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# SPECKLE TRACKING ECHOCARDIOGRAPHY IN PATIENTS UNDERGOING PCI

Cardiology

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## ABSTRACT

**INTRODUCTION:** Coronary Artery Disease is the leading cause of death worldwide. Effective management of this epidemic imposes a technical challenge. In addition to the routine clinical and ECG evaluation, Echocardiography is an integral part of CAD management. Assessment of Left ventricular (LV) function and the regional wall motion of individual myocardial segments is the essence of Echocardiography. Traditionally the regional wall motion is assessed subjectively by 2D imaging and objectively by calculation of wall motion score index. These modalities have their own limitations. The introduction of Strain imaging has added substance to the imaging of patients with CAD. Hence aim of this study is to evaluate the usefulness of 2D/4D speckle tracking imaging in prediction of LV remodelling before and after revascularization with PCI. **MATERIALS AND METHODS:** This study was done in the Department of Cardiology, Government Dharmapuri Medical College as a prospective study over a period of 4 months in 20 (16 males and 4 females) consecutive patients who were scheduled for percutaneous coronary intervention in whom ≥70% of stenosis of culprit artery with TIMI 1 or 2 flow were enrolled in this study. 10 age and gender (8 males and 2 females) matched normal subjects served as controls. **RESULTS & CONCLUSIONS:** Abnormal longitudinal strain, strain rate, transverse velocity and displacement were present before PCI and these parameters improve significantly after PCI irrespective of wall motion abnormality. Improvement of LV function after PCI was mainly by augmentation LV longitudinal mechanics which is shown by improvement in longitudinal strain with persistence of abnormal WMSI. 4D speckle tracking derived LV volumes and ejection fraction have shown substantial improvement following PCI, hence these parameters may be utilised to monitor patient progress.

## KEYWORDS

Speckle Tracking Echocardiography, Percutaneous Coronary Intervention.

## INTRODUCTION

Coronary Artery Disease is the leading cause of death worldwide. Every year about 100,000 people in the United States suffer acute Myocardial Infarction (AMI)[1]. The AMI incidence though shows declining trend in the west it is on the rise in the developing world[2]. In addition to the routine clinical and Electrocardiographic (ECG) evaluation, Echocardiography is an integral part of AMI management. Assessment of overall Left ventricular (LV) function and the regional wall motion of individual myocardial segments is the essence of Echocardiography in the patients with AMI. Traditionally the regional wall motion is assessed subjectively by 2D imaging and objectively by calculation of wall motion score index[3,4]. Global LV function is usually assessed by Teichholz and Simpson`s methodologies. These modalities have their own limitations in patients with Acute myocardial infarction. The introduction of Strain imaging has added substance to the imaging of patients with AMI. Strain and strain rate imaging has overcome the disadvantages of 2D as well as Tissue Doppler. The modality of Strain imaging is fast advancing with the initial reports of Doppler based strain imaging now giving way to strain by 2D Speckle tracking. Based on this aim of our study is to evaluate the usefulness of 2D/4D speckle tracking imaging in prediction of LV remodeling before and after revascularization with percutaneous coronary interventions (PCI).

## MATERIALS AND METHODS

This study was done in the Department of Cardiology, Government Dharmapuri Medical College, Dharmapuri. This is a prospective study done over a period of 4 months. 20 consecutive patients who were scheduled for percutaneous coronary intervention in whom ≥70% of stenosis of culprit artery with TIMI 1 or 2 flow were enrolled in this study. 10 age and gender matched normal subjects served as controls. Patients with chronic stable angina, acute coronary syndrome, healed myocardial infarction who underwent PCI for significant single coronary artery stenosis and in sinus rhythm. Whereas patients with unstable rhythm, severe left ventricular dysfunction, prior CABG, associated valvular heart disease, permanent pacemaker implantation, congenital heart disease, cardiomyopathies and critically ill patients were excluded.

All patients have undergone routine 2D Echocardiographic evaluation for ejection fraction, wall motion abnormalities and wall motion score and 2D/4D speckle tracking echocardiography before and within 48 hours after PCI. Control subjects have undergone 2D echocardiographic evaluation for the same parameters and 2D/4D speckle tracking echocardiography once. ESAOTE My Lab 7 echocardiographic system was used for this study. For analyzing 2D and 4D speckle tracking echocardiography X-strain software was used.

The study was approved by the Local Medical Ethics Committee and all the participants included in the study had given their written informed consent. All continuous data are reported as mean ± SD. The categorical data are reported as percentage. For comparison of qualitative (categorical) data chi square test was used. For comparison of continuous variables unpaired t test was used. SPSS software version 20 was used for statistical analysis.

## RESULTS

According to angiographic findings majority of the patients had single vessel disease i.e 17 out of 20 (85%), two (10%) patients had two vessel disease. One (5%) patient had triple vessel disease. All patients underwent PCI with bare metal stenting. Majority, 17 out of 20 (85%) of patients had significant disease in (i.e >70% stenosis) in LAD. 2 patients (10%) had disease in Obtuse marginal and one (5%) had significant stenosis of RCA. Two patients already underwent PCI in other coronary vessel (one in LAD, one in LCX). Two patients required deployment of two stents in LAD.

Study group had a total of 20 patients - 16 males (85%) and 4 females (15%). Control group consists of 10 normal individuals - 8 males (80%) 2 females (20%). Mean age in study group was 49±8. Mean age in control group was 40±5. Between study and control group age wise no significant (<0.05) difference was found.

Among study group 10 (50%) patients had history of recent (<1month) acute myocardial infarction and also undergone thrombolysis with streptokinase. 3 (15%) patients had old myocardial infarction of > 2 months. All patients received thrombolytic therapy with streptokinase. Most patients from study group came with complaints of effort angina class II (85%), next important symptoms were dyspnea (65%) mainly of class II. Except 4 (20%) patients who gave history of chronic stable angina, all other patients had history of previous myocardial infarction.

Coming to Echocardiography, ejection fraction, Wall motion score index were obtained using standard methods recommended by American society of echocardiography. Table 1 shows comparison of various parameters, End diastolic dimension, End systolic dimension and LVEF among patients before and after angioplasty.

**Table 1: Comparison of 2D – ECHO.**

| | Mean | Std. Deviation | P value |
|---|---|---|---|
| EDD-Pre | 4.8550 | .63202 | 0.428 |
| EDD-Post | 4.8150 | .56501 | |
| ESD-Pre | 3.7600 | .66364 | 0.004 |

| | | | |
|---|---|---|---|
| ESD-Post | 3.6600 | .63776 | |
| LVEF- Pre | 49.1500 | 8.05426 | 0.524 |
| LVEF- Post | 49.8000 | 8.08898 | |

There is no significant difference in LVEF pre- and post-angioplasty as measured by M-mode Teichholz method. However, ejection fraction is an indirect measurement of left ventricular function and LVEF may improve at a later date. Also there is no significant difference was noted in WMSI after intervention. Most patients had normal diastolic function or Grade I diastolic dysfunction after PCI. There was some improvement in LV diastolic function following PCI.

In 2D & 4D STE global longitudinal strain was the major parameter assessed, which is more relevant and affected early by myocardial ischemia and recovery too. In all 17 segment it was assessed

Global longitudinal strain appears abnormal which is statistically significant ($p < 0.001$) when study group before PCI is compared to control group. Significant decrease in strain was present in the following segments 1) Basal anterior 2) basal anterior septal 3) mid anterior 4) mid anterior septal 5) mid anterior lateral 6) mid inferior(R) 7) mid inferior, 8) mid inferior septal(R) 9) apical anterior 10) true apex. which predominantly involve LAD territory. Very few had decrease in strain in RCA & LCX segments. Most of the patients in study group had LAD disease and received for stent to LAD. Some patients had associated RCA and LCX .

When comparing 17 segments of study group after PCI with normal controls global longitudinal strain has shown statistically significant ($p<.001$) decrease in strain. Significant decrease in strain was present in the following segments 1) Basal anterior 2) mid anterior 3) mid anterior septal 4)mid anterior lateral 5) mid inferior 6) mid inferior 7) apical anterior 8) true apex with 9)apical inferior. Same segment which showed the significantly reduced strain pattern was present in post PCI excluding 1)basal anterior septal and 2)mid inferior septal, which predominantly represented LAD territory. Significant ($p<0.001$) improvement was present in only 2 segments when compared to pre PCI with normal.

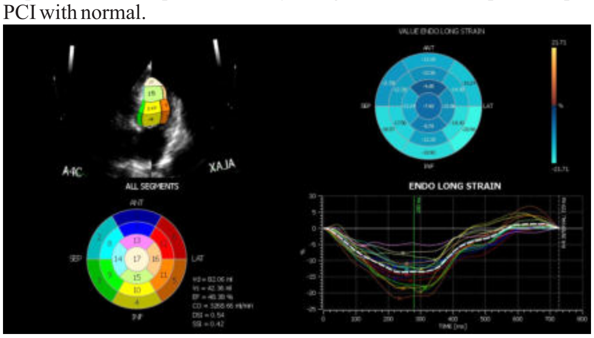


**Fig. 1: ECHO -4D speckle tracking showing longitudinal strain with bull's eye mapping of 17 segments before PCI.**

When comparing pre PCI and Post PCI cases of 17 segments the following 5 segments which show statistically significant ($p<0.050$) improvement in longitudinal strain within 48 hrs. Segments which show significant improvement are 1) basal anterior septal 2) mid anterior septal 3)mid inferior lateral 4)apical septal 5) mid anterior.
While comparing pre- and post-PCI with normal controls, there is statistically significant difference in global longitudinal strain and transverse displacement. Global Longitudinal Strain has improved following PCI but Global longituidal strain rate was not very different after PCI.

Data derived from 4D speckle tracking echocardiography shows increase in end systolic and end diastolic volumes when compared with normal controls. After PCI there is no significant difference in volumes. But Ejection fraction had improved after PCI, ($p<0.001$).

When comparing 2D strain parameters there is statistically significant improvement in longitudinal strain and strain rate, transverse displacement and transverse velocity.($p<0.050$). 4D strain derived LV volumes and ejection fraction when directly compared pre PCI with post PCI cases showed that there is statistically significant($p<0.001$) improvement in end systolic volumes and ejection fraction.

## DISCUSSION

Strain imaging measures tissue deformation rather than tissue velocity. It localizes regional wall motion abnormalities as does the conventional methods like wall motion score index. Conventional methods are based on the principle of measuring tissue velocity. Hence strain imaging (by STE) using peak systolic longitudinal strain in patients undergoing revascularisation by PCI may be used to overcome this disadvantage and quantify both wall motion score and overall LV systolic function.

Strain can be measured in all three dimensions as the tissue deforms three dimensionally. Thus the deformation in the longitudinal, radial and circumferential planes can be assessed in a patient undergoing PCI. However the Longitudinal fibres are the main fibres distributed in the Sub- endocardial region, the region most susceptible for ischemia. Thus measurement of longitudinal strain is more reasonable to assess effect of revascularization in a patient undergoing PCI. Our study demonstrated that longitudinal strain is abnormal after Acute MI and improves following PCI. Improvement in longitudinal strain and strain rate predicts improvement of LV function. Even though the WMSI is persistently abnormal thorough out our study longitudinal strain is the earliest to recover after myocardial infarction, and also provides insight that how LV function recovers following myocardial ischemia.
WMSI score was included in this study because it represents cumulative burden of abnormally functioning myocardial segments that result in LV systolic dysfunction[5,6]. Higher the wall motion score even with preserved EF following AMI was associated with increased morbidity and mortality[5]. In our study WMSI has not recovered significantly after PCI.

Currently studies are going on actively studying strain and strain rate for prognosis after acute MI[7]. It has been found that global LS founds to be correlates with myocardial viability and it predicts recovery of LV function after acute MI. One study[8] (2005) done using TDI and STE in patients who underwent PCI or thrombolysis, has shown that longitudinal strain predicted LV dilatation with increased LV volume during 18 months follow up. Strain was able to predict independently death and congestive heart failure.

In the study from Norway[9] 17 patients undergoing angioplasty of the LAD were assessed. Left ventricular longitudinal wall motion was assessed by Tissue Doppler Echocardiography and Strain Doppler Echocardiography from the apical 4 chamber view before, during and after angioplasty from multiple myocardial segments simultaneously. Segments which were not supplied by LAD remained unchanged. TDI showed reduced velocities in all septal segments ($p = 0.05$) during Angioplasty. Wall motion score index increased during ischemia ($p=0.05$). It was concluded that the new SDE approach might be a more accurate marker than TDE for detecting systolic regional myocardial dysfunction induced by LAD occlusion. The results of our study correlates well with that of this study mentioned. This was one of the pioneering studies by the authors early in 2001 regarding the utility of the new modality at that point of time.

One study done in Mayo clinic USA[10] (2010) in STEMI patients undergoing primary PCI, 2D speckle tracking echocardiography was evaluated. Similar to our study there is marked attenuation of endocardial and epicardial LS at 48 hrs following PCI ($p<.001$). An improvement of LVEF i.e >5% following PCI was seen in 24 patients (57%) and associated with improvements in endocardial ($p<0.001$) and epicardial longitudinal LS($p=0.003$) also circumferential strain($p=0.001$).

These results are similar to our study. Improvement of LV function occurred because of change in longitudinal strain. But in our study only longitudinal strain was taken along with WMSI. Radial and circumferential strain were not measured. Additionally, 4D derived values of LV volumes with EF were measured in our study before and after PCI that have shown substantial improvement than WMSI.

## CONCLUSIONS

Abnormal longitudinal strain, strain rate, transverse velocity and displacement were present before PCI and these parameters improve significantly after PCI irrespective of wall motion abnormality. Improvement of LV function after PCI was mainly by augmentation LV longitudinal mechanics which is shown by improvement in longitudinal strain with persistence of abnormal WMSI. 4D speckle tracking derived LV volumes and ejection fraction have shown substantial improvement following PCI, hence these parameters may be utilised to monitor patient progress.

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