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DETECTION OF CORONARY ARTERY DISEASE USING 2D- REGIONAL (SEGMENTAL) LONGITUDINAL STRAIN (RLS) COMPARED WITH CORONARY ANGIOGRAPHY IN PATIENT WITH ACUTE CORONARY SYNDROME

[1]Dr. Ghazi Farhan Haji, [2*]Imad Mahmood Hussein,
[3]Dr. Wajih Qasim Taha

[1]MD.FJCMS (Med.) FICM (Cardio).
[2]M. B. Ch. B, D.M, Mosul College of Medicine, Kufa College of Medicine, Department of Internal Medicine -Iraq-Baghdad.
[3]M. B. Ch. B, D.M, Basrah Medical College, College of Medicine Baghdad, Department of Internal Medicine -Iraq-Baghdad.

***Corresponding Author: Imad Mahmood Hussein**
M. B. Ch. B, D.M, Mosul College of Medicine, Kufa College of Medicine, Department of Internal Medicine -Iraq-Baghdad.

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ABSTRACT

Speckle-tracking echocardiography is a new noninvasive ultrasound imaging technique that allows for evaluation of global and regional myocardial function. Our study aimed to evaluate the accuracy of regional (segmental) longitudinal strain by 2D - STE for pick up culprit vessels in acute coronary syndrome (ACS) by detecting ischemic segments of the corresponding territories and its severity compared with coronary angiography as a gold standard, in patients with acute coronary syndrome. This cross sectional study was performed in Baghdad teaching hospital / Iraq during the period from March 2017 to March 2018 on (50) patients with (ACS) who underwent 2-dimensional speckle tracking echocardiography (2D-STE) for left ventricular regional longitudinal strain (RLS) immediately before invasive coronary angiography. Results showed that the mean age of patients was 57.2 (+ 7.9) years, regional longitudinal strain-speckle tracking showed that 38 patients had coronary artery disease (CAD) and 12 patients had no CAD, versus coronary angiography which showed that 29 patients had CAD, while 21 patient had no CAD or non significant lesions. The validity of RLS according to coronary angiography showed 100% sensitivity, 57.1% specificity, 76.3% positive predictive value (PPV), 100% negative predictive value (NPV) and 82% accuracy. It can be concluded from the current study that (RLS) Speckle-tracking echocardiography technique has high sensitivity but with relatively low specificity in diagnosis of coronary artery disease in patients with acute coronary syndrome.

KEYWORDS: ACS, CAD, NPV.

INTRODUCTION

Coronary artery disease (CAD) is mostly characterized by atherosclerosis in the wall of coronary arteries. Atherosclerotic plaques, the hallmark of atherosclerosis, progressively narrow the coronary artery lumen and impair antegrade myocardial blood flow. Coronary ischemia is a medical term for not having enough blood through the coronary arteries.[1] Modifiable CAD risk factors include cigarette smoking, obesity, hypertension, physical inactivity, chronic kidney disease, diabetes mellitus, alcohol consumption, stress and dyslipidemia, while non-modifiable risk factors include age males > 45 years, females >55 years, sex malws and family history of CAD.[2]

The term acute coronary syndrome encompasses unstable angina and acute myocardial infarction (MI). Unstable angina refers to new-onset or rapidly worsening (crescendo) angina, and angina on minimal exertion or at rest without myocardial damage. In MI there are symptoms at rest and myocardial necrosis occurs, leading to partial thickness, non-ST elevation MI (NSTEMI) or full thickness, ST elevation MI (STEMI).[3]

Speckle-tracking echocardiography is a new non-invasive ultrasound imaging technique that allows for an objective and quantitative evaluation of global and regional myocardial function.[4]

Speckle-tracking echocardiography is based on an analysis of the spatial dislocation of speckles (defined as spots generated by the interaction between the ultrasound beam and myocardial fibers) on routine 2-dimensional sonograms.[4]

Clinical application of STE include hypertension, Diabetes mellitus, coronary artery disease, valvular heart disease, heart failure, mechanical dyssynchrony cardiomyopathies, heart transplantation, left atrial function and identification of subclinical dysfunction during chemotherapy.[5]

PATIENTS AND METHODS

This cross-sectional hospital based study was conducted from March 2017 to 2018 in Baghdad teaching hospital/Iraq on (50) patients with (ACS) who underwent 2-dimensional speckle tracking echocardiography (2D-STE) for left ventricular regional longitudinal strain (RLS) immediately before invasive coronary angiography depending history of presentation and clinical examination of the patients.

Patients with acute coronary syndrome (STEMI, NSTEMI, unstable angina) who had planned for coronary angiography and suitable for transthoracic echocardiographic examination were included in the study, while patients with history of previous PCI, severe valvular heart disease, decompensated heart failure, severe LV. Hypertrophy, poor echocardiographic windows and advanced renal failure were excluded.

Institutional ethics committee approval was obtained and the personal and clinical data were collected including age, height, weight, HT, DM, Dyslipidaemia, smoking, family history of premature CAD and previous history of ischemia. Then the last ischemic event which suggest ACS was proven by ECG and cardiac enzyme (troponin I).

The transthoracic echocardiographic study was performed before coronary angiography using 2D and M-mode echocardiography, 2D/Biplane Simpson's method for estimation of EF% and 2D Speckle tracking TTE.

A commercial ultrasound system [Vivid E9, general Electric Healthcare, SN=VE97900, 2014.08] with a phase array transducer of 5.3 MHZ frequency with TDI and Speckle Tracking capabilities were also used with the subject in the left lateral decubitus position without breathing holding. Full detailed echocardiographic parameters were obtained from multiple views by two observers to avoid bias in results.

The regional Longitudinal strain (RLS) was measured by using a 17 LV segments model and from which end-systolic strain was measured. The peak negative systolic strain value (representing maximum segmental or regional systolic shortening) was recorded by fully automated software for each 17 segments of LV myocardium.

Based on a standardized model of myocardial perfusion territories, RLS was calculated as the average value of the segments belonging to each perfusion territory of the LAD, LCX, and RCA respectively and GLS was obtained using Bull's eye model measuring peak regional and global LV longitudinal strain of 17 segments was calculated.

2D - speckle-tracking was analyzed by automated functional imaging (AFI) in echo device. GLS was only computed from patients with > 92 % of segments adequately tracked (≥15 segments for a 17 - segments model). Given the average value of (-17 ± 0.1%) for normal GLS. Any value assessed by AFI < -16 % was considered as Impaired GLS.

The value of RLS −16 % was also considered to be abnormal and diagnosis of corresponding CAD if it involves more than 3 segments in the same coronary territories.[6]

The coronary angiography was done for all patient in the same day following speckle tracking echocardiography study ,using standard protocol and the diagnosis of culprit lesion was defined if there is stenosis > 50% in left mainstem coronary artery(LMCA) and if stenosis > 70 % in RCA, LAD and CX arteries.[6]

Statistical analysis

Data were analyzed using SPSS software version 21. Descriptive statistic [frequency, percentages, mean, SD, table, graph] and analytic statistics (t- test, ANOVA and chi square test) were used. P - Value of < 0.05 was considered statistically significant.

RESULTS

A total of 50 patients with coronary artery disease (CAD) were included in this study with mean age of 57.2 ± 7.9 years; 10 (20%) of them were less than 50 years of age, 23 (46%) were in the age group (50-59) years, 14 (28%) were in the age group (60-69) years and 3 (6%) were ≥ 70 years. Male patients with CAD were more than females with 1.9:1 male to female ratio as shown in table 1.

Table (1): Distribution of CAD Patients according to age and gender.

Variable	Patient NO.	%
Age Mean Age ± SD (57.2 ± 7.9 Years)		
< 50 Years	**10**	**20 %**
50-59 Years	**23**	**46 %**
60-69 Years	**14**	**28 %**
≥ 70 Years	**3**	**6 %**
Gender		
Male	**33**	**66 %**
Female	**17**	**34 %**

Typical chest pain was present among 42(84%) patients, while 16% of patients were presented with atypical chest pain. The ECG findings were abnormal among 35 (70%) of patients. Mean EF of patients was 56.0 ± 10.0 %, and 9(18%) had lower than normal EF. The 2D-RWMA was

found in 29 (58%) of patients, while LV. Dilatation was observed in 22 % of patients as shown in table 2.

Table (2): Clinical examination and 2D echo and ECG findings.

Variable	Patient No.	%
ECG		
Normal	15	30 %
Abnormal	35	70 %
EF	Mean ± SD (57% ± 10.0)	
Abnormal	9	18 %
Normal	41	82 %
2D-RWM		
Normal	21	42 %
Abnormal	29	58 %
LVEDD/LVESD		
Normal	39	78 %
Abnormal	11	22 %

The mean GLS of patients was -14.0 ± 3.0 % with 34(68%) had abnormal GLS. The LAD measured by RLS revealed that 25(50%) of patients had ischemic lesions. The LCX measured by RLS revealed that 38(76%) of patients had ischemic lesions, while RCA by RLS showed that 27(54%) of patients had ischemic lesions. In general, the RLS showed that 38(76%) of patients had abnormal findings as illustrated in in table 3.

Table (3): RLS Findings of patients.

Variable	No.	%
GLS	Mean ± SD (-14.0 ± 3.0 %)	
Normal	16	32 %
Abnormal	34	68 %
LAD- Related Segments(RLS)		
Normal	25	50 %
Ischemic Lesion	25	50 %
LCX-Related Segments(RLS)		
Normal	12	24 %
Ischemic Lesion	38	76 %
RCA- Related Segments (RLS)		
Normal	23	46 %
Ischemic Lesion	27	54 %
RLS- Speckle Findings		
Normal	12	24 %
Abnormal	38	76 %

LAD-angiography revealed that 12 % of patients had non- critical lesions and 17(34%) of them had critical lesion. LCX examined by angiography showed that 2(4%) of patients had non-critical lesions and 14(28%) had critical lesions. RCA examined by angiography revealed that 2(4%) had non-critical lesions and 16(32%) of them had critical lesions. Generally, angiography showed that 29(58%) of patients had significant lesions as shown in table 4.

Table (4): Angiography findings of patients.

Variable	No. of patients	%
LAD-Angiography		
Normal	**27**	**54 %**
Abnormal	**23**	**46 %**
Non-Critical Lesion	**6**	**12 %**
Critical lesion	**17**	**34 %**
LCX-Angiography		
Normal	**34**	**68 %**
Abnormal	**16**	**32 %**
Non-Critical Lesion	**2**	**4 %**
Critical Lesion	**14**	**28 %**
RCA-Angiography		
Normal	**32**	**64 %**
Abnormal	**18**	**36 %**
No-Critical Lesion	**2**	**4 %**
Critical Lesion	**16**	**32 %**
Angiography Finding		
No Critical Lesion	**21**	**42 %**
Critical Lesion	**29**	**58**

There was a significant association between abnormal GLS of CAD patients and critical angiography lesions P=0.001. A significant association was observed between ischemic lesion of LAD by RLS of patients and critical angiography lesions P=0.02. There was a highly significant association between ischemic lesions of LCX by RLS in CAD patients and critical angiography lesions P<0.001. CAD patients with ischemic lesions of RCA by RLS were significantly associated with critical angiography lesions P=0.002. In general, abnormal regional longitudinal strain (RLS) findings of CAD patients were significantly associated with critical angiography lesions P< 0.001. All these findings were shown in table 5.

Table (5): Distribution of (RLS) echocardiography findings according to angiography.

Variable	No Critical Lesion		Critical Lesion		P
	No.	%	No.	%	
LAD-Related Segments					
Normal	**16**	**76.2 %**	**9**	**31%**	**0.002*** S
Ischemic lesions	**5**	**23.8 %**	**20**	**69%**	
LCX- Related Segments					
Normal	**12**	**57.1 %**	**0**	**-**	**<0.001*** S
Ischemic lesion	**9**	**42.9 %**	**29**	**100%**	
RCA-related segments					**0.002*** S
Normal	**15**	**71.4 %**	**8**	**27.6%**	

Ischemic lesion	**6**	**28.6 %**	**21**	**72.4%**	
Speckle RLS findings in general					**<0.001*** S
Normal	**12**	**57.1 %**	**0**	**-**	
Abnormal	**9**	**42.9 %**	**29**	**100%**	

Chi square test, S= Significant.

The validity results of **LAD** examined with RLS showed 69% sensitivity, 76.2% specificity, 80% PPV, 64% NPV and 72% accuracy. The validity results of **LCX** examined with echo showed 100% sensitivity, 57.1% specificity, 76.3% PPV, 100% NPV and 82%. The validity results of **RCA** examined with echo showed 72.4% sensitivity and 7 1 . 4 % specificity, 77.8% PPV, 65.2% NPV and 72 %accuracy. In general, RLS had validity results of (sensitivity 100%, specificity 57.1 %, PPV 76.3%, NPV 100 % and accuracy 82 % as shown in table 6.

Table (6): Validity results of echocardiography regarding angiographicaly confirmed critical coronary lesions.

Variable	Sensitivity	Specificity	PPV	NPV	Accuracy
LAD-strain	69 %	76.2 %	80 %	64 %	72 %
LCX-strain	100 %	57.1 %	76.3 %	100 %	82 %
RCA strain	72.4 %	71.4 %	77.8 %	65.2 %	72 %
(RLS) in General	**100 %**	**57.1 %**	**76.3**	**100 %**	**82 %**

DISCUSSION

The current study showed a significant association between younger age CAD patients and critical angiography lesions (P=0.001). This finding is similar to results of Al-Koubaisy et al,[7] study in Iraq which reported that coronary artery diseases among younger age population of 40 years age and younger are frequent. Our findings regarding younger age patients are consistent with results of Suresh et al,[8] study in India who found that incidence of critical lesions of coronary arteries is high. Regarding gender, our study found a significant association between male CAD patients and critical angiography lesions (P=0.001). This finding is in agreement with the results of Mohammad et al[9] study in Iraq which stated that premature coronary artery lesions were more prevalent among male patients. Maroszyńska - Dmoch et al.[10] study in Poland examined the clinical and angiography findings of coronary artery diseases in young adult population and found that male gender is a significant risk factor in developing critical angiography lesions of coronary arteries. Early and accurate diagnosis of lesions of coronary artery disease is the cornerstone in the treatment of patients. The echocardiography is characterized by high accuracy and non- invasiveness in diagnosis of coronary artery diseases; however, it is affected by the radiologist experience and variance in interpretation of images.[11] The speckle tracking echocardiography is new diagnostic tool used mainly for checking the heart functions and detecting the deformities of myocardial activity.[12]

The present study showed that the validity findings of speckle tracking echocardiography in comparison to coronary angiography were sensitivity 100%, specificity 57.1%, PPV 76.3%, NPV 100 % and accuracy 82%. These findings are close to results of Aggeli et al study in Greece who revealed that use of echocardiography speckling is helpful in assessment of coronary artery disease and the sensitivity was 91%, while the specificity was 79% in comparison to coronary angiography. Hubbard et al.[3] in USA who explored the effectiveness of two dimensional speckle tracking echocardiography in assessment of coronary artery disease in women and found that echocardiography speckling is highly sensitive 97% and acceptable specific 86% in detecting abnormal lesion in women with normal left ventricular function. In Iran, a study conducted by Mabjoob et al.[14] recruited 216 patients suspected for coronary artery and examined them with both coronary angiography and speckle tracking echocardiography and found that the sensitivity of speckling echocardiography in assessment of coronary artery diseases is high (91.1%), while the specificity was low 63 %. Ng et al study in Australia stated that uniting abnormal wall motion analysis and longitudinal strain with dobutamine stress is very helpful in early detection of coronary artery disease. This finding might be attributed to fact that strain must be accompanied with stress test.[15] The speckle tacking by echocardiography could be achieved easily with low time waste as compared to magnetic resonance imaging.[16] The negative predictive value of 100% in our study for speckle echocardiography in prediction of coronary artery diseases is very important for excluding suspected cases with no coronary artery lesions, that will be helpful for medical staff in emergency units. The problem in speckle tracking is in the specificity and positive predictive value (false positive results) that lead to inclusion of normal cases as suspected with coronary lesions, that lead to time and resources wasting. The explanation of low specificity of speckling echocardiography is related to reduced strain of speckle tracking caused by microvascular dysfunction without significant stenosis of coronary artery disease.[17,18] The validity results of speckle tracking by echocardiography for LCX were better than validity results for assessment of LAD and RCA/PDA in comparison to coronary angiography. This finding is consistent with results of Anwar study in Saudi Arabia.[19] who concluded that

speckle tracking echocardiography is highly accurate for segmental longitudinal strain in detection of ischemia of myocardium. Moaref et al.[20] study in Iran included 37 patients with acute coronary syndrome and found that speckle tracking echocardiography is effective in diagnosis of non ST segment elevation acute coronary syndrome. Despite that, Mondillo et al.[21] study recommended the use of speckle tracking echocardiography as adjunct diagnostic method in assessment of coronary artery diseases.

The examination and investigations findings of patients with critical lesions of coronary arteries showed significantly typical chest pain, abnormal ECG, low ejection fraction, abnormal 2D Rwmsi, dilated LVEDVI and LVESVI. These findings are consistent with results of Cassar et al,[22] study in USA and Mahmoodzadeh et al,[23] study in Iran which stated that clinical examination, ECG and echocardiography findings are the main diagnostic tools for critical lesions of coronary arteries.

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