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Original Article

The relation between tissue doppler imaging and the severity of coronary artery stenosis in patients undergoing coronary angiography

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Abstract

Objectives: Early detection of local dysfunction in patients suspected of coronary artery disease (CAD) is usually performed using Tissue Doppler Imaging (TDI). The present study investigated the relationship between TDI and the severity of coronary artery stenosis in hospitalized patients with suspected CAD.

Methods: The present study is a descriptive-analytical study. The research population was 200 patients hospitalized in Seyyed al-Shohada Hospital, Urmia University of Medical Sciences, undergoing coronary angiography between 2013 and 2018. The patients were divided into three groups- mild, moderate, and severe. All patients underwent echocardiography and color TD. Myocardial performance index (TIE index) was evaluated using Doppler echo. Logistic regression analysis was used to investigate the effect of tissue Doppler indices on the degree of coronary artery involvement. SPSS version 22 software was used for statistical analysis.

Results: A total of 200 patients, 113 (56.5%) males, were investigated. The age range of participants was between 25 to 78 years. Left ventricular systolic and diastolic function indices and mean velocity E in the three groups were 0.73 ± 0.158, 0.68 ± 0.134, and 0.64 ± 0.145, respectively ($P = 0.025$). The average velocity A, the average ratio E/A, the MP index, the average velocity e, and the average ratio E/e had significant differences in all the three groups.

Conclusions: Due to the significant correlation between numerous left ventricular functional indices, TDI can be used as a non-invasive tool in evaluating coronary arteries.

Keywords: Coronary artery disease; Tissue Doppler Imaging; Coronary artery stenosis, Syntax score

Introduction

Coronary artery disease (CAD) is the most prevalent kind of cardiovascular diseases (CVDs) and the most common cause of death globally (1). The incidence of cardiac events has increased most dramatically in Latin America, the Middle East, and the Far East, notwithstanding regional differences (2). Given the enormous cost of disease, early detection and treatment are essential (3). Non-invasive imaging methods such as radionuclide imaging and stress echocardiography are used to

diagnose and evaluate CAD(4,5). A distinguishing indicator of CAD in stress echocardiography is global and regional left ventricular (LV) systolic function, which can be measured by two-dimensional (2D) echocardiography (6).

Considering that contrast material is used in some techniques, it cannot be used (7). Initially, in 1989, tissue Doppler imaging (TDI) was used to evaluate LV systolic and diastolic function (8, 9). By using TDI and analyzing low-frequency and high-amplitude signals of heart movement, it is possible to observe the speed of the myocardium.

TDI echocardiography and analysis of low-frequency and high-amplitude heart movement signals can determine myocardial velocity. Spectral pulsed wave technique or color-coded pulsed wave approach is used to perform TDI (9). Therefore, the use of TDI can provide helpful information about the classification of these people. Doppler echocardiography is a simple, beneficial, non-invasive, non-radioactive, economical and repeatable imaging method (10).

TDI has proven to be an effective predictive tool in the general population (11, 12) and patients with known CVDs (13-15). Furthermore, prior research has shown that TDI can identify patients with CAD with poor systolic and diastolic heart functioning (16, 17). However, the question is whether TDI can predict the severity of CAD in successive patients with suspected CAD.

The present study investigated the relationship between TDI and the severity of coronary artery stenosis in hospitalized patients with suspected CAD.

Materials and Methods

Study population

In this descriptive-analytical study 200 patients hospitalized in Seyyed al-Shohada Hospital affiliated to Urmia University of Medical Sciences between 1393 and 1398 were studied. Patients who could enter the study based on the entry and exit criteria were informed and filled out the informed consent forms. Inclusion criteria included patients with EF more than 50%. Only the patients hospitalizing with acute coronary syndrome (ACS) with left ventricular ejection fraction (LVEF) more than 50% and were candidates for angiography were studied.Exclusion criteria included patients with ejection fraction (EF) less than 50%, previous history of percutaneous coronary intervention (PCI), coronary artery bypass graft surgery (CABG), acute myocardial infarction (MI), pacemaker patients, patients with a previous history of premature ventricular systole (PVCs) or recurrent premature atrial contraction (PACs). Patients with right bundle branch block (RBBB) and left bundle branch block (LBBB) and patients with limiting physiology of systolic function were included. Based on the study of Marghani et al. (2018) (13), taking into account the type one error of 5%, type two error of 20%, and the average probability of index Tissue Doppler Imaging (TDI), a sample size of 200 patients participated in the present study.

Echocardiography

Echocardiography images were acquired with the Vivid S6 Dimension (GE Healthcare, Horten, Norway) equipped with a 3.5-MHz transducer. According to a predetermined study procedure, conventional two-dimensional echocardiography and color TDI were performed for all patients. A researcher who was blinded to all other information conducted all analyses offline using commercially accessible software (EchoPac, GE Healthcare, Horten, Norway). In addition to echocardiography, the myocardial performance index (TIE Index) was calculated with Doppler echo. Being independent of electromechanical delay, it showed the exact beginning of isovolumic contraction and was calculated as a percentage in the following way:

IMP= IVCT + IVRT／RVET

IMP: Index myocardial performance

IVCT: Isovolumetric contraction time

IVRT: Isovolumetric relaxation time

RVET: Right ventricular ejection time

Tissue Doppler imaging

With the highest frame rate, color TDI loops of the apical four-chamber, two-chamber, and long-axis views were obtained. The smoothing setting was 30 ms. The septal, lateral, anterior, inferior, posterior, and anteroseptal myocardial walls were the six mitral annular sites where peak longitudinal systolic (s′), early diastolic (e′), and late diastolic (a′) velocities were measured. The total longitudinal performance of the left ventricle was evaluated by averaging the myocardial velocities from the six mitral annular sites, the average e′ as determined by color TDI was used to calculate E/e′. Mitral annular velocities calculated by color TDI have been reported to exhibit low inter- and intra-observer variability.

Assessment of the severity of CAD

Two interventional physicians blindly evaluated coronary angiography. According to the American Heart Association (AHA) and the American College of Cardiology (ACC) classifications of coronary artery

lesions, the presence of considerable constriction (>50%) in any of the primary coronary arteries was considered a symptom of CAD. Diagnostic angiography was assessed using syntactic scores. A relatively well-established system of evaluation called the syntax score can indicate coronary stenosis prospectively. All information syntax score calculation was reported by Georgios et al (18). The Syntax score was also used to categorize CAD patients into three groups: mild (scores between 22 and 33), moderate (scores between 23 and 32), and severe (scores over 33).

Laboratory analysis

All patients had blood samples taken from their extremity limbs' veins. Before blood collection, patients were instructed to avoid eating for at least 12 hours. The clinical laboratory of our hospital measured the biochemical indicators and blood routine. Total cholesterol (TC), triglycerides (TG), low-densitylipoprotein cholesterol (LDL), and high-density lipoprotein cholesterol (HDL) were the biochemical indicators. An automatic biochemical analyzer was used to determine the biochemical indicators (Beckman Coulter, CA, USA).

Statistical analysis

The SPSS 22.0 software was used for the statistical analysis. Measurement data were reported as mean ± SD. Logistic regression analysis was performed to investigate the effect of tissue Doppler indices on the severity of coronary artery involvement.

Ethics

The Medical Ethics Committee of Urmia University of Medical Sciences, Urmia, Iran(IR.UMSU.REC. 1400.414) approved the study and all patients signed the informed written consent.

Results

Table1 shows the demographic characteristics of the participants.

Table1. Demographic characteristics of the studied samples (N=200)

Variable	
Age(year)	56.26±10.62
Male, n (%)	113(56.5)
BMI(Kg/m^2)	27.39±4.09
Hypertension, n (%)	130(65.3)
DM, n (%)	67(33.5)
Cardiovascular disease, n (%)	70(35.3)
Smoker, n (%)	52(26)
TC(mmol/L)	144.32±38.54
TG(mmol/L)	155.41±79.42
LDL(mmol/L)	87.35±43.5
HDL(mmol/L)	39.75±9.23

BMI: Body mass, HDL: high-density lipoprotein, LDL: Low-density lipoprotein, TC: Total Cholesterol, TG: Triglyceride, DM: Diabetes mellitus

According to the syntax scores, the patients were divided into three groups: the first group included 97 patients with a score less than or equal to 22, the second group included 76 patients with a score between 23 and 32, and the third group included: 27 patients with a syntax score greater than or equal to 33 Table2.

Table2. Eechocardiography findings based on syntax score

	First group Mean ± SD	Second group Mean ± SD	Third group Mean ± SD	*p*-value
LVEDD, cm	5.02 ± 0.23	5.04 ± 0.23	5.11 ± 0.17	0.741
LVESD, cm	3.23 ± 0.29	3.35 ± 0.31	3.30 ± 0.26	0.319
IVS, cm	0.95 ± 0.12	0.97 ± 0.69	0.93 ± 0.10	0.7
EF, %	55.86 ± 2.2	55.8 ± 2.2	55.03 ± 1.87	0.1
LAVI, cc/m^2	23.75 ± 4.2	25.2 ± 4.23	24.13 ± 4.15	0.54
E/A	1.211 ± 0.35	0.96 ± 0.042	0.96 ± 0.038	0.037
E, m/s	0.73 ± 0.158	0.68 ± 0.134	0.64 ± 0.145	0.025
A, m/s	0.72 ± 0.128	0.69 ± 0.126	0.66 ± 0.0129	0.012
E, m/s	0.086 ± 0.019	0.082 ± 0.02	0.081 ± 0.018	0.019
A, m/s	0.107 ± 0.21	0.106 ± 0.19	0.104 ± 0.22	0.117
E/e	8.10 ± 1.23	9.56 ± 1.56	9.18 ± 1.63	0.031
S' septal, m/s	0.961 ± 1.59	0.920 ± 1.64	0.97 ± 1.64	0.226
MAPSE, mm	15.82 ± 5.1	15.78 ± 5.02	15.76 ± 5.12	0.835
TAPSE, mm	21.54 ± 3.6	21.56 ± 3.45	21.49 ± 3.51	0.223
MPI	0.462 ± 0.08	0.485 ± 0.086	0.512 ± 0.086	0.012
DT, msec	190 ± 72	191 ± 63	193 ± 56	0.355

LVEDD: Dilated Left Ventricular End-Diastolic Diameter, VEDS: Left ventricular end-systolic diameter, IVS: Isolated interventricular septum, EF: Ejection Fraction, LAVI: Left atrial volume index, E/A MAPSE: Mitral annular plane systolic excursion, TAPSE: Tricuspid annular plane systolic excursion, MPI: Message Passing Interface, DT: Deceleration time.

The values of the E, A, e, and E/A indices in the third group were significantly lower than those in the first group. There was no statistically significant relationship between S', a, Mitral and Tricuspid Annular Plane Systolic Excursion (MAPSE), Tricuspid Annular Plane Systolic Excursion (TAPSE), and DT indices in the three groups. The values of the Message Passing Interface (MPI) and E/e indices in the third group were significantly higher compared to the first group.

Discussion

In recent decades, atherosclerotic coronary artery disease has beenthe leading cause of death worldwide. Coronary artery stenosis can cause systolic and diastolic dysfunction. This dysfunction can be measured by echocardiography parameters (19, 20). The present study was designed to investigate the relationship between TDI and the severity of coronary artery stenosis in patients with suspected coronary artery disease. The results of the present study revealed that the indices of E/A, e, A, and E in the third group were significantly lower than those in the first group. The values of the E/e and MPI indices in the third group were significantly higher compared to the first group. Therefore, these indicators are valuable in analyzing the severity of coronary artery involvement, although there was no statistically significant relation between S', a, MAPSE, TAPSE, and DT indices in the three groups. It can be considered that the assessment of left ventricular systolic and diastolic performance indicators in TDI has predictive value for coronary artery involvement and therefore can be used as a screening method in suspected CAD patients.

A few studies have been conducted to investigate these parameters, many of which have been associated with established heart diseases such as ST-elevation myocardial infarction (STEMI), or have examined the changes after therapeutic intervention, specifying which parameters remain unchanged and which parameters are modified. There are few studies analyzing the changes in TDI indices in hospitalized patients with and without ACS. Sahin et al. designed an analytical study in 2012 to investigate the relationship between the Tai index and the severity of coronary artery disease based on the Syntax rating. Accordingly, 106 patients who were diagnosed with CAD by angiography were included in the study as the case group, and 30 patients without coronary artery stenosis were considered as the control group. Patients were divided into three groups based on SYNTAX rating. The results of the study showed that patients with high SS had higher MPI than patients with low and moderate SS and the control group (21). The results are consistent with our study.

In Tunisia in 2010, Fennira and colleagues, in a prospective study, selected 60 patients with coronary heart disease (CHD) and 40 healthy people as controls.

Patients were examined with TDI, and then they underwent coronary angiography. In the evaluation of 16 segments of the left ventricle, the IVRT, Ea, and Aa indices were measured. Compared to the healthy group, patients with coronary heart disease had a significant increase in the IVRT index and a decrease in the Ea and Ea/Aa indices, which are the same as our study. Furthermore, the above-mentioned changes were observed in the segments of the involved vessels more than in the normal segments(22).In another study by Hoffmann et al. in 2010 in Denmark, to determine the role of left ventricular wall motions, TIC was used to analyze the severity of coronary artery involvement in patients with coronary artery involvement. In their study, 82 patients with angina pectoris without a history of coronary artery involvement and a normal left ventricular ejection fraction were assessed with TDI and angiography. The results of the study showed that the assessment of systolic and diastolic function (based on S' and E/E' indexes) had a reverse relation with the number and extent of coronary artery involvement, which is contrary to the findings of our study (23).

In a study conducted in 2018 by Marghany et al. at Al-Azhar University, the systolic and diastolic indices of the left ventricle (especially S') using the TDI method and their relation with the syntax score in 60 patients were analyzed results showed that there is a significant relation between the E/A, E/e, and E indices and the syntax score. The results are consistent with our study. However, contrary to Marghany's study (13) in our study, there was no significant relation between S' index and SYNTAX score. The major limitation of our study was the various categories of patients, including patients with previous MI, diabetic patients, hypertensive patients, and AF patients, were not included. Due to the influence of MI on LV systolic and diastolic functions, we did not consider these categories.

Conclusion

Evaluation of left ventricular systolic and diastolic performance indicators in TDI has predictive value for coronary artery involvement and therefore can be used as a screening method in patients suspected of CAD.

Conflicts of Interest

The authors declare no conflict of interest.

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