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The Role of 2-Dimensional Speckle Tracking Echocardiography in prediction of significant coronary artery

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Abstract

Background: Speckle tracking echocardiography is new technique to evaluate left ventricular function.

Objective: To evaluate sensitivity and specificity of two dimension global longitudinal strain (2D-GLS) estimated by speckle tracking echocardiography (2D-STE) to predict the diagnosis and degree of severity of CAD(coronary artery disease) in patient suspected to have stable ischemic heart diseases (IHD).

Patients and Methods: An observational cross-sectional study, patients underwent echocardiography (TTE), left ventricular (LV)systolic function were estimate initially, (calculate LVEF) then assessment of LV global and regional longitudinal strain (GLS) were calculated next.All patient underwent coronary angiography in the catheterization unite and according to the result of coronary angiography, we separated patients into two groups: one how have significant (≥70%) coronary arteries stenosis (group A),and another group with non- significant(<70%) coronary arteries stenosis (group B). The study was done in echocardiography unit and catheterization lab in Ibn-Albitar center of cardiac surgery, the study carried out from April 2018 to May 2019.

Results: This study 93 patients were included , there is mean ages was (60.2 ±6.3) years, majority of cases were males (72.0%), 47.3% of all cases had ≥3 risk factors, and according to angiography study (67.7%) had significant CAD .The frequency of DM, dyslipidemia, and the occurrence of ≥3 risk factors were significantly elevated in group A(patients with significant coronary artery stenosis) in comparison to the group B. Mean EF and GLS were considerably lower in group A related to group B. There was not much difference in GLS between single and two vessels involvement,

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however, the GLS value in three vessels was significantly lower compared to single and two vessels involvement. GLS were independent predictor of significant coronary artery stenosis, independent of the effect DM, dyslipidemia, and the presence of ≥3 concomitant risk factor.

Conclusion: Assessment (GLS) value by 2D speckle tracking echocardiography is good test for predicating diagnostic and severity of coronary arteries diseases, global longitudinal strain had positive relationship with increasing number of stenotic coronary arteries, and provides high quantitative diagnostic information for detection of the CAD.

Keywords: Echocardiography, significant coronary artery disease

Introduction

Speckle tracking echocardiography is a new technique for the assessment of cardiac function. By assessment of global longitudinal strain (GLS) we can provide important insight to myocardial deformation by advantage of being angle-independent [1, 2].

Two dimensional speckle tracking echocardiography(2D-STE) has been used for evaluate wide range of heart diseases, where it can predate myocardial disease process early when usual TTE appear to be normal[3, 4].

Deformation parameters of strain and strain rate: cardiac fibers has special helical architecture that's important to know when evaluate the myocardial deformation and concordantly study the myocardial fibers actions throughout period of contraction and relaxation (systole and diastole)in terms of shortening, thickening and torsion around its own axis .moreover to the closing of two myocardial opposite walls, the basal segment approximate to the apex in rotary motion in different directions that lead to the arrangement of vortex flows (vertical flows), where additional energy is conserved in comparison with linear flow mechanics. This principle, when applied for ejection period of systole, is essentially important given that it provides efficient absorption power throughout diastole [5].

Strain is dimensionless quantity of cardiac muscle deformation, strain(e) is the alteration of myocardial fibers length throughout stress between end-systole and its normal length at end-diastole. Strain is generally represented in per cent (%) while strain rate (SR) is defined as the alteration of strain per unit of time.Negative strain be a sign of cardiac fiber f or thinning, while a positive strain explain thickening or lengthening [6].

Reference values of (GLS) were well-known for both left ventricle (LV) and atrium[14]. However, there's no established value for peak systolic strain and strain rate(SR) to determent pathological conditions . normal left ventricle GLS values are global reference value ,(mean 6SEM) for the longitudinal peak systolic

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strain (GLPSS: 18.66%), peak systolic strain rate (PSSR:1.1060.01/s)[4].

Ischemic heart disease (IHD) recently became the main causes of morbidity and mortality that will improving with earlier management and of essential importance to assist the patients, decrease time of hospital stay and also economic costs[7]. Severe CAD is identified cause of LV dysfunction. In spite of this the LV systolic function(estimated by LV ejection fraction EF%) is commonly normal at in early diseased stage[8].

As GLS is decrease earliest in course of CAD. Therefore the assessment of LV deformation became the most sensitive diagnostic markers of IHD mainly in patients how have significant coronary arteries disease(stenosis)9. Choi [10] study found that in asymptomatic patient how have normal LV systolic function thesis significant association between decrease GLS value and stable IHD. in patients presented with acute coronary syndrome(STMI) , studies reported that GLS is positively correlated to the height levels of cardiac serum troponin T[11]. And , when calculated directly after revascularization therapy, GLS represent a good predication of left ventricular remodeling and other adverse events, such as heart failure and death [12]. Also other study reported that GLS value associates with the global extent of myocardial scar tissue when estimated by contrast- enhanced MRI [13].

The goal of our study was to evaluation the sensitivity and specificity of GLS obtained by 2D-STE in prediction diagnosis and severity of CAD in patient suspected to have stable IHD.

Patients and Methods

Study design: An observational cross-sectional study, patients underwent echocardiography (TTE), left ventricular (LV)systolic function were estimate initially, (calculate LVEF), then assessment of LV global and regional longitudinal strain were calculated next. All patient underwent transcutaneous coronary angiography in the catheterization unite and according to the result , patients were separated into two groups:

Group A: patients with significant (≥70%) coronary arteries stenosis (63 patients).

Group B:patients with no significant (<70%) coronary arteries stenosis(30 patient).

Setting: The study was done in echocardiography unit and catheterization lab in Ibn- Albitar center of cardiac surgery, the study carried out from April 2018 to May 2019.The study included initially 105 patients, of them 12 patients were discarded due to poor acoustic window, inappropriate for speckle tracking echo, ultimately only 93 patients were included in the study.

Exclusion criteria : patients with acute coronary syndrome (ACS), previous history of STMI (myocardial infarction), IHD managed by percutaneous coronary intervention (PCI) or CABG. Patients with LV systolic dysfunction (EF%≤50), moderate to severe valvular heart disease, chronic arrhythmias like permanent AF, large burden of premature ventricular complexes, and complete bundle branch block.

Variables: Detailed history was taken from the patients after referral for elective diagnostic coronary angiography, the patients were those suspected to have IHD.

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Additional information taken was history of chest Pain (typical or atypical),angina class, electrocardiographic changes, echo study, and the Maine cardiovascular risk factors (diabetes mellitus, hypertension hyperlipidemia, positive family history of IHD, and smoking history).

All patients underwent resttransthoracic echocardiography examination (TTE) and 2-D speckle tracking echocardiography (2D-STE).

Echocardiography: Two-dimension echocardiography and speckle tracking examination study of patents done using GE VIVID-9, assessment LV systolic function were done using end-diastole and end-systole dimension in long axis view and LV EF% was obtained.

Speckle tracking Strain analyses: Speckle trucking echo study obtained in three frequent heart cycle at rest under ECG monitor, in usual apical planes all three stander views was done (4-chambers, two-chambers, and long-axis). Were measured by 2D gray scale echocardiography these images were saved and then carefully analyzed. In each of these views, when the picture is opened in the program (software), the program automatically brings up the end-systolic frame of the cardiac cycle. If the automated frame choice not accurate, it can adjust itself manually.

By the software the left ventricle divided automatically in to the six segments in equidistant pattern and generates of global and segmental longitudinal(GLS), strain rate (SR), velocity and displacement curves.

Regional longitudinal strain was calculated in all 3 basic apical views t through a period of opening and closing of aortic valve of total of 17 segments that include sex basal and mid ventricular, four apical segment and final one segment of apical cup to give GLS.

The cut off point value for normal negative GLS of systolic left ventricular assessed by speckle tracking echo study was considered 18%.

Coronary Angiography (CA):CA was done by the percutaneous trance femoral and radial approach. Standard projections were obtained for all coronary vessel, significant lesion is recorded when>70% decrease in coronary calibrate, in supervision of general and intervention cardiologist' assessment of the coronary angiograms was visually performed.

Statistical Analysis

Separate variables obtainable by means of their number and percentage, chi square test used to examine the discrete variable. the differences in means between two groups will be analyzed by two samples t test (if both groups follow normal distribution with no important outlier), whereas one way ANOVA use to investigate the differences between more than two groups ,subsequently if the results is significant post Hoc Tukey test will be used to find which pair is significant. Binary logistic regression analysis used to calculate the odd ratio (OR) and their 95% confidence intervals, the result can be classify into two binary levels. Linear regression analysis achieve to evaluate the association among different variables. Scatter plot used to present the regression analysis, r s (correlation coefficient is a representative of magnitude and direction of the relationship). Receiver operator curve used to see the cogency of different parameters in separating active cases from control (negative

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cases) and area under the curve i.e. AUC and its p value prescribe this validity (if AUC ≥ 0.9 mean excellent test, 0.8 –0.89 means good test, 0.7 – 0.79 fair test otherwise unacceptable). Trapezoidal the ability. Sensitivity is defined as the ability of screening test to recognized all people how have disease , (true positive rate). Specificity is defined as the ability of screening test to recognized people how have no disease ,(true negative rate). Positive predictive value: Probability that the disease is present when the test is positive.

$$PPV = \frac{sensitivity \times prevalence}{sensitivity \times prevalence + (1 - specificity) \times (1 - prevalence)}$$

Negative predictive value: Probability that the disease is not present when the test is negative.

$$NPV = \frac{specificity \times (1 - prevalence)}{(1 - sensitivity) \times prevalence + specificity \times (1 - prevalence)}$$

SPSS 22.0.0 (Chicago, IL)software package used to make the statistical analysis, p value considered when appropriate to be significant if less than0.05.

Results

The study included 93 patients, their mean age was 60.2 ± 6.3 years, the majority of cases were males (72.0%), 47.3% of all cases had ≥3 risk factors, and according to angiography study 67.7% had significant CAD,as illustrated in table 1The frequency of DM, dyslipidemia, and the presence of ≥3 risk factors are significantly greater in group A compared to group B, as illustrated in Table (3).

Table (1): Comparison of various variables according to the level of stenosis in coronary arteries

Variable	Group A	Group B	All	p-value
Number	63	30	93	-
Age (years), mean ± SD	60.3 ± 6.6	60.0 ± 5.6	60.2 ± 6.3	0.813
Gender, n (%)				0.425
Female	16 (25.4%)	10 (33.3%)	26 (28.0%)	
Male	47 (74.6%)	20 (66.7%)	67 (72.0%)	
Hypertension, n (%)	37 (58.7%)	17 (56.7%)	54 (58.1%)	0.850
DM, n (%)	36 (57.1%)	9 (30.0%)	45 (48.4%)	0.014
Family history of IHD, n (%)	26 (41.3%)	8 (26.7%)	34 (36.6%)	0.172
Smoking, n (%)	20 (31.7%)	13 (43.3%)	33 (35.5%)	0.275
Dyslipidemia, n (%)	48 (76.2%)	10 (33.3%)	58 (62.4%)	<0.001
Patients with ≥3 risk factors, n (%)	35 (55.6%)	9 (30.0%)	44 (47.3%)	0.021
Group A: ≥70% coronary artery stenosis, Group B: <70% coronary artery stenosis				

The distribution of vessels involvement according to angiography study are shown in Table (2).

Table (2): Distribution of study sample according to coronary artery findings

	Value
No significant CAD	30 (32.3%)
Single vessel involvement	26 (28.0%)
Two vessels involvement	21 (22.6%)
Three vessels involvement	16 (17.2%)
CAD: coronary artery disease	

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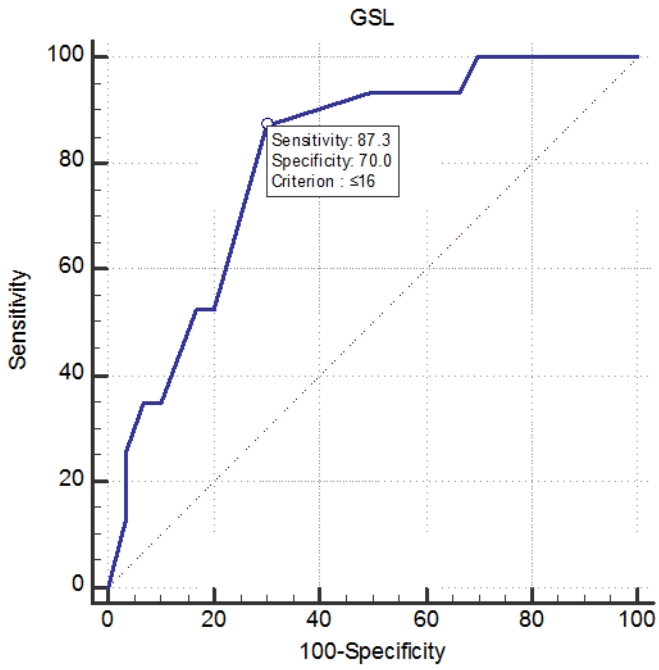
Mean EF and GLS were significantly lower in group A compared to group B, as illustrated in Table (3).

Table (3): Distribution of ejection fraction and GLS according to level of stenosis in coronary arteries

Variable	Group A	Group B	p-value
Number	63	30	-
EF (%), mean ± SD	54.7 ± 2.6	60.7 ± 2.4	<0.001
GLS (-%), mean ± SD	14.7 ± 2.2	17.6 ± 2.7	<0.001
EF: ejection fraction, GLS: global longitudinal strain			

Overall, GLS had good ability (since the AUC between 0.8 – 0.89) as diagnostic methods for predicting significant coronary stenosis, as illustrated in Figure (1).



	AUC	95%CI	p-value
GLS (-%)	0.810	0.715 – 0.884	<0.001
GLS: global longitudinal strain, CI: confidence interval, AUC: area under the curve			

Figure (1): ROC curve analysis of the role of GLS as predictor of significant coronary stenosis

In order to determine the value of GLS which represent the optimal cut off Youdenindex was used (J = max (sensitivity + specificity – 1)) and at cut off ≤16.0, maximum accuracy was reported, this cut point offered higher SN compared to SP (87.3 vs. 70%), also the PPV was higher than its NPV (85.9 vs. 72.4%), as illustrated in Table (4).

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Table (4): Assessment of diagnostic accuracy of GLS as predictor of significant stenosis

	Cut – off	SN	SP	PPV	NPV
GLS (-%)	≤16.0	87.3	70.0	85.9	72.4
GLS: global longitudinal strain, SN: sensitivity, SP: specificity, PPV: positive predictive value, NPV: negative predictive value					

There was no significant difference in GLS between single and two vessels involvement, however, the GLS value in three vessels was significantly lower compared to single and two vessels involvement, as illustrated in Table (5).

Table (5): analysis of GLS according to extent of vessels involvement

	Number of vessels involvement				p-value
	No vessel	Single	Two	Three	
Number	30	26	21	16	-
GLS	17.6 ± 2.7	15.3 ± 2.2	15.7 ± 0.6	12.4 ± 1.7	<0.001
Pairwise comparison (p-value)					
No vessel vs single		**Single vs two**		**Two vs three**	
0.001		0.931		<0.001	

There was direct significant correlation between GLS and LVEF in the patients, as illustrated in Figure (2).

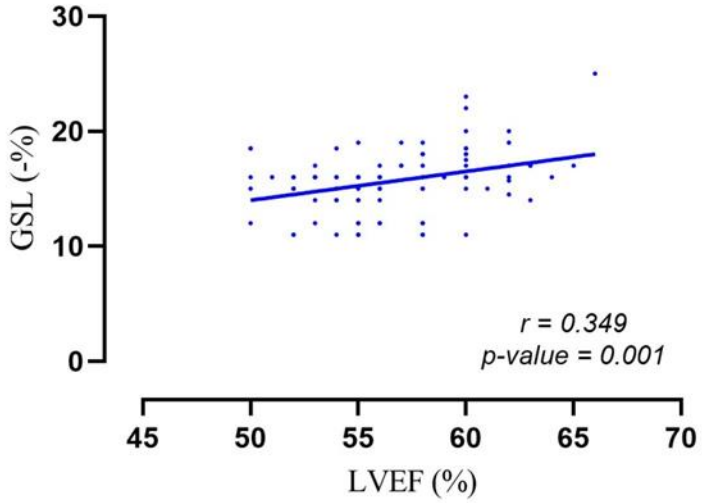

Figure (2): Relationship between GLS with LVEF in all the patients

Based on the result from table 3 the following risk factor were entered the statistical model to the relationship between GLS with associated with significant coronary artery stenosis, (DM, dyslipidemia, and the presence of ≥3 concomitant risk factor), to exclude their effect from the relationship.GLS were independent predictor (i.e. it relationship with significant coronary artery stenosis is not affect by other variables) of significant coronary artery stenosis, independent of the effect DM, dyslipidemia, and the presence of ≥3 concomitant risk factor, as illustrated in table (6).

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Table (6): multivariate analysis of the GLS and other risk factors as predictor of significant coronary artery stenosis

Variables	OR	95%CI	p-value
GLS	0.534	0.382 – 0.746	<0.001
≥3 risk factors	0.861	0.007 – 9.642	0.903
DM	2.971	0.309 – 28.561	0.346
Dyslipidemia	3.826	1.080 – 13.550	0.038
R^2 (Cox & Snell) = 0.352 **OR: odd ratio, CI: confidence interval**			

Discussion

Coronary artery disease (CAD) is identified predictor of of ischemic heart disease(IHD) prognosis , since significant stenosis of coronary artery leads to widespread myocardial ischemia [14]. In patient with three-vessel CAD when most LV wall are exposed to ischemia, is another high-risk group and thus treatment by coronary bypass surgery(CABG) is commonly needed to enhance long-term prognosis in symptomatic patients [15].

While stress testing (exercise or pharmacological) has high sensitivity for three-vessel (3VD) and left main CAD, Therese increasing patients risk in this tests [16].also , in some patients who has left main CAD, exercise(stress/rest) myocardial perfusion imaging(MPI) may be have normal result and not demonstrate any transient or fixed perfusion defect due to balanced ischemia [17]. Most of these patients when assessed by trance thoracic echocardiography study they have no regional wall motion abnormality and normal LV systolic function at rest and its useful to predicate the severity of CAD by using different resting parameter . Calculation of GLS by speckle tracking echocardiography study was newly advanced for the quantitative assessment of LV systolic function [18].

In the present study mean age of patients was 60.2 ± 6.3years, m ,most of patient where a male(72%) witch was in agreement with Choi et al study in which mean 59 ± 9 years, with 70.8% males [14], and similar to Radwan and Hussein study in which mean between 51.6 to 55.5 years, and 65% were males (19.32), in Nucifora et al study which involved 182 participants, with mean age 54 ± 10 years with 59% were males [20].

In the present study dyslipidemia was significantly elevated in patients with significant CAD (76.2% vs. 33.3%) compared to those without significant CAD, which agreed with Choi et al in which 42.1% of the high-risk CAD had dyslipidemia while 16.7% of the normal patients had dyslipidemia (p-value = 0.033) [14], and similar to Radwan and Hussein study (55.2% vs. 18.2%, p-value = 0.03) [19], in Nucifora et al study hypercholesteremia was significantly elevated in subjects with severe CAD compared to those with non-obstructive CAD (59% vs. 43%) [20].

Regarding cardiovascular risk factors, patients with hypertension (elevated mean arterial blood pressure) also evident in patients with increased afterload as in aortic stenosis, theirs independent association with lower GLS values [21,22], and also decreased GLS has been found in children and adolescents with hyprcholestremia how

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has negative history of cardiovascular risk factors or heart diseases in comparison with controls group [23].

In the present study 67.7% of patients had significant (>70%) CAD, this agreed with Radwan and Hussein study in which 72.5% had significant CAD [19,32]. And theirs considerable decrease of GLS value in patients with significant(>70%stenosis)CAD in comparison to those with non significant CAD , mean values of (GLS) were (- 14.7 ± 2.2vs - 17.6 ± 2.7). After performing ROC analysis GLS was found to have good ability to predict significant CAD (≥70% stenosis) at cut off >16.0%, with sensitivity (SN) and specificity (SP) (87.3% and 70.0%) positive predictive value (PPV) of (85.9%), and negative predictive value (NPV) of (72.4%) for rest 2D-STE in predict of significant CAD.This indicate that estimation of LV deformation by calculated GLS value at rest had important diagnostic correctness in predicting significant CAD.

Our findings agreed with Choi et al study in which 38 high risk CAD compared to 28 low risk CAD (18.0 ± 2.3 vs. 19.4 ± 2.4%; p-value = 0.032. respectively), and in ROC analysis the AUC for predicting high risk CAD was 0.803, at <19.4 optimal cut off with 76.5% SN and 74.1% SP [14], similar to Radwan and Hussein study in which mean values of (GLS) were (11.86 ± 2.89 vs 18.65± 0.79, p < 0.000), AUC = 0.88, optimal cut-off <15.6, 93.1% SN, 81.8% SP, 93.1% PPV, and 81.8% NPV [19], similar to Ng et al which included 102 patients mean GLS was significantly lower in those with significant CAD (16.3 vs 19.1, p-value = 0.001), the optimal cut-off was >17.4% with 84.2% SN, and 87.5% SP [24], similar to Nucifora et al study with GLS <17.4% (83% SN, 77% SP) associated with obstructive CAD [20].

Shimoni *et al.* study incorporated 97 patients how supposed to have CAD. When assessment GLS value it was significantly deceases' in patients with significant (>70% stenosis) CAD in related to those patient with non-significant CAD, with mean values of (GLS) were (17.3 ± 2.4 vs 20.8 ± 2.3 p-value < 0.001). and they found that GLS value less than and equal 19.7 may predict significant coranry artery stenosis (>50%) with sensitivity 81% and specificity 67% (AUC = 0.85) [25].

Montgomery *et al*. also study the significant value of GLS in patient with IHD. And they reported that patient complain of significant CAD has decrease GLS value ,mean values of (GLS) were (16.8± 3.2 vs 19.1 ±3.4, p <0.000). They found that GLS ≤17.8 may predict significant CAD stenosis (>50%) , with sensitivity and specificity 66% ,76% respectively [26].

CAD represent one of the important causes of LV systolic and diastolic dysfunction [27]. Same studies previously identified elevated prevalence LV diastolic dysfunction in patients with IHD and have normal left ventricular systolic function [28,41, 29,42]. in addition, a progressive decline of LV relaxation function has been recorded in positive relation to the number and severity of coronary diseased vessels [28, 30] and improvement LV diastolic function (returned to normal function)has been reported after percutaneous coronary artery revascularization [31].one of mechanisms that explain this association, is the recurrence of subclinical ischemia

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(microvascular) may lead to impair LV diastolic function, which is an active, energy-dependent process [32]. Moreover , the severely abstracted coronary blood flow may initiate structural cardiac muscle remodeling witch lead to LV diastolic dysfunction [28].

In multivariate analysis GLS was independent predictor of significant CAD, which was in agreement with Radwan and Hussein study (OR = 1.52, p-value <0.001) [19], in agreement with Nucifora et al study (OR 1.97, 95%CI 1.43-2.71) [20].

Few previous studies addressed regarding study the subjects of subclinical presentation of left ventricular systolic dysfunction and comparison to the CAD, showed differing results. A study like Bolognesi et al , found a decrease of LV longitudinal strain (shortening) in patients with significant CAD when evaluated by tissue-Doppler and long-axis M-mode echocardiography, in spite of normal LV systolic function(LVEF), [33]. On the othe hand, Yuda et al study showed no changes in systolic myocardial velocity value and strain rate when estimated by (tissue-Doppler TTE) among different LV segments supplied by coronary artery with significant and non significant CAD [28].

Newly , Edvardsen et al study the significant of myocardial strain when estimated by tagged cardiac MRI and CAD (expressed as calcium score by MSCT or electron-beam computed tomography) in a large percent of patients population how has no history of IHD and hav normal LV systolic function. a significant relation found between the impaired regional LV systolic function and the occurrence of coronary disease(atherosclerosis) [34].

Interestingly, a progressive decline of LV systolic function estimated by lowering GLS value that found in significant CAD; and , there's an independent association between lower GLS value and severe CAD. Un explanation of this result will agreement with the theory witch suggested that subclinical myocardial injure may be a indicator of coronary arteries atherosclerosis in spit of the absence history of myocardial infarction, which may be due to small-vessel microembolization , endothelial damage (dysfunction), and chronic ischemia [34].

Conclusions

Assessment global longitudinal strain value by 2D-STE is sensitive and specific for predicating diagnostic and severity of coronary arteries diseases, global longitudinal strain had positive relationship with increasing number of stenotic coronary arteries, and provides high quantitative diagnostic information for detection of the CAD.

Recommendations

Assessment of GLS by 3D speckle tracking echocardiography my need to become one of non-invasive parameters in risk stratification of patients with suspected CAD. In future study using wide range of speckle tracking parameters may enhanced the significant o 2D-STE study in IHD.

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Ethical clearance: The project for this study was taken from the College of Medicine/ University of Diyala ethical committee.

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Conflict of interest: Nill

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فحص تتبع البقع في ثنائي صدى القلب يتوقع ان يساهم في تشخيص وشدة مرض الشرايين التاجية في امراض القلب الاقفازي المستقر

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الملخص

خلفية الدراسة: يعد تخطيط صدى القلب لتتبع ضربات القلب طريقة جديدة لتقييم عضلة البطين الايسر للقلب.
اهداف الدراسة: لتقييم دقة تشخيص السلالة الطولية العالمية ثنائية الابعاد (GLS) التي تم الحصول عليها من خلال تخطيط صدى القلب لتتبع البقع وللتنبؤ بالتشخيص والشدة لمرضى تضيق الشرايين التاجية التي تكون حالتهم مستقرة.
المرضى والطرائق: شملت دراستنا ١٠٥ مريض، تم رفض ١٢ مريضاً في نهاية المطاف تم تضمين ٩٣ مريضاً بالدراسة. خضع المرضى لفحص صدى القلب وتم تقييم وضيفة عضلة القلب اولاً، ثم تم تقييم السلالة الطولية العالمية ثنائية الابعاد. خضع كل مريض لتصوير الاوعية التاجية عبر الجلد في مختبر القسطرة. تشير مجموعات السحب المقسمة ببراءة الاختراع، المجموعة الاولى ان تكون موجبة وتشمل ٦٣ مريضاً لديهم تضيق كبير في الشرايين التاجية اكثر من ٧٠%. المجموعة الثانية (ب) ويشار اليهم بأنهم سلبيون بلا دلالة اقل من ٧٠% تضيق الشرايين التاجية.
النتائج: شملت دراستنا ٩٣ مريض معدل اعمارهم ٦٠,٢ +- ٦,٣ سنة غالبيتهم من الرجال ٧٢,٠%. نسبة الذين لديهم اكثر من ثلاثة اسباب او اكثر من اسباب تصلب الشرايين كانت ٤٧,٣%. واعتماداً على نتيجة تلوين الشرايين التاجية تبين ان ٦٧,٧% من المرضى لديهم تضيق كبير في الشرايين التاجية. نسبة مرضى السكر ومرضى زيادة الدهون ووجود اكثر من ٣ اسباب لتصلب الشرايين كانت مرتفعة بالمجموعة A بالنسبة للمجموعة B. معدل EF و ال السلالة الطولية العالمية، كان اقل بشكل مهم مقارنة بالمجموعة A. لم يكن هنالك فرق كبير بنتيجة السلالة الطولية العالمية في شريان واحد من الشرايين التاجية او اثنين. بينما السلالة الطولية لثلاثة اوعية تاجية مريضة كانت اقل بالمقارنة بشريان تاجي او اثنين للمرضى. السلالة الطولية العالمية مؤشر مستقل لشدة تضيق الشرايين التاجية مستقل عن مرضى السكر وعن وجود اكثر من وجود ثلاثة عوامل لتصلب الشرايين.
الاستنتاجات: تقييم السلالة الطولية العالمية بوساطة فحص صدى القلب المتتبع للبقع ثنائي الابعاد هو فحص جيد للتنبؤ بتشخيص وبيان الشدة في مرضى الشرايين التاجية. السلالة الطولية العالمية لها علاقة ايجابية مع زيادة عدد الشرايين التاجية المتضيقة وتوفر معلومات تشخيصية كمية دقيقة لتشخيص امراض القلب الاقفازي المستقر.

الكلمات المفتاحية: تخطيط صدى القلب ، مرض الشريان التاجي الكبير

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