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# ASSESSMENT OF CHANGES IN LEFT VENTRICULAR FUNCTIONS AFTER PERCUTANEOUS CORONARY INTERVENTION OF CHRONIC TOTAL OCCLUSION OF LEFT ANTERIOR DESCENDING ARTERY; ECHOCARDIOGRAPHY AND TISSUE DOPPLER STUDY

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## ABSTRACT

Chronic totally occluded lesions (CTO) are common, and over the past 20 years, CTO lesions have represented the most difficult anatomy for treatment with lower success rates and higher complication rates, CTO continue to represent one of the greatest challenges to interventional cardiologists. Although data are limited, successful percutaneous coronary intervention (PCI) may improve ventricular relaxation and regional wall motion, global ejection fraction improved in some studies, but not in another, among patients with successfully recanalized occlusions, those with persistent patency and normal flow had better global function and less ventricular dilatation than patients without patent vessels. **Aim of the work**: The purpose of this study is to assess change in left ventricular functions using conventional echocardiography and tissue Doppler study in patients with chronic total occlusion of Left Anterior Descending (LAD) after Percutineous Coronary Intervention (PCI). **Subjects and methods:** The study was conducted through the period from April 2011 to April 2014 and included 30 patients, 22 (73.3%) males and 8 (26.7%) females, with age from 40 to 67 years old with mean age 55.92. They were selected from patients admitted to Cardiology department in Al-Azhar University Hospitals**.** Inclusion criteria: Patients with Chronically Occluded Left Anterior Descending Artery**.** Exclusion criteria: Patients with rheumatic heart disease, Patients with end stage renal disease, Patients with end stage liver disease, Heamodynamicaly unstable patients, Patients with acute coronary syndrome and patients with decompensated heart failure. The following was done for all patients. a. Full history taking, b. Complete clinical examination, c. Resting surface 12 leads electrocardiography (ECG), d. Coronary angiography and PCI to the CTO LAD artery, and e.Transthorasic echocardiography with TDI before PCI and within 3 month after PCI. **Results:** Using M mode there was improvement in LVEF in 18 (60%) patients, unchanged in 4 (13.3%) patients, and decreased in 8 (26.6%) patients. With Mean ± SD = 64.5±8.5 pre PCI and 65.7±6.1 post PCI, with P value = 0.09. Using 2D to assess LVEF there was improvement in LVEF in 18 (60%) patients, unchanged in 5 (16.6%) patients, and decreased in 7 (23.3%) patients. With Mean ± SD = 58.48±5.1 pre PCI and 60.6±4.2 post PCI, with P value = 0.005. Using TDI to assess Left ventricular systolic function there was improvement in LV systolic function in 18 (60%) patients, unchanged in 5 (16.6%) patients, and decreased in 7 (23.3%) patients with Mean ± SD = 11.7±2.7pre PCI and 12.05±2.3 post PCI, with P value = 0.07. Regarding LV diastolic function using pulsed Doppler over mitral flow there was improvement in LV diastolic function by measuring E/A ratio which was Pre PCI:- normal or pseudonormal (E/A ratio 1- 2) in 5 (16.7 %) patients, and Impaired relaxation (E/A ratio < 1) in 25 (83.3 %) patients and post PCI become normal or pseudonormal (E/A ratio 1- 2) in 8 (26.7 %) patients, and impaired relaxation (E/A ratio < 1) in 22 (73.3 %) patients. Mean ± SD = 0.64±0.39 pre PCI and 0.90±0.24 post PCI, with P value = 0.001. And using TDI in patients pre and post PCI there was improvement in LV diastolic function as pre PCI:- normal or pseudonormal (E/A ratio 1- 2) in 3 (10 %) patients, and impaied Impaired relaxation (E/A ratio < 1) in in 27 (90 %) patients. Post PCI become normal or pseudonormal (E/A ratio 1- 2) in 7 (23.3 %) patients, and impaied Impaired relaxation (E/A ratio < 1) in 23 (76.7 %) patients. Mean ± SD = 0.64±0.39 pre PCI and 0.90±0.24 post PCI, with P value = 0.009 **Conclusion:** PCI for a CTO LAD has a beneficial effect and improvement in global LV functions that can be predicted by conventional echocardiography and tissue Doppler.

**KEYWORDS:** CTO= coronary totally occluded, CAD= coronary artery disease, echocardiography, tissue Doppler imaiging, and left ventricular function.

## INTRODUCTION

Cardiovascular diseases (CVD) are one of the most common and serious disease all over the world and the most cause of mortality and morbidity worldwide.[1] Coronary artery disease (CAD) is one of the most common causes of mortality and morbidity across the world.[2] It has been expected that the mortality rate of CAD increases in the developing countries.[3] Myocardial necrosis following myocardial infarction (MI) causes left ventricular (LV) dilatation, followed by LV systolic dysfunction as a result of cardiac remodeling, cardiac remodeling is a determinant of clinical course of heart failure.[4] Early coronary re-canalization helps to survive the viable myocardium and improve global LV function and survival.[5] According to the studies in patients with CAD and LV dysfunction, the disease outcome can be improved with CABG or PCI.[6] Chronic totally occlusion (CTO) are common, and over the past 20 years, CTO lesions have represented the most difficult anatomy for treatment with lower success rates and higher complication rates, CTO continue to represent one of the greatest challenges to interventional cardiologists.[7] Percutaneous coronary intervention (PCI ) in patients with preserved LV function and optimal medical therapy doesn't reduce the cardiac death and MI, but it decreases the need for other procedure and the risk of angina, its effect on LV systolic or diastolic function is not clear.[8] Primary PCI is performed in the stage of acute myocardial infarction (MI), late PCI is carried out some days after acute MI, and elective PCI is done in CAD patients who are candidate for PCI in diagnostic processes, the basis of pathophysiologic benefit of revascularization is improving the function of viable myocardium.[6] Early coronary re-canalization helps to survive the viable myocardium and improve global LV function and survival, according to the studies in patients with CAD and LV dysfunction, the disease outcome can be improved with PCI or CABG.[5] PCI has been used increasingly for revascularization in ischemic heart disease (IHD) patients, in most of the studies, the primary PCI, criterion such as ejection fraction (EF), diastolic function and the wall motion or chamber sizes has been investigated. Result of previous studies in related area, about elective PCI, has shown unequal viewpoints.[9] Intervals between MI and PCI, basic LVEF before PCI and global condition of the patients affect the result of PCI.[10] Transthoracic echocardiography (TTE) was proved to be potential in CTO detection. Development of high-frequency transthoracic transducers and technology of the second tissue harmonic imaging have allowed application of TTE as a noninvasive, inexpensive, and widely used in clinical practice method for the diagnosis of coronary narrowing.[11] Although data are limited, successful PCI may improve ventricular relaxation and regional wall motion, global ejection fraction improved in some studies, but not in another, among patients with successfully recanalized occlusions, those with persistent patency and normal flow had better global function and less LV dilatation than patients without patent vessels.[12] Meta-analysis of 13 studies demonstrates that successful CTO PCI reduces mortality by 44% compared to unsuccessful CTO PCI (odds ratio 0.56; 95% confidence interval 0.43-0.72.[13]

### Aim of study

The purpose of this study is Assessment of the LV functions in patients with CTO of Left Anterior Descending (LAD) after PCI using conventional echocardiography and tissue Doppler study (TDI).

**Patients and methods:** The study was conducted through the period from April 2011 to April 2014 and included 30 patients, 22 (73.3%) males and 8 (26.7%) females, with age from 40 to 67 years old with mean age 55.92. They were selected from patients admitted to Cardiology department in Al-Azhar University Hospitals and Cardiology department in Railway hospital to do coronary angiography.

**Inclusion criteria:** Patients with CTO of LAD Artery, with normal LV systolic function (EF≥ 55 %) and dimensions, either with or with out other coronary aetery affection.

**Exclusion criteria:** 1.Patients with acute coronary syndrome. 2. Patients with old MI. 3. Patients with Impaired LV systolic function (EF< 55 %), 4. Patients with dilated LV dimensions. 5. Patients with rheumatic heart disease. 6. Patients with end stage renal disease. 7. Patients with end stage liver disease. 8. Heamodynamicaly unstable patients. 9. Patients with decompensated heart failure.

**The following was done for all patients:** Full history taking: and Complete clinical examination: general and local examination.

1- **Resting surface 12 leads electrocardiography (ECG):** Resting 12 lead ECG in the supine position by Cardiomax Fukuda Denshi model FX 7102.
2- **Transthorasic echocardiography:** TTE performed with Vived 7 Dimensions echocardiograme using 3-7 MHz transducer with the patients breathing quietly and lying in the left lateral position and the following views were taken: Parasternal long axis view. Parasternal short axis view, Apical four and two chamber views, Subcostal view in some patients with poor echo window, And using the following modalities of echo: 2D, M mode, Colour Doppler, CW and PW Doppler, Pulsed tissue Doppler imaging Echocardiography done according to the recommendation of American Society of Echocardiography. Patients were grouped according to the following grading of LV systolic and diastolic functions choosing only patients with normal LV systolic function and dimensions: LV EF by M mode and 2D 1-Normal ≥ 55 %. 2-Mild impaired 45 to < 55 %. 3-Moderate impaired 30 to < 45 %. 4. Severe impaired < 30 %. LV function by TDI 1-Normal: average S wave > 8.25 cm/s. 2- Impaired:

average S wave < 8.25 cm/s, LV diastolic function by pulsed Doppler over mitral flow 1- Normal or pseudonormal E/A ratio 1- 2. 2- Impaired relaxation E/A ratio < 1. 3-Restrictive pattern E/A > 2, LV diastolic function by TDI. 1- $E_m$ wave normal > 12 cm/s. 2-$A_m$ wave normal > 5.05 cm/s, LV diastolic function impaired $E_m/A_m$ ratio < 1

3- **PCI for CTO LAD Arteries:** Left and right coronary angiography in multiple planes was done to diagnose coronary lesions and assess severity of these lesions. The type of lesions classified according to the ACC/AHA classification, and then PCI to CTO LAD is done.
4- **TTE:** Three months after PCI to CTO LAD and repeat all echo measurements to assess the changes of LV functions after PCI.

**Statistical analysis:** The clinical and investigating data were collected and transferred to statistical program "SPSS" for windows V6.12 to obtain: - Minimum. - Maximum. -Mean (´X). -Standard deviation ± SD. - Number and percentage (from quantitative data).

**Analytic statistics:** "T" tests to compare more than two groups.

**Conclusion matrix:** P-value = level of significance -P > 0.05 = not significant -P < 0.05 = significant -P < 0.001= highly significant.

## RESULTS

The study included 30 patients 22male (73.3%) and 8 female (26.7%), with 25 pateints (83.3%) HTN, 20 patients (66.7%) diabetic, 21 patients (70%) smokers. And 17 patients (56.7%) compiend diabetic andHTN as in table 1.

### I-According to patient´s demographic characteristics, risk factors

**Table 1: Comparison of basic characteristics of the patients.**

| Patients risk % | No | |
|---|---|---|
| Gender | | |
| Male | 22 | 73.3% |
| Female | 8 | 26.7% |
| HIN | 25 | 83.3% |
| DM | 20 | 66.7% |
| Smoking | 21 | 70% |
| DM and HTN | 17 | 56.7% |

### II-Comparison between all patient's according to Echo characteristics pre and post PCI

**A- LV systolic function**

1. Comparison between all patients according to EF by modified Simpson's method pre and post PCI: As regard EF by modified Simpson's there was statistically significant difference between the patient's preandpost PCI (mean ± SD was 58.48± 5.1 % pre-PCI versus 62.4±4.81% post-PCI (P value = 0.005).

**Table 2: Comparison between patient's as regard EF pre and post PCI.**

| EF " modified Simpson's' | | P value |
|---|---|---|
| LVEF 2D Pre – PCI | 58.48±5.1 | P value = 0.005 |
| LVEF 2D Post – PCI | 60.6±4.2 | |

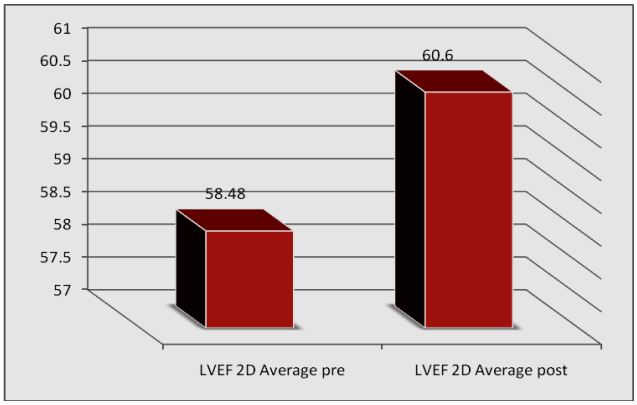



**Figure 1: Comparison between patient's as regard EF pre and post PCI.**

2. Comparison between all patients according to EF by M -mode method pre and post PCI: As regard EF by M mode there was no statistically significant difference between the patient's preandpost PCI (mean ± SD was 64.5± 8.5 % pre-PCI, 65.7±6.1% post-PCI (P value = 0.09).

**Table 3: Comparison between patients's as regard EF "M mode" pre And post PCI .**

| LVEFby M-Mode | | P value |
|---|---|---|
| LVEFby M-Mode pre | 64.5±8.5 | P value = 0.09 |
| LVEFby M-Mode post | 65.7±6.1 | |

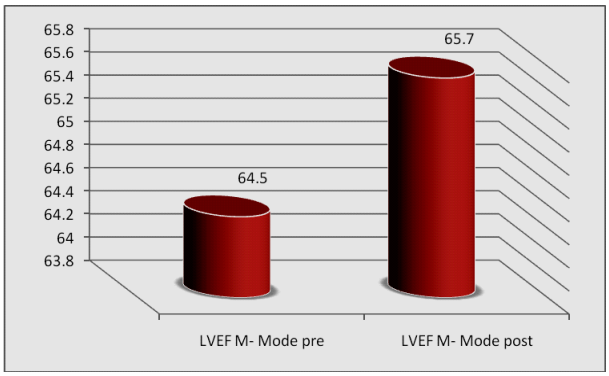



**Figure 2: Comparison between patient's as regard EF "M mode' pre and post PCI.**

3. Comparison between all patients according to EF by TDI method "(S) wave" pre and post PCI: As regard EF by TDI "(S) wave" there was no statistically significant difference between the patient's preandpost PCI (mean ± SD was 11.7± 2.7 % pre-PCI , 12.1± 2.3% post-PCI (P value = 0.07).

**Table 4: Comparison between patient's as regard (S) wave pre and post PCI.**

| Aver SW | | P value |
|---|---|---|
| Aver SW pre | 11.7±2.7 | P value = 0.07 |
| Aver SW post | 12.05±2.3 | |

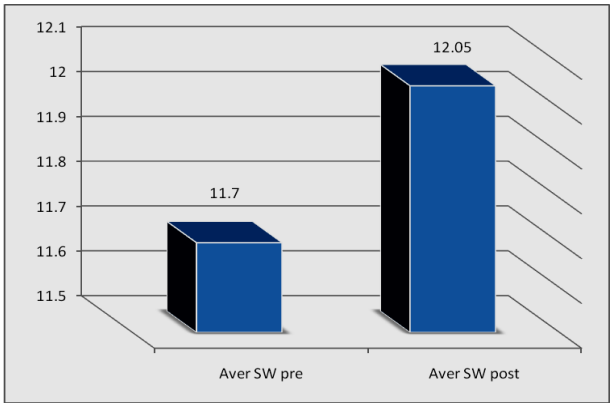



**Figure 3: Comparison between patient's as regard (S) wave pre and post PCI.**

**B- LV diastolic function**

1. Comparison between all patients according to LV diastolic function by PWD over mitral inflow " E/A" pre and post PCI : As regard LV diastolic function by PWD over mitral inflow there was statistically significant difference between the patient's preandpost PCI (mean ± SD was 0.64± 0.39 % pre-PCI group, 0.90±0.24% post-PCI (P value = 0.001).

**Table 5: Comparison between patients as regard E/A ratio pre and post PCI.**

| E/A | | P value |
|---|---|---|
| E/A pre | 0.64±0.39 | P value = 0.001 |
| E/A post | 0.90±0.24 | |

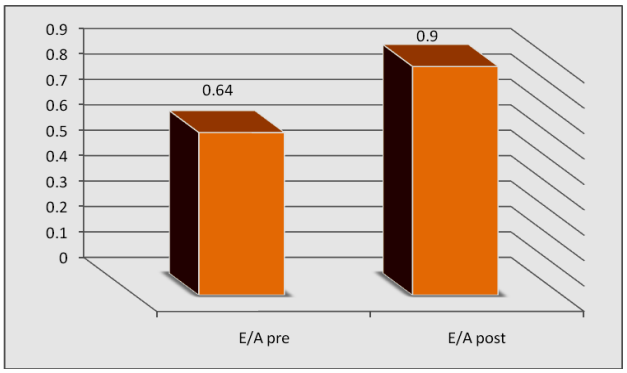



**Figure 4: Comparison between patients as regard E/A ratio pre and post PCI.**

2. Comparison between all patients according to LV diastolic function by TDI pre and post PCI : As regard LV diastolic function by TDI over mitral inflow there was statistically significant difference between the patient's pre and post PCI (mean ± SD was 7.8±2.7 % pre-PCI group, 8.4±2.9 % post-PCI (P value = 0.009).

Patients with impaired LV diastolic function were decrease in number from 27 (90%) of patients before PCI to 23 (76.7 %) after PCI, 4 (13.3 %) of patients were improved.

**Table 6: Comparison between patients's as regard by TDI pre and post PCI.**

| E/A by TDI | | P value |
|---|---|---|
| E/Am pre | 7.8±2.7 | P value = 0.009 |
| E/Am post | 8.4±2.9 | |

3. Comparison between all patients according to regional ventricular function by (RWS) pre and post PCI : As regard regional ventricular function by (RWS) there was statistically significant difference between the patient's preandpost PCI.

**Table 7: Comparison between patient's as regard (RWS) pre and post PCI.**

| RWS | | P value |
|---|---|---|
| Pre – PCI | 1.28±0.25 | P value=0.05 |
| Post – PCI | 1.16±0.25 | |

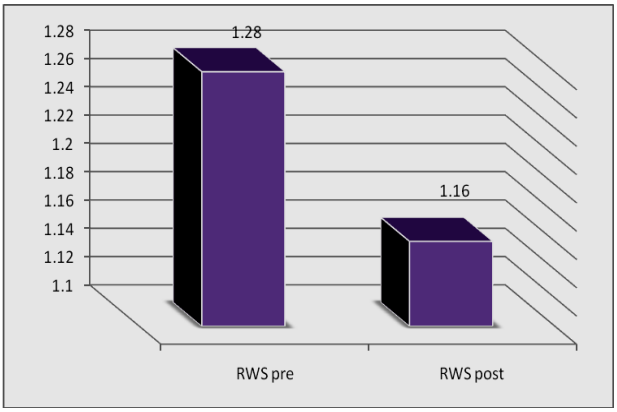



**Figure 5: Comparison between patient's as regard (RWS) ratio pre and post PCI.**

**Echocardiography results**

**Table 8: Conventional Echo results of the studied group.**

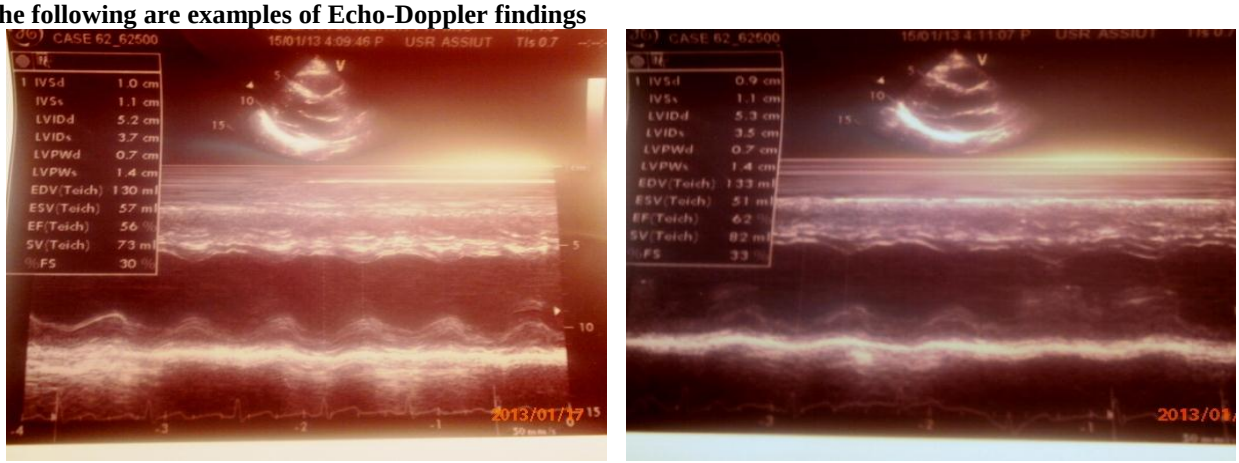
| | Mean ± SD | P value |
|---|---|---|
| FS | | |
| Pre – PCI | 33.57±5.5 | 0.3 |
| Post – PCI | 34.17±7.2 | |
| LVEF M- Mode | | |
| Pre – PCI | 64.5±8.5 | 0.09 |
| Post– PCI | 65.7±6.1 | |
| LVEF 2D average | | |
| Pre – PCI | 58.48±5.1 | 0.005 |
| Post – PCI | 60.6±4.2 | |
| E/A | | |
| Pre – PCI | 0.64±0.39 | 0.001 |
| P – PCI | 0.90±0.24 | |

**Table 9: Tissue Doppler results of the studied group.**

| | Mean ± SD | P- Value |
|---|---|---|
| Aver E wave | | |
| Pre- PCI | 7.8±2.7 | 0.009 |
| Post PCI | 8.4±2.9 | |
| Aver Awave | | |
| Pre- PCI | 10.4± | 0.6 |
| Post- PCI | 10.5± | |
| Aver S wave | | |
| Pre- PCI | 11.7±2.7 | 0.07 |
| Post- PCI | 12.05±2.3 | |
| RWS | | |
| Pre- PCI | 1.28±0.25 | 0.05 |
| Post- PCI | 1.16±0.25 | Post – PCI |

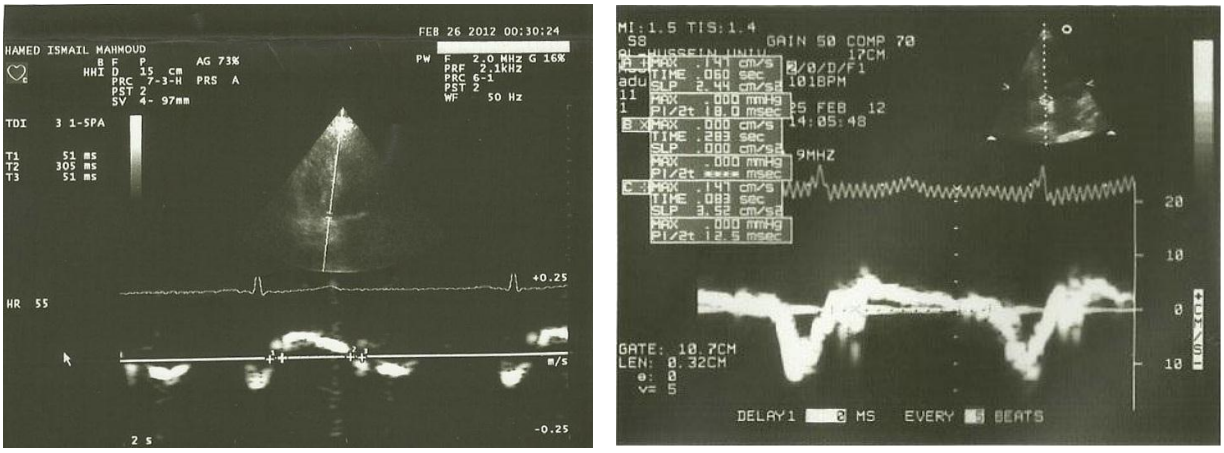
**Selected cases**

**The following are examples of Echo-Doppler findings**




**A** **B**

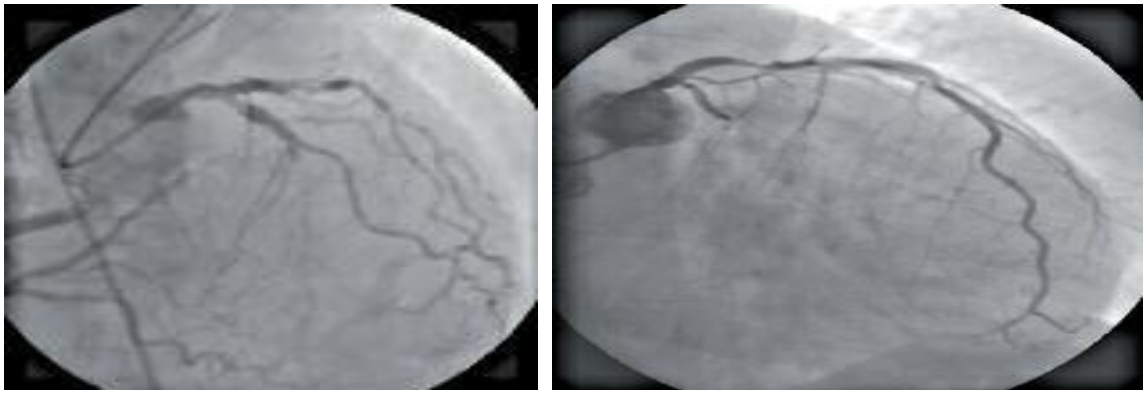
**Figure 6(A): show Case no. 10 pre PCI Echo parasternal long axis view, LV EF=56% by M mode, (B) post PCI Echo parasternal long axis view, LV EF=62% by M mode.**




**A** **B**

**Figure 7(A): show Pre PCI:-Echo Apical 2 chamber view, TDI, MAV at Inferior point, S wave 9 cm./sec., E wave –7cm./sec. and A wave – 8 cm./sec. (B) P0st PCI:- Echo Apical 2 chamber view, TDI, MAV at Inferior point, S wave 10 cm./sec., E wave –9cm./sec. and A wave – 10 cm./sec.**

**The following are examples of angiographic findings**



**A** **B**

**Figure 8(A): show LAD CTO PRE PCI Total occlusion with interruption of antegrade blood flow in proximal LCx with TIMI 0 flow (B) Post PCI result.**

## DISCUSSION

CVD is one of the most common and serious disease and the most common cause of mortality throughout the world.[1] Myocardial necrosis following MI causes LV dilatation, followed by LV systolic dysfunction as a result of cardiac remodeling, cardiac remodeling is a determinant of clinical course of HF.[7] Medical treatment, PCI and CABG are the treatment options for CAD.[14] CTO is a common condition in patients with CAD, CTO represents one of the most challenging targets of lesion re-canalization, because of its complexity, PCI in cases with CTO is associated with lower rates of procedural success, higher complication rates, greater radiation exposure, and longer procedure times compared with interventions in non-CTO lesions, despite these obstacles, reported benefits of successful CTO - PCI include a reduction in symptoms and improvement in both ventricular function and survival.[15] The basis of pathophysiologic benefit of revascularization is improving the function of viable myocardium.[6] Early coronary re-canalization helps to survive the viable myocardium and improve global LV function, according to the studies in patients with CAD and LV dysfunction the outcome can be improved with PCI or surgical revascularization (CABG).[5] Intervals between MI and PCI, basic LVEF before PCI and global condition of the patients affect the result of PCI; many studies have been done to study the effect of PCI on cardiac function.[14] CTOs are a common, and over the past 20 years, CTO lesions have represented the most difficult anatomy for treatment with lower success rates and higher complication rates, CTO continue to represent one of the greatest challenges to interventional cardiologists, successful revascularization has been strongly associated with improved LV functions, freedom from angina and future revascularization and in several studies increased survival.[16]

The present study was to evaluate the effect of elective PCI to a CTO LAD artery on LV functions, using conventional echocardiography and TDI. In this study, 30 patients with a CTO LAD artery selected and global LV systolic and diastolic functions examined by echo and TDI, before PCI and within 3 months after PCI.

Our findings suggest a survival benefit of successful CTO PCI of the LAD Procedural success was associated with an improvement in survival only among Patients with LAD CTO. The present study indicated that PCI provides functional and clinical benefits in patients with CTO lesion in LAD artery.

**From our study the following data was obtained**
**LV systolic function According to changes in LVEF by M mode in patients pre and post PCI there was**: Improvement in LVEF in 18 (60%) of patients, unchanged in 4 (13.3%) of patients, and decreased (but still normal function) in 8 (26.6%) of patients. With Mean ± SD = 64.5±8.5 pre PCI and 65.7±6.1 post PCI, with P value = 0.09.

**According to changes in LVEF by 2D in patients pre and post PCI there was:** Significant improvement in LVEF in 18 (60%) of patients, unchanged in 5 (16.6%) of patients, and decreased (but still normal function) in 7 (23.3%) of patients. With Mean ± SD = 58.48±5.1 pre PCI and 60.6±4.2 post PCI, with P value = 0.005**.

**According to changes LV systolic function by TDI in patients pre and post PCI there was**: Improvement in LVEF in 18 (60%) of patients, unchanged in 5 (16.6%) of patients, and decreased in 7 (23.3%) of patients. With Mean ± SD = 11.7±2.7pre PCI and 12.05±2.3post PCI, with P value = 0.07.

**LV diastolic function According to changes LV diastolic function by pulsed Doppler over mitral flow in patients pre and post PCI there was**:-Significant improvement in LV diastolic function by measuring E\A ratio which was:- Pre PCI:- normal or pseudonormal (E/A ratio 1- 2) in 5 (16.7 %) patients, and impaired Impaired relaxation (E/A ratio < 1) in 25 (83.3 %) of patients. Post PCI:- normal or pseudonormal (E/A ratio

1- 2) in 8 (26.7 %) patients, and impaired Impaired relaxation (E/A ratio < 1) in 22 (73.3 %) of patients. Mean ± SD = 0.64±0.39 pre PCI and 0.90±0.24 post PCI, with P value = 0.001. According to changes LV diastolic function by TDI in patients pre and post PCI there was:- Significant improvement in LV diastolic function by TDI and measuring average E/ average A ratio which was:- Pre PCI:- normal or pseudonormal (E/A ratio 1- 2) in 3 (10 %) patients, and impaired Impaired relaxation (E/A ratio < 1) in in 27 (90 %) patients. Post PCI: - normal or pseudonormal (E/A ratio 1- 2) in 7 (23.3 %) patients, and impaired Impaired relaxation (E/A ratio < 1) in 23 (76.7 %) patients Mean ± SD = 0.64±0.39 pre PCI and 0.90±0.24 post PCI, with P value = 0.009.

**Regional LV function: by resting wall motion score (RWS):** Reduction in Regional ventricular function: by resting wall motion score (RWS) in 15 (50%) of patients, unchanged in 5 (16.6%) of patients, and decreased in 10 (33.3%) of patients. With Mean ± SD = 1.28±0.25pre PCI and 1.16±0.25 post PCI, with P value = 0.05. A series of small to medium-sized heterogenous observational studies have been performed that report the effect of CTO recanalisation on LVEF.Taken together, the results strongly suggest a modest (<5%) improvement of regional and global LV function when patients are selected on the presence of dysfunctional hibernating myocardium. The greatest recovery in LV function is thus seen in those patients with no prior history of MI, who have regional dysfunction at baseline and a patent artery at follow up. Further studies have attempted to more precisely predict functional myocardial recovery using contrast enhanced MRI, dobutamine stress ECHO, wall thickness or a combination of these different modalities. Infarction of<2 5% of the myocardial wall thickness strongly predicts recovery, >75% predicts no recovery, and between these values lies a grey zone.[15] However, a more recent study during the DES-era found no difference in in-hospital mortality or MACE between successful and unsuccessful cases. A number of potential mechanisms by which revascularisation of CTOs might improve prognosis have been proposed. These include prevention of adverse left ventricular remodelling, prevention of sudden cardiac death through improved electrical stability, and greater tolerance of any subsequent ACS events.[17] A growing body of studies have shown that the mechanisms by which PCI of a CTO artery might improve outcomes include reduction in adverse LV remodeling with preservation of LV function, increased electrical stability, and provision of collateral vessels for protection against future events, patients with reversible and fixed perfusion defects might benefit more from PCI procedure due to the improvements in myocardial blood flow and in the contractility within the affected myocardium. CTO patients without significant myocardial perfusion defects usually have a short anatomic coronary lesion, abundant collaterals, and less angina pectoris presentation.[18]

**As Regard LV systolic function by conventional echo in Pre and post PCI to CTO LAD:** Our study revealed that the EF by M mode method was higher in post PCI period (65.7±6.1) compared to that obtained pre PCI (64.5±8.5), also the EF by modified Simpson's method was in higher post PCI period (60.6±4.2) compared o that obtained pre PCI (58.48±5.1).

**As Regard LVsystolic function by TDI in Pre and post PCI to CTO LAD:** Our study revealed that the LV systolic function by TDI "S wave" was higher in post PCI period (12.05±2.3) compared to that obtained pre PCI (11.7±2.7). From the aforementioned statistics we can find that there was improvement in LV systolic function by either means of M mode EF, modified Simpson's EF method or by TDI "Average S wave" in patients post PCI to CTO LAD. That comes in agreement with previous study performed by, Safely and colleagues from Kansas City in a new study demonstrates that PCI for CTO of the LAD artery is associated with improved long-term survival compared with PCI to the RCA and the LCx arteries, PCI for CTO has been demonstrated to be associated with improvement in the anginal status of patients, improved EF, reduced risk of recurrent MI and improved survival rates, advances in the techniques to recanalize the CTO have improved the PCI success rates.[19] Buszman, et al. who revealed that LVEF was increased (6 % ± 7.2) after PCI to a CTO artery,[20] Improvement of LVEF was seen in 2 other studies by Nechvatal et al.[23] and Ioannidis, et al. who showed improvement of LVEF after PCI to CTO LAD.[10] Carluccio, et al. demonstrated that PCI improved LVEF (from 32% to 43%; P=0.0004) and diastolic function.[22] Silva et al. have shown that late recanalization, 12 hours to 14 days post anterior MI improved LV EF and myocardial contractility.[5] Horie et al. 83 patients with anterior MI were randomized to PCI or medical therapy after 24 hours from the onset of symptoms, the trial showed that late PCI leads to smaller enddiastolic and end systolic volumes at 6 months as well as fewer deaths, recurrent MI, and congestive HF at 50 months.[23]

Safley and colleagues in a new study demonstrates that PCI for CTO of the LAD artery is associated with improved long-term survival compared with PCI to the RCA and the LCx arteries, PCI for CTO has been demonstrated to be associated with improvement in the anginal status of patients, improved EF, reduced risk of recurrent MI and improved survival rates, advances in the techniques to recanalize the CTO have improved the PCI success rates. in a new study published in JACC Interventions investigated if there were differences in long-term survival with respect to the target vessel that was intervened and compared the outcomes among patients undergoing PCI of single CTO across each of the three major epicardial coronary arteries.[19] Successful procedure to the LAD compared with failure was associated with improved 5 year survival rates (88.9% vs. 80.2%, p<0.001) but not in the LCX (86.1% vs. 82.1%, p=0.21) and RCA (87.7% vs. 84.9%, p=0.23).

Even after adjustment for demographic and procedural differences between success and failure groups, successful PCI CTO was associated with improved long-term survival in the LAD group (HR: 0.61, 95% CI 0.42-0.89, p<0.001) but not in the LCX (HR: 0.86, 95% CI 0.55-1.35) and RCA (HR: 0.82 95% CI 0.57-1.19) groups.

**While this disagree with**
TOSCA (Total Occlusion Study of Canada) sub study which reported no improvement in LV function at one year.[24] Our study differ from TOSCA in that we select patient with normal LV systolic function and normal LV dimensions. Only concluded randomized trial comparing medical therapy with PCI in patients with subacute total coronary occlusion,Occluded Artery Trial(OAT),has shown no clinical benefit at 2year follow-up of revascularization when compared with medical therapy in asymptomatic or poorly symptomatic patients with subacute MI, however, most OAT patients had single-vessel disease and 93% underwent single-vessel PCI, there are no data from randomized studies assessing impact of CTO revascularization on survival in patients with multivessel disease.[25] The percentage of patients with LAD occlusion in OAT (36% of all IRAs) was modestly lower than in primary PCI trials, this difference is most likely because OAT focused on stable patients after MI, whereas LAD occlusion, more often than occlusion of other IRAs, leads to hemodynamic instability in the acute phase of MI. Therefore, patients with LAD occlusion were less likely to qualify for OAT; this is also supported by the evidence of higher prevalence of collateral vessels in patients with LAD as IRA in OAT, in comparison to patients from primary PCI trials.[26] The TOSCA-2 study, an ancillary study of OAT, also demonstrated that assignment to PCI was associated with a smaller increase of LV volume in a subgroup of patients with LV measurements, with no heterogeneity of the effect by IRA location.[24] Banerjee et al. in another study reported that late PCI on persistent total LAD artery occlusion did not reduce rate of death, re-infarction, HF and no change was observed in LVEF compared with optimal medical therapy.[27] Only one more recently reported, small trial, TOAT (The Open Artery Trial) enrolled 66 patients with clinical characteristics similar to the OAT subgroup in this report (occluded LAD, EF 50%, mostly 1-vessel disease and no ischemia on symptomlimited exercise treadmill test, N80% of patients receiving β-blockers and 100% ACE inhibitors) and used stents in all PCI patients, of note, contrary to TOAT, OAT allowed mild or moderate ischemia at randomization, although not powered for clinical events, TOAT reported an apparent excess of events, including death, MI, stroke, congestive HF, and revascularization at 12 months in patients randomized to PCI.[28] In the same trial, the end-systolic and end-diastolic volumes increased more in patients undergoing PCI than in patients treated conservatively, as demonstrated above, previously published clinical trials on late reperfusion in patients with LAD occlusion after MI, except TOAT, reported improvement of LV function measured with LVEF or volumes.

**As Regard LV diastolic function by PWD over mitral inflow in Pre and post PCI to CTO LAD:** Significant improvement in LV diastolic function by measuring E\A ratio which was:- Pre PCI:- normal or pseudonormal (E/A ratio 1- 2) in 5 (16.7 %) patients, and impaired Impaired relaxation (E/A ratio < 1) in 25 (83.3 %) of patients. Post PCI: - normal or pseudonormal (E/A ratio 1- 2) in 8 (26.7 %) patients, and impaired Impaired relaxation (E/A ratio < 1) in 22 (73.3 %) of patients. Mean ± SD = 0.64±0.39 pre PCI and 0.90±0.24 post PCI, with P value = 0.001.

**As Regard LV diastolic function by TDI in Pre and post PCI to CTO LAD:** Significant improvement in LV diastolic function by TDI and measuring average E \ average A ratio which was:- Pre PCI:- normal or pseudonormal (E/A ratio 1- 2) in 3 (10 %) patients, and impaired Impaired relaxation (E/A ratio < 1) in in 27 (90 %) patients. Post PCI:- normal or pseudonormal (E/A ratio 1- 2) in 7 (23.3 %) patients, and impaired Impaired relaxation (E/A ratio < 1) in 23 (76.7 %) patients. Mean ± SD = 0.64±0.39 pre PCI and 0.90±0.24 post PCI, with P value = 0.009.

**That comes in agreement with previous study performed by:** Tanaka et al. studied 27 patients and showed improvement in LV early diastolic filling after PCI (**29)**. Carluccio et al. also had reported by Improvement of LV diastolic function.[30] Improving of myocardial function including EF and diastolic function after revascularization may be due to improved perfusion at stunning area, regarding to achievement of various results in current and previous studies in one hand, and many influencing factors such as (interval between MI and PCI, basic LVEF before PCI and etc.) in other hand, it seems more and long term investigation is required for obtaining more meaningful finding.[31] Patients in the current study were several years older, and more frequently had multivessel intervention when compared with previous studies, and the current study shows that age, LVEF, and completeness of revascularization are independent predictors of survival. Moreover, all patients before PCI attempt had the evidence of viable myocardium in the territory of the occluded vessel by echography Thus, it is likely that the high-risk profile of the studied population made possible the demonstration of strong survival benefit of CTO–PCI success with a relatively lower than in other studies, but still better than others. Possible explanation of the clinical benefit of CTO revascularization survival include improvement in LV function in patients with viable myocardium, prevention, or slowdown of ventricular remodeling, decrease in electrical instability, and associated risk of fatal arrhythmic events, increased tolerance of future coronary occlusion events.[32] While this disagree with Few studies on the role of PCI in CTO LAD to confirm that the LAD IRA is a risk indicator among stable

patients with persistent total occlusion of the infarct artery over a time horizon of several years post MI. The main reason for the unfavorable outcome in this group of patients compared to other infarct locations was an association with larger index infarctions, as demonstrated by lower EF and higher Killip and NYHA classes. Multivariable modeling for the primary end point and death suggested that higher risk associated with the LAD IRA was mediated by lower ejection fraction and more frequent history of heart failure in those patients.[33]

**As Regard regional ventricular function by resting wall motion score (RWS) in Pre and post PCI to CTO LAD:** Reduction in Regional ventricular function: by resting wall motion score (RWS) in 15 (50%) of patients, unchanged in 5 (16.6%) of patients, and decreased in 10 (33.3%) of patients. With Mean ± SD = 1.28±0.25pre PCI and 1.16±0.25 post PCI, with P value = 0.05. That comes in agreement with previous study performed by Pizzetti and colleagues showed that coronary angioplasty performed after a mean of 15 days in 67 patients with anterior MI improved LVEF and reduced a degree of LV dilation at 6 months in comparison to conservative treatment.[34] Improvements in regional and global wall motion are evident on myocardial perfusion scintigraphy, echocardiography, and left ventriculography following PCI of CTO, positive effects on LV remodeling have been reported in patients undergoing cardiac magnetic resonance imaging up to 3 years after.[15] While this disagree with Ermis et al. concluded that our data suggest that successful CTO PCI is associated with no improvement in long-term survival as compared to CTO PCI failure in the subpopulation of patients with LAD CTO. Therefore, attempted PCI of LAD CTO may be not improving survival, and no comparison to medical therapy is possible with these data, CTO PCI should be attempted only after a detailed discussion of the potential risks and benefits of the procedure.[35] Persistent COT of the LAD is associated with a worse prognosis compared with occlusion of other IRAs, strategy of routine PCI of the occluded LAD 24 hours post MI in stable patients is not beneficial and may increase risk of adverse events in comparison to optimal medical treatment alone, therefore, additional emphasis should be placed on public health strategies aimed toward avoiding late presentation of patients with acute MI and toward improving availability of reperfusion therapies.[36] Possible explanation of the clinical benefit of CTO revascularization survival include, improvement in LV function in patients with viable myocardium, prevention, or slowdown of ventricular remodeling, decrease in electrical instability, and associated risk of fatal arrhythmic events, increased tolerance of future coronary occlusion events.[35] Discrepancy between various studies may be from: interval between MI and PCI, basic LVEF before PCI, global condition of the patients and degree of coronary artery stenosis, presence or absence of affection of other coronaries…, etc. Some studies have included patients with a shorter duration of the occlusion also, and PCI was undertaken without the contemporary specialized technologies, it seems likely that the selection process of CTO with more favorable characteristics for PCI success used in these studies was associated with the selection of patients with a better baseline cardiac risk profile when compared with the our study, and so the results of these studies were better.

## CONCLUSION

PCI for a CTO LAD has a beneficial effect on LV functions, improvement in regional and global LV functions and myocardial contractility after revascularization that can be predicted by conventional echo and TDI.

### Recommendations

1- PCI for a CTO LAD has a beneficial effect on LV functions, myocardial contractility.
2- Improvement in regional and global LV functions after revascularization can be predicted by conventional echo and TDI.
3- Further studies are recommended to assess CTO of other coronaries and there beneficial effect on LV functions, myocardial contractility.

### Limitations

**Study limitations:** 1-These data from an assessment of the benefits of successful CTO LAD patient group. 2- The duration of CTO was not known for the entire group. 3- Only patients with normal LV systolic functions. 4- Only patients with normal LV dimensions. 5- Other coronary affection. 6- No medical therapy patient group for comparison. 7- No failed CTO LAD PCI patient group for comparison. 8-Cardiac troponin and creatine phosphokinase data were not collected following PCI during the study period.

### Summary

CTO of a coronary artery is the complete obstruction of the vessel aged at least one month according to most researchers or three months according to others, the term is also used to describe total occlusions with TIMI grade 1 flow, the so-called "functional occlusions". Which are defined as the presence of only faint, late anterograde flow in the absence of a discernible lumen?

TTE has proved to be potential in CTO detection, development of high-frequency transthoracic transducers and technology of the second tissue harmonic imaging have allowed application of TTE as a noninvasive, inexpensive, and widely used in clinical practice method for the diagnosis of coronary narrowing. PCI for a CTO has a beneficial effect on LV volumes and function that can be predicted by performing TTE before revascularization, in patients with a CTO has a beneficial effect on myocardial contractility and LV volumes, improvement in regional and global LV function after revascularization is related to the extent of dysfunctional but viable myocardium before revascularization. Successful CTO procedure in LAD was associated with improved survival at 5 years, In many studies done on

both large and small groups, successful PCI as compared with unsuccessful PCI for CTO conferred a survival benefit, but only in patients with LAD lesions, for many interventionalists, these findings may justify recommending PCI for patients with CTO, particularly those with ischemia and LAD occlusion. Although data are limited, successful PTCA may improve ventricular relaxation and regional wall motion, global EF improved in some studies, but not in another, among patients with successfully recanalized occlusions, those with persistent patency and normal flow had better global function and less ventricular dilatation than patients without patent vessels.

**Assessment of LV function before and after PCI to CTO LAD:** Thirty patients with normal LV dimensions and systolic functions, with CTO LAD artery, they are assessed with conventional echo and TDI before and after PCI to CTO LAD artery, and we search for improvement in LV functions (LV functions, global systolic and diastolic functions), either there is improvement, deterioration or no effect on LV functions. LV functions (LV functions, global systolic and diastolic functions) are assessed by: standard Echo and TDI. Each of the following parameter was improved in the majority of cases after PCI to CTO LAD: 1-LV systolic function (by M mode, 2D and TDI). 2- LV diastolic function (by E/Am ratio, Average Em wave and Average Am wave) 3-The overall RWS was improved.

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