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# Assessment of LV function Pre and Post PTCA in ACS patients with Echo Strain Imaging

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## ABSTRACT

**Introduction:** The clinical recognition that myocardial dysfunction in patients with coronary artery disease was potentially reversible preceded basic science investigations into pathophysiologic mechanisms of viability. The term "hibernating myocardium" was subsequently coined to characterize this chronic situation of "resting LV dysfunction due to reduced coronary blood flow that can be partially or completely reversed by myocardial revascularization and/or by reducing myocardial oxygen demand".

**Aims:** This study aims to evaluate the left ventricular function in adult patients (≥ 18 years of age) with ACS total occlusion in CAG, pre & Post PTCA by conventional echocardiographic parameters, strain imaging and tissue velocity imaging.

**Materials and Methods:** The present study was a Cross-sectional and observational study. This Study was conducted from July, 2017 – December, 2018 at Department of cardiology, NRS Hospital, Kolkata. 40 patients were included in this study.

**Result:** Main findings of the present study can be summarized as follows: (1) RLS in TO area, RLS in donor area, and GLS were significantly improved 1 day after TO-PCI, but these improvements diminished during 3 months; (2) only the improvement of RLS in donor area remained significant 3 months after the index procedure; (3) RLS in non-CTO/ non-donor area was not influenced by TO-PCI; (4) mitral septal annulus velocity was improved 3 months after TO- PCI.

**Conclusion:** It was found that the global longitudinal strain assessed with 2D-STE was improved as early as 1 day after TO-PCI, whereas LVEF tended to improve up to 3 months after TO-PCI. 2D-STE is a superior technique for objectively quantifying the functional change earlier .PCI for a TO has a beneficial effect and improvement in global LV functions that can be predicted by 2D ST echocardiography and tissue Doppler.

**Keywords:** ACS, TO-PCI, LVEF and Echocardiography.

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## INTRODUCTION

The clinical recognition that myocardial dysfunction in patients with coronary artery disease was potentially reversible preceded basic science investigations into pathophysiologic mechanisms of viability. The term "hibernating myocardium" was subsequently coined to characterize this chronic situation of "resting LV dysfunction due to reduced coronary blood flow that can be partially or completely reversed by myocardial revascularization and/or by reducing myocardial oxygen demand" [1]. Reversible global LV dysfunction was observed in experimental animals after brief coronary occlusion and reflow. This phenomenon was called myocardial stunning. Allman et al. performed a meta-analysis of 24 prognostic studies that used various viability techniques and showed a 3.2% annual death rate in patients who were considered to have viable myocardium and who underwent revascularization, compared with a 16% annual death rate in patients who had viable myocardium but were treated medically. There is a growing body of literature that supports the superiority of Strain and Strain rate measurement over tissue velocity assessment by Tissue Doppler imaging for the evaluation of regional myocardial function. Clinical evolution of Cardiac function is required both pre & post PTCA assessment by only EF has limitation related with its intra and inter observer variability so which can reduce by global longitudinal strain has higher accuracy [2].

Evaluation of left ventricular (LV) regional ischemia was traditional based on the visual assessment of wall motion and wall thickening, which were derived from two-dimensional (2D) gray scale imaging. This echo technique has its limitations, with relatively high for both intra-observer anointer-observer variability, and the limited ability of the human eye to resolve rapid and short-lived myocardial motion [3]. Of note, visual evaluation of wall motion only assesses radial deformation of the myocardium, and it is well known that myocardial contractility consists of thickening, shortening, and twisting. Acute myocardial ischemia induces a delay in the onset of the contraction, a progressive decrease in the rate and degree of thickening and a progressive delay in the timing of the peak thickening. Finally, systolic thickening is virtually or completely abolished by total occlusion, and only late systolic/early diastolic thinning occurs. Second, improvement of global LV ejection fraction has never been achieved by TO-PCI so far. Only regional improvement of the hibernating myocardium in the TO area (collateral ow "recipient" area) was reported in magnetic resonance imaging studies [4].

**:** This study aims to evaluate the left ventricular function in adult patients (≥ 18 years of age) with ACS total occlusion in CAG, pre & Post PTCA by conventional echocardiographic parameters, strain imaging and tissue velocity imaging.

## MATERIALS AND METHODS

- **PLACE OF STUDY:** Department of cardiology, NRS Hospital, Kolkata
- **STUDY POPULATION:** Patient's admitted in department of cardiology. Patients will be followed up in department of cardiology OPD.
- **INCLUSION CRITERIA:** Patients aged 18 years admitted in SSKM HOSPITAL with diagnosis of ACS (Total occlusion in CAG)
- **EXCLUSION CRITERIA:**

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- RVMI
- Partial occlusion CAD in CAG.
- Patients with chronic kidney disease (GFR less than 60 ml. per min).
- Suspected or diagnosed case of septicaemia.
- Age less than 18 years.
- Serious ventricular arrthymias (VT, VF)
- Cerebrovascular accident.

- **PERIOD OF STUDY:** July, 2017 – December, 2018 (18 academic months)
- **STUDY DESIGN: C**ross-sectional and observational study involving more than 40 patients suffering from ACS (total occlusion in CAG) assessment of LV function Pre & Post PTCA.
- **SAMPLE SIZE:** As it is an observational study so exact sample size cannot be mention now but minimum number of cases is 40.

## RESULT AND DISCUSSION

**Erdogan E et al [5] (2013)** found that the left ventricular ejection fraction, left ventricular volumes, and three-dimensional systolic dyssynchrony index were quantified. An immediate procedural success was obtained in 118 patients (91.5%). There were no acute or sub-acute stent thromboses during follow-up. The mean left ventricular ejection fraction significantly increased ($p$<0.001), while the left ventricular end-diastolic and end-systolic volumes significantly decreased ($p$ = 0.001 and $p$<0.001, respectively). The three-dimensional systolic dyssynchrony index also decreased significantly ($p$<0.001). The global longitudinal strain showed a significant increase after successful revascularization ($p$<0.001). An increase in the global longitudinal strain was correlated with an increase in the left ventricular ejection fraction (r = 0.27, $p$ = 0.02).
**Wang P et al [6](2018)** found that this study evaluated the feasibility of using two-dimensional speckle tracking echocardiography (2D-STE) to monitor left ventricular (LV) and overall function after percutaneous recanalization. LV function after percutaneous recanalization was monitored by 2D-STE and conventional echocardiography in 43 patients with coronary chronic total occlusion (CTO) who underwent primary percutaneous coronary intervention (PCI). Follow-ups were carried out 1 day as well as 3 and 6 months after CTO-PCI. At each time point, LV ejection fraction (LVEF) was examined by echocardiography, and LV global longitudinal strain (GLS) was measured by 2D-STE. It was found that the global longitudinal strain assessed with 2D-STE was improved as early as 1 day after CTO-PCI, whereas LVEF tended to improve up to 3 and 6 months after CTO-PCI. PCI can effectively improve LV function in patients with CTO. 2D-STE is a superior technique for objectively quantifying the functional change earlier.
**El Shafey WH et al [7] (2015)** found that PW-TDI was used to assess the velocity curves of basal and mid segments of the septal, lateral, anterior, inferior, posterior, and anteroseptal LV walls. The following indices were measured: Tp, Sv, $E0'$, $A'$, $E'/A'$, acceleration of isovolumic contraction (IVC), isovolumic relaxation period, isovolumic contraction time (IVCT), contraction time, and TEI index. After recanalization of the CTO vessel by PCI, the patients in the noninfarction group showed a highly significant improvement in left ventricular ejection

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fraction% after 3 months of follow-up (P < 0.001), whereas the infarction group did not show any significant improvement (P = NS). In the LAD, left circumflex, and right coronary artery subgroup, noninfarction patients showed a reduction in left ventricular end-systolic volume, and increased fraction shorting% and ejection fraction% after 3 months of follow-up; also, there were improvements in TDI parameters in the form of increased *E′* and acceleration of IVC in all three subgroups and increased *E′*/ *A′* in LAD and left circumflex, and an increase in the peak velocity of IVC and a reduction in *A′* and time to peak of IVC in both LAD and right coronary artery; only the S wave velocity increased in the LAD subgroup after 3 months of follow-up. In patients with CTO, acceleration of IVC measured by PW-TDI can differentiate early improvement after successful recanalization of the CTO vessel by PCI. Noninfarction territories might show earlier recovery than that in patients with evident myocardial infarction.

**Sotomi Y et al [8] (2017)** found that 2D-STE computed global longitudinal strain (GLS) and regional longitudinal strain (RLS) in CTO area, collateral blood-supplying donor artery area, and non-CTO/nondonor area. A total of 37 patients (66 ± 11 years, 78% male) were analyzed. RLS in CTO and donor areas and GLS were significantly improved 1-day after the procedure, but these improvements diminished during 3 months. The improvement of RLS in donor area remained significant after 3-months the index procedure (pre-PCI −13.4 ± 4.8% vs. post-3M −15.1 ± 4.5%, *P* = 0.034). RLS in non-CTO/nondonor area and LV ejection fraction were not influenced. Mitral annulus velocity was improved at 3-month follow-up (5.0 ± 1.4 vs. 5.6 ± 1.7 cm/s, *P* = 0.049). Before the procedure, 12 patients (35%) had a late potential. All components of the late potential (filtered QRS duration, root-meansquare voltage in the terminal 40 ms, and duration of the low amplitude signal <40 μV) were not improved. CTOPCI improved RLS in the donor area at 3-month follow-up without changes of LV ejection fraction. Although higher prevalence of late potential in the current population compared to healthy population was observed, late potential as a surrogate of arrhythmogenic substrate was not influenced by CTO-PCI.

**Mohamed Mahmoud et al [9] (2017)** found that 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

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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.

We found that 5(12.5%) patients had ≤50 Yrs, 20(50.0%) patients had 51-60 Yrs, 13(32.5%) patients had 61-70 Yrs and 2(5.0%) patients had 71-80 Yrs. The mean age (mean± s.d.) of patients was 58.3250 ± 7.3113 years.14(35.0%) patients had female and 26(65.0%) patients had male. 12(30.0%) patients had HTN. 9(22.5%) patients had DM. 10(25.0%) patients had dyslemidemia. 10(25.0%) patients had smoker. 5(12.5%) patients had CKD (<60). It was found that 3(7.5%) patients had prior PCI, 40(100.0%) patients had no prior CABG, 20(50.0%) patients had LAD, 8(20.0%) patients had RCA and 12(30.0%) patients had LCX.The mean BMI (mean± s.d.) of patients was 25.0250 ± 2.7892 kg/$m^2$. In pre PCI, the mean RLS in to area (mean± s.d.) of patients was -11.2350 ± 2.3391. In at discharge, the mean RLS in to area (mean± s.d.) of patients was -12.1350 ± 2.2142. In at 3 months, the mean RLS in to area (mean± s.d.) of patients was -12.8950 ± 1.4454. Distribution of mean RLS in to area vs. follow-up was statistically significant (p=0.0018). In pre PCI, the mean RLS in donar area (mean± s.d.) of patients was -12.9750 ± 1.9573. In at discharge, the mean RLS in donar area (mean± s.d.) of patients was -15.3825 ± 1.8298. In at 3 months, the mean RLS in donar area (mean± s.d.) of patients was -14.9300 ± 1.9647. Distribution of mean RLS in donar areavs. Follow-up was statistically significant (p<0.0001). In pre PCI, the mean RLS in non CTO non donar (mean± s.d.) of patients was -15.3975 ± 2.6529. In at discharge, the mean RLS in non CTO non donar (mean± s.d.) of patients was -16.2300 ± 2.1387. In at 3 months, the mean RLS in non CTO non donar (mean± s.d.) of patients was -15.6375 ± 2.1137. Distribution of mean RLS in non CTO non donar vs. follow-up was not statistically significant (p=0.2581). In pre PCI, the mean GLS (mean± s.d.) of patients was -12.2400 ± 2.7083. In at discharge, the mean GLS (mean± s.d.) of patients was -14.6675 ± 1.8924. In at 3 months, the mean GLS (mean± s.d.) of patients was -14.1375 ± 1.5692. Distribution of mean GLS vs. follow-up was statistically significant (p<0.0001).

Main findings of the present study can be summarized as follows: (1) RLS in TO area, RLS in donor area, and GLS were significantly improved 1 day after TO-PCI, but these improvements diminished during 3 months; (2) only the improvement of RLS in donor area remained significant 3 months after the index procedure; (3) RLS in non-CTO/ non-donor area was not influenced by TO-PCI; (4) mitral septal annulus velocity was improved 3 months after TO- PCI.

Our findings suggested that TO-PCI could have beneficial effects on systolic and diastolic LV function even in patients with preserved LV ejection fraction.

Ischemia produces a cascade of events beginning with metabolic and biochemical alternations that lead to impaired ventricular relaxation and diastolic dysfunction followed by impaired systolic function. In the early stage of ischemia, ventricular relaxation is initially impaired.

In TO patients, as a hypothesis, the distal arterioles of the TO area would maximally dilate and increase myocardial perfusion from the donor artery. In order to pro- vide enough perfusion for the TO area, the pre capillary arterioles and arteriolar capillary vessels in the donor area must

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constrict to maintain the perfusion pressure. These compensatory mechanisms might limit the coronary blood flow to the donor area. As a result, myocardium in donor area could be in the early stage of ischemia or more. Improvement of mitral annulus velocity by TO-PCI could partially be a representation of the relief from the early stage of ischemia in donor area. In addition, subendocarium is the most vulnerable part to ischemia. The longitude component of cardiac deformation predominates in this part of myocardium. Longitudinal strain analysis by 2D-STE is a quite sensitive and suit- able method to evaluate this component of cardiac motion. Thus, the improvement of strain by CTO-PCI in patients with preserved LV ejection fraction would also re ect the release from the early stage of ischemia.

## CONCLUSION

The present study demonstrated that TO-PCI improved RLS in donor area at 3 months follow-up without changes of LV ejection fraction. Although higher prevalence of late potential in the current population than healthy population was observed.Our results showed that restoring the coronary blood flow in total occlusion patients reduces the left ventricular volumes and improves the left ventricular ejection fraction and the global longitudinal strain of hibernating myocardium. It was found that the global longitudinal strain assessed with 2D-STE was improved as early as 1 day after TO-PCI, whereas LVEF tended to improve up to 3 months after TO-PCI. PCI can effectively improve LV function in patients with TO. 2D-STE is a superior technique for objectively quantifying the functional change earlier .PCI for a TO has a beneficial effect and improvement in global LV functions that can be predicted by 2D ST echocardiography and tissue Doppler.

## REFERENCES

1. Chatterjee K, Swan HJ, Parmley WW, Sustaita H, Marcus HS, Matloff J. Influence of direct myocardial revascularization on left ventricular Asynergy and function in patients with coronary heart disease : with and Without previous myocardial infraction. Circulation. 1973;47:276-286.
2. Hella-Valle T, Crosby J, Edvardson T, lyseggen E, Amundsen BH. New noninvasive method for assessment of LV rotation : Speckle tracking echocardiography circulation 2005, 112: 3149-3156.
3. Bolli R, Marban E. Molecular and cellular mechanisms of myocardial Stunning. Physiol Rev. 1
4. Sachdeva R, Agrawal M, Flynn SE, Werner GS, Uretsky BF (2013) Reversal of ischemia of donor artery myocardium after recanalization of a chronic total occlusion. Cathet Cardiovasc Interv 82(4):E453–E458. doi:10.1002/ccd.25031
5. Erdogan E, Akkaya M, Bacaksiz A, Tasal A, Sonmez O, Elbey MA, Kul S, Vatankulu MA, Turfan M, Goktekin O. Early assessment of percutaneous coronary interventions for chronic total occlusions analyzed by novel echocardiographic techniques. Clinics. 2013;68(10):1333-7.
6. Wang P, Liu Y, Ren L. Evaluation of left ventricular function after percutaneous recanalization of chronic coronary occlusions. Herz. 2018 Jan 16:1-5.

ISSN: 0975-3583,0976-2833 VOL13,ISSUE08,2022

7. El Shafey WH, Montaser SS, Badran HM, Gabr MK, Shokry KA, Galassi AR. Assessment of left ventricular function before and after a percutanous coronary intervention to chronic total coronary occlusion: Doppler tissue imaging study. Menoufia Medical Journal. 2015 Apr 1;28(2):400.
8. Sotomi Y, Okamura A, Iwakura K, Date M, Nagai H, Yamasaki T, Koyama Y, Inoue K, Sakata Y, Fujii K. Impact of revascularization of coronary chronic total occlusion on left ventricular function and electrical stability: analysis by speckle tracking echocardiography and signal-averaged electrocardiogram. The international journal of cardiovascular imaging. 2017 Jun 1;33(6):815-23.
9. Mohamed Mahmoud, Mahmoud Ahmed A. Elbaset and Waleed Yousof. 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. Ejpmr, 2017,4(05), 162-172.

**Table: Distribution of prior PCI, RCA and LCX**

| | | Frequency | Percent |
|---|---|---|---|
| **Prior PCI** | **No** | 37 | 92.5% |
| | **Yes** | 3 | 7.5% |
| | **Total** | 40 | 100.0% |
| **RCA** | **No** | 32 | 80.0% |
| | **Yes** | 8 | 20.0% |
| | **Total** | 40 | 100.0% |
| **LCX** | **No** | 28 | 70.0% |
| | **Yes** | 12 | 30.0% |
| | **Total** | 40 | 100.0% |

**Table: Distribution of mean RLS in TO area vs. follow-up**

| | | Number | Mean | SD | Minimum | Maximum | Median | p-value |
|---|---|---|---|---|---|---|---|---|
| **RLS in TO area** | PRE PCI | 40 | -11.2350 | 2.3391 | -8.2000 | -10.5000 | -10.5000 | 0.0018 |
| | AT DISCHARGE | 40 | -12.1350 | 2.2142 | -8.2000 | -12.7000 | -12.7000 | |
| | AT 3 MONTHS | 40 | -12.8950 | 1.4454 | -10.6000 | -12.8000 | -12.8000 | |

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**Table: Distribution of mean RLS in donar area vs. follow-up**

| | | Number | Mean | SD | Minimum | Maximum | Median | p-value |
|---|---|---|---|---|---|---|---|---|
| **RLS in donar area** | PRE PCI | 40 | -12.9750 | 1.9573 | -8.2000 | -15.9000 | -13.1500 | <0.0001 |
| | AT DISCHARGE | 40 | -15.3825 | 1.8298 | -11.7000 | -17.8000 | -15.8000 | |
| | AT 3 MONTHS | 40 | -14.9300 | 1.9647 | -11.7000 | -17.8000 | -15.5500 | |

**Table: Distribution of mean RLS in non CTO non donar vs. follow-up**

| | | Number | Mean | SD | Minimum | Maximum | Median | p-value |
|---|---|---|---|---|---|---|---|---|
| **RLS in non CTO non donar** | PRE PCI | 40 | -15.3975 | 2.6529 | -10.3000 | -19.6000 | -15.5500 | 0.2581 |
| | AT DISCHARGE | 40 | -16.2300 | 2.1387 | -12.4000 | -19.8000 | -16.0500 | |
| | AT 3 MONTHS | 40 | -15.6375 | 2.1137 | -12.3000 | -19.6000 | -15.8000 | |