasty. Our study showed that diastolic function of left ventricle improved over time. In contrast with other studies, in this study, Aa velocity significantly improved one month after revascularization.

Keywords: Angioplasty, Percutaneous Coronary, Echocardiography, Doppler, Tissue Doppler Imaging.

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Introduction

In 13 epidemiological studies, the incidence of heart failure with normal ejection fraction (HF_nEF) has been shown 50 to 55 percent. As age increases, the incidence increases. Its prevalence in women is more than men.¹⁻⁸ Mortalities and morbidities of HF_nEF have been reduced the same as heart failure (HF) with reduced ejection fraction (EF). However, while the survival of HF patients with reduced EF has improved over time, the life expectancy has remained unchanged in HF_nEF patients.⁹

Non-cardiac vascular causes of death in HF_nEF are much more common.¹⁰ Patients with this complication are frequently older than 65 years. Most of them (60%-70%) are females with past medical

history of hypertension (60%-80%), obesity (30%-50%), diabetes (30%-50%) and atrial fibrillation (20%-40%).¹¹⁻¹⁴ There is not much difference between the signs, symptoms and findings of radiography in heart failure with normal or reduced EF. Therefore, in order to differentiate them, the assessment of EF by imaging techniques is necessary.^{6,7,11} Left ventricular systolic and diastolic cardiac dysfunction in patients with coronary artery disease (CAD) may cause myocardial ischemia at the beginning.¹⁵⁻¹⁸ The complete revascularization by angioplasty in these patients may cause the recovery of left ventricular diastolic function.¹⁹⁻²¹

Today, the most common method of assessing diastolic function is investigating the Doppler mitral flow. However, there is controversy in different

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studies.¹⁹⁻²⁴ Tissue Doppler imaging (TDI) is used because of effect of different variables on Doppler mitral flow. It is a sensitive, simple and inexpensive method that confounding factors such as heart rate, pre-load and after-load do not have any effects on its outcome.²⁵

Materials and Methods

In a prospective randomized clinical trial, 40 patients with chronic stable angina enrolled that suffered from severe stenosis (greater than 75%) of left anterior descending (LAD) artery in coronary angiography. The patients underwent Doppler echocardiography 6 to 12 hours before the angioplasty and again after 30 days. Six patients did not participate in follow-ups and were excluded. Due to the potential impact of medications on echocardiographic parameters, no changes were given in the patient's medication over one month after angioplasty. The patients received aspirin (ASA), clopidogrel, beta-blockers, acetyl cholinesterase inhibitors (ACEI) and nitrate, if needed. Exclusion criteria included EF less than 40%, valvular regurgitation (moderate to severe), high blood urea nitrogen, previous myocardial infarction (MI), bundle branched block on ECG and risk of COPD.

Echocardiography was performed in left lateral decubitus position with the Vivid3 machine in an apical 4-chamber angle. The parameters of E velocity, A velocity and E deceleration time were measured. The pulse wave tissue Doppler imaging (PW-TDI) echocardiography was performed in septum and lateral mitral annulus area from apical 4-chamber angle too. Sa velocity, Ae velocity and Ea velocity parameters were measured. Guiding catheter (with the thickness of french 7) were used for the angioplasty of the patients. According to the vessel's diameter, the balloon catheter (2.5 to 3.5) was used with a pressure of 10 to 15 atmospheres for 45 to 60 seconds. After PCI, stenosis of the vessels less than 30% lumen were considered as a successful PCI. No deaths or need for emergency surgery occurred. Diastolic mitral flow (PW) was measured at the tip of the mitral valves in apical 4-chamber view. Gain control was optimized as much as possible in all of the patients. SPSS software was used for statistical analysis. The comparison of the data was performed by using the paired t-test and Wilcoxon signal ranks tests. The $P < 0.05$ was considered as statistically significant.

Results

From 34 subjects, 19 patients (55.9%) were males and 15 (44.1%) were females. The mean age of the patients was 62 years (with the minimum of 31 and maximum of 85 years). The mean artery stenosis

(before angioplasty) was 87 ± 8 percent. It was decreased to 10 ± 4 percent after angioplasty. The mean values of E wave deceleration time (DT) before and after the angioplasty was shown in table 1.

Table 1. Deceleration time indexes before and after angioplasty

Deceleration time	Before angioplasty n (%)	After angioplasty n (%)
< 160	1 (2.9)	3 (8.8)
160 – 240	8 (23.5)	14 (41.2)
> 240	25 (73.5)	17 (50)

The Wilcoxon test showed that the DT after angioplasty were improved significantly ($P = 0.03$). The mean of a velocity before the angioplasty was 48 cm/s and after the angioplasty, it reached to 45 cm/s. This change was not statistically significant. The mean of E velocity before the angioplasty was 62 cm/s and after the angioplasty, it insignificantly increased to 64 cm/s. After angioplasty, the mean of septum Ea velocity significantly increased from 6.4 ± 2.1 cm/s to 7.6 ± 2.5 cm/s ($P = 0.008$). The mean of Aa velocity in the septum area (after angioplasty) significantly declined from a value of 8.8 ± 2.2 cm/s to 7.9 ± 2.4 cm/s ($P = 0.09$). The mean of Sa velocity in the septum area was 7.2 ± 1.6 cm/s before angioplasty 7.4 ± 1.8 cm/s after it but the difference was not statistically significant. The PW-TDI data in the septum area (before and after angioplasty) is given in table 2.

Table 2. Tissue Doppler imaging indexes in the Septal area before and after angioplasty

Index	Before angioplasty	After angioplasty	P
	Mean \pm SD	Mean \pm SD	
Aa velocity	8.8 ± 2.2	7.9 ± 2.4	0.009
Ea velocity	6.4 ± 2.1	7.6 ± 2.1	0.008
Sa velocity	7.2 ± 1.6	7.4 ± 1.2	0.060

After the angioplasty, the mean of lateral Ea velocity increased from 7.7 ± 3.0 cm/s to 9.6 ± 8.2 cm/s. This difference was statistically significant ($P = 0.002$). After angioplasty, the mean of lateral area Aa velocity declined from 9.0 ± 3.9 cm/s to 8.1 ± 2.9 cm/s but it was not statistically significant ($P = 0.25$). After angioplasty, the mean of lateral area Sa velocity insignificantly increased from 8.0 ± 3.0 cm/s to 8.1 ± 0.2 cm/s ($P = 0.07$). The PW-TDI data in the lateral wall (before and after angioplasty) is given in table 3. Thus, a significant improvement was occurred in the left ventricular diastolic function (in 30 days) only in the Aa and Ea parameters.

Table 3. Tissue Doppler imaging indexes in the lateral wall before and after angioplasty

Index	Before	After	P
	angioplasty	angioplasty	
	Mean \pm SD	Mean \pm SD	
Aa velocity	9.0 \pm 3.9	8.1 \pm 2.9	0.250
Ea velocity	7.7 \pm 3.0	9.6 \pm 2.8	0.002
Sa velocity	3.0 \pm 8.0	8.1 \pm 0.2	0.070

Discussion

After angioplasty E velocity is reduced and A velocity is increased in CAD.^{26,27} In the study conducted by De Bruyne and colleagues, the isolated lesions of LAD were evaluated. They showed that when E is smaller than A, the change will not be occurred in PW or in diastolic mitral flow (24 hours after the angioplasty).²⁸ Snow and colleagues showed that in 42 patients with acute coronary syndrome (in the first 48 hours), DT was reduced and the ratio of E/A was increased.²³ In the present study, within 30 days, A velocity and E velocity did not change significantly but DT had significant improvement. Several studies showed that DTI parameters (including Ea velocity, Aa velocity and Sa velocity), are improved in the areas of ischemic myocardium at the first 24 hours after angioplasty.²⁹⁻³¹ In the Surucu and colleagues study, the patients were evaluated after 24 hours. Ea velocity and the ratio of Ea/Aa were significantly increased. The decrease in Aa velocity was not statistically significant. In that study, the isovolumic relaxation time and isovolumic contraction time decreased.³² In our study, Ea velocity increased and Aa velocity significantly decreased. Our findings showed that the decrease in Aa velocity did not happen in the first 24 hours and required more time. This change was done in 30 days. Sa velocity changes after angioplasty have been inconsistent in various studies. Sucuru et al.³² showed that Sa velocity was improved after the angioplasty but this index did not change in other studies.^{15,24,25,28,29} In another studies (with no controls), Sa velocity increased after angioplasty.^{15,24,28,29} In our study, the Sa velocity increased but this increase was not statistically significant.

Conclusion

In patients with CAD, the systolic and diastolic functions are impaired. In the early stages after the angioplasty, the systolic function remains unchanged but the diastolic function is improved significantly. This change cannot be proved by mitral echo Doppler (PW) but PW-TDI can obviously prove it. The superiority of our study (compared to previous studies, which evaluated the patients 24 hours after the angioplasty) was that the evaluation of our

patients was performed after 30 days. Therefore, it was shown that making changes in some TDI indexes after angioplasty requires a longer time.

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Conflict of Interests

Authors have no conflict of interests.

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