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Original Article

Effect of elective percutaneous coronary intervention of left anterior descending coronary artery on regional myocardial function using strain imaging

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ABSTRACT

Background: Percutaneous coronary intervention (PCI) is a commonly used procedure for revascularization, however the impairment of regional myocardial function in patients with stable coronary artery disease (CAD) has not been well characterized, our study aimed to assess the improvement of left ventricular (LV) systolic function after elective PCI of the left anterior descending artery (LAD) using strain and strain rate imaging techniques.

Materials and methods: The study included 30 patients (aged 56.8 ± 6.6 years, 66.7% males) presented with stable CAD on optimal medical therapy, and recommended for elective PCI to LAD, all patients included in the study had a normal LV wall motions, and normal LV systolic function. Tissue Doppler imaging (TDI) was done before PCI, immediately, and three months post PCI. The peak systolic longitudinal strain (PSLS), and peak systolic strain rate (PSSR) were measured and averaged for the 6 LAD segments (the basal, mid, and apical segments of the anterior wall, the basal, mid anteroseptal, and the apicoseptal segments), 15 healthy control subjects were included as a control group.

Results: The average PSLS and PSSR of the ischemic segments were significantly lower in patients compared to control in the ischemic segments, and significantly increased 3 months post PCI but not immediately post PCI. Using the ROC curve a cutoff value of -13.69% for PSLS can detect regional ischemia with a sensitivity 93.3% and a specificity of 80%.

Conclusions: TDI derived strain and strain rate can detect resting regional myocardial dysfunction in presence of preserved LV systolic function, and can assess the improvement of regional myocardial function after successful elective PCI in patients with stable CAD.

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1. Introduction

Left ventricular systolic function is a major predictor of long-term survival in patients with coronary artery disease (CAD),^{1,2} evaluation of regional and global subclinical left ventricular (LV) systolic dysfunction could be a good strategy to identify myocardial regions with impaired coronary artery flow and reduced myocardial perfusion. Tissue Doppler imaging (TDI) has been introduced in an attempt to provide a more objective assessment of myocardial contractility but it had confounding effects of cardiac translational motion and passive pathological tethering,³ These limitations may be overcome by the measurement of myocardial

deformation with strain and strain rate (SR) echocardiography which are a variation of TDI that provides a high-resolution evaluation of regional myocardial function. SR is defined as the rate of deformation in response to an applied force and is determined from the spatial gradient of local myocardial tissue velocities between two points. Strain is calculated from the time integral of SR and reflects the magnitude of deformation.⁴ Percutaneous coronary intervention (PCI) in patients with preserved LV function and on optimal medical therapy doesn't reduce the cardiac death and myocardial infarction, but it also decreases the need for other procedure and the degree of angina.^{5–7} In most of the studies, the effect of primary PCI on cardiac function is well investigated, however result of previous studies about elective PCI and its effect on LV systolic or diastolic function is not clear.^{5,8–10} Our study aimed to assess the improvement of left ventricular systolic function after elective PCI of the left anterior descending (LAD) artery using tissue Doppler strain and SR imaging techniques.

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Nomenclature

A	late transmitral inflow velocity	LAD	left anterior descending coronary artery
Aa	late diastolic annular velocity	LV	left ventricle
ACEI	angiotensin converting enzyme inhibitors	PCI	percutaneous coronary intervention
BP	blood pressure	PSLS	peak systolic longitudinal strain
ASA	acetyl salicylic acid	PSSR	peak systolic strain rate
CAD	coronary artery disease	Sa	systolic annular velocity
E	early transmitral inflow velocity	TDI	Tissue Doppler imaging
Ea	early diastolic annular velocity	SR	strain rate
EF	ejection fraction		

2. Methods

2.1. Study population

An informed consent was obtained from all patients. And the study was approved by the ethical committee. The study was conducted on 30 patients presented with stable CAD on optimal medical therapy, and with angiographically significant lesion ($\geq 50\%$ luminal narrowing) in LAD recommended for PCI, all the patients had objective evidence of ischemia before coronary angiography and PCI (15(50%) had a positive exercise stress test, 10(33.3%) had positive myocardial perfusion scan, 5(16.7%) had a multislice computed tomography coronary angiography), all patients included in the study had a normal resting LV wall motions, and normal LV systolic function with ejection fraction (EF) $\geq 50\%$, patients with diabetes mellitus, paced rhythm, atrial fibrillation, left bundle branch block, conduction delay in their electrocardiogram, or those with previous PCI or coronary artery bypass graft were excluded from the study.

2.2. Clinical evaluation

All the patients were subjected to full history taking, clinical examination, laboratory investigations including (hemoglobin %, creatinine level).

2.3. Coronary angiography and PCI

Coronary angiography was done and only patients with LAD significant stenosis ($\geq 50\%$ luminal narrowing) were included, the site of occlusion in LAD where divided into, ostial, proximal, mid and distal (ostial LAD is from the origin of the vessel and or within 3 mm from the origin, Proximal LAD is the segment 3 mm from LAD origin to the first diagonal branch (D1), mid LAD from D1 to second diagonal branch (D2) and distal LAD segment was beyond D2 elective PCI was done to all patients, acetyl salicylic acid (ASA) 325 mg as well as clopidogrel 600 mg were administered before PCI. After the PCI, they were maintained on a regimen of a low dose ASA (75–100 mg) and clopidogrel 75 mg daily.

2.4. Conventional transthoracic echocardiography¹¹

It was done to all patients before PCI (within 24 h), immediately post PCI (within 24 h), and three months post PCI. The following parameters were calculated using (HD11 XE, Philips) machine, EF was calculated by modified Simpson method, pulsed wave Doppler mitral inflow velocities were obtained from the apical 4-chamber view to measure diastolic early filling velocity (E) wave, late diastolic velocity (A) wave, and Pulsed wave TDI was obtained after placement of the sample volume at the level of the septal and lateral mitral annuli. From these recordings, myocardial systolic (Sa),

early diastolic (Ea), late diastolic velocities (Aa), and E/Ea ratio were measured and averaged.

2.5. Strain and strain rate imaging¹²

It was done by acquiring color TDI in apical 4,3, and 2 chambers views, sector adjusted to keep frame rates of at least higher than 200 frames and cine images were stored for offline analysis, then the peak systolic longitudinal strain (PSLS), and peak systolic strain rate (PSSR) were measured and averaged for the 6 segments supplied by LAD territory from the 16 LV segments model (the basal, mid, and apical segments of the anterior wall, the basal, mid anteroseptal segments, and the apicoseptal segment). It was done to all patients before PCI (within 24 hour), immediately post PCI (within 24hour), and three months post PCI (Fig. 1).

2.6. Statistical analysis

Statistical analyses were performed by using SPSS system for Windows (version 20 Chicago, IL, USA), Continuous variables were presented as mean \pm SD and were compared by Student's t-test or Mann-Whitney U test for variables with or without normal distribution, respectively. Categorical variables were expressed as percentages and evaluated with a Chi square test or Fisher's exact test. Wilcoxon signed ranks test for comparing between results before and after PCI. The receiver operational characteristic (ROC) analyses was performed and best cut off value was determined and at that point sensitivity and specificity were determined, the results were considered significant when the p value was less than 0.05.

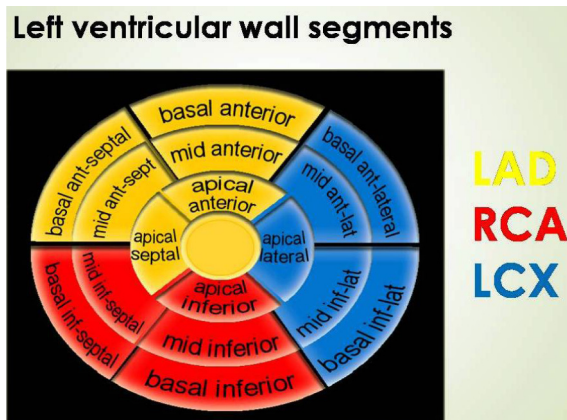


Fig. 1. Left ventricular wall segments in the 16 LV segment model, LAD: left anterior descending artery, LCX: left circumflex artery, RCA: right coronary artery.

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