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Research Article

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Alteration in the Global and Regional Left Ventricular and Right Ventricular Myocardial Strain Patterns in Patients with Inferior ST-Elevation Myocardial Infarction Early and Late after Percutaneous Coronary Intervention

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Abstract

Background: Precise evaluation of regional or global heart contractility is very important for the diagnosis, decision of treatment options, and prognosis of clinical outcomes in the Myocardial Ischemia (MI) and infarction.

Aims: Evaluation of the regional or global distortion of Left Ventricle (LV) and Right Ventricle (RV) in cases with Inferior Wall Myocardial Ischemia (IWMI) early and late afterward percutaneous coronary treatment.

Materials and Methods: This prospective study was conducted at Monofia University Hospital during the period from November 2017 till December 2019. The study included patients who presented to the cardiology department with inferior ST Segment Elevation MI (STEMI). Only 40 patients fulfilled the criteria of inclusion and were classified to 2 groups; Group I: include cases suffering from inferior STEMI. Group II (control): 20 healthy volunteer subjects.

Results: This study showed that LV global strain were reduced with highly significant value in cases suffering from IWMI prior to Percutaneous Coronary Intervention (PCI) than in controls (-11.10 ± 1.75 vs -19.84 ± 1.37) P value <0.001 respectively While LV global strain was significantly improved in cases with post-PCI than pre-PCI (-15.86 ± 1.50 vs -11.10 ± 1.75) P value < 0.001 respectively.

Conclusion: Reperfusion by PCI outcomes in significant recovery of LV and RV global strains, which are at most exist in the infarct and adjacent myocardium of apical and middle segments.

Keywords

Myocardial Infarction; Percutaneous coronary intervention; Regional left ventricular myocardial strain; Global right ventricular myocardial strain

Introduction

Precise evaluation of regional or global heart contractility is very important for management and estimation of clinical results in the myocardial ischemia and infarction area. Presently, generality of echocardiography labs still using the optical monitoring of the wall thickening or Wall Motion Score Index (WMSI) for clinical assessment; but, the personal vision and semi quantitative results are highly perturbed by changing the observer [1]. Strain imaging was considered as an objective and quantitative measure of the anomalies in the wall motion [2].

Regional myocardial strain was calculated from the speed gradient obtained from Tissue Doppler Imaging (TDI). However, TDI is dependent on the angle of the Doppler, leading to a harder data acquisition and interpretation. Also, the medical applications of strain calculated by TDI need users with high experience because of the signal-to-noise low ratio [3].

Lately, the hardware and software were improved to make the measurements independent on angle of myocardial strain established on the speckle-tracking method in 2D echocardiography. Strain calculations by tracking of the speckle technique were able to recognize the existence, position, and transmural spread of MI [4,5] and to prognosis the clinical results and LV restoration to the normal condition after MI [6,7].

Speckle-tracking imaging-derived strains can give additional precise calculations of myocardial contractility and also give a quantitative measure of the LV sectional myocardial distortion by one of three major types: longitudinal, radial, and circumferential [8]. RV function is highly significant in outcomes prediction in cases suffering from severe MI of LV. Also, RV contribution happens in a portion of cases suffering from IWMI and rise in mortality rates [9,10]. RV involvement occurs in a percentage of patients suffering an inferior wall MI and increase in-hospital death rate. RV function assessment has an important prognostic factor for clinical out-comes in patients with MI of LV. Moreover, objective of present study was to quantify regional and global deformation of the LV and the burden occurs to RV in particular happen only in inferior STEMI in which LV wall strain changes associated with RV involvement.

Methods and materials

This prospective work was conducted at Monofia University Hospital during the period from November 2017 till December 2019. The study included patients who presented to the cardiology department with inferior STEMI. Only 40 patients fulfilled the criteria of inclusion and were classified to 2 groups; Group I: include cases suffering from STEMI. Group II (control): 20 healthy volunteer subjects.

Inclusion criteria:

- Patients presented by acute inferior ST raise MI for the first time.
- All patients within 12 hours from the start of chest pain were re-perfused by primary PCI.

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Exclusion criteria:

- History of previous MI.
- Patients with RV contribution.
- Cases with systolic pulmonary artery pressure (sPAP>30 mmHg).

All the cases will be subjected to the following: complete history, total cardiovascular valuations. Investigations involved Electrocardiogram (ECG), serial Cardiac enzymes and echocardiography counting conventional echocardiographic calculations, strain and 2D speckle tracking echocardiography for all cases.

Statistical analysis

The collected information (History, Clinical assessments, Lab. investigations and outcome measures) were coded and analyzed using MS Excel program. The collected information was analyzed by IBM SPSS version 25 (Armonk, NY: IBM Corp). The data was examined for normality via Kolmogorov–Smirnov test, Shapiro-Wilk tests.

Two types of statistics were done:

Descriptive statistics:

- According to the type of data qualitative represent as number and percentage, quantitative continues group represent by mean ± SD

Analytic statistics :

- Chi-square test ($\chi 2$): was used for comparison and association between two qualitative variables.
- Paired samples Student t-test: was used for pairwise comparison of the quantitative variables with normal distribution (pre and post)
- Independent samples Student t-test: is a test of significance used for comparison between two groups having quantitative variables with normal distribution (control and pre or post)
- A P-value of >0.05 was considered statistically insignificant
- A P-value of<0.05 was considered statistically significant
- A P-value of<0.001 was considered statistically highly significant.

Results

The LV End-Systolic Diameter (LVESD) and LV End-Diastolic Diameter (LVEDD) have a higher significance in cases suffering from IWMI pre-PCI in comparison with reference cases, (40.61 ± 2.60 *vs* 37.77 ± 1.71) and (53.38 ± 1.30 *vs* 45.31 ± 1.98), P value <0.05 respectively. While they showed reduction in the dimensions but with no significant change in cases pre & post PCI, (39.32 ± 2.96 *vs* 40.61 ± 2.60) P value=0.083 and (52.84 ± 1.57 *vs* 53.38 ± 1.30), P value=0.057 respectively. LVEF, Right Ventricular Fractional Area Change (RVFAC), Tricuspid Annular Place Systolic Excursion (TAPSE) were significantly decreased in cases suffering from IWMI pre-PCI in comparison with reference cases and were significantly improved in patients post-PCI (P<0.001) than in patients pre-PCI, (P<0.05) (Table 1).

The LV global strain were reduced with highly significant value for cases suffering from IWMI previous to PCI in comparison with in reference cases (-11.10 ± 1.75 *vs* -19.84 ± 1.37) P value<0.001 respectively While LV global strain was improved significantly in post-PCI cases than pre-PCI (-15.86 ± 1.50 *vs* -11.10 ± 1.75) P value<0.001 respectively. LV segments (basal, mid, and apical) strains were significantly lower in cases suffering from IWMI previous to PCI than in control group (P value<001). LV segments longitudinal strains were significantly greater afterward PCI vs. previous to PCI (P value<0.001) (Table 2).

The RV global strain were significantly lower in cases prior to PCI than in reference cases (-13.23 ± 2.05 *vs* -20.09 ± 1.34) with high statistically value (P value<0.001). While RV global strain were significantly improved in patients post PCI than prior PCI (-16.72 ± 1.35 *vs* -13.23 ± 2.05) (P value<0.001). RV segments strains were significantly lower in cases suffering from IWMI prior to PCI than in controls. RV basal longitudinal strain didn't vary as significant as mid and apical segments before & afterward PCI (P-value<0.05); however,

Table 1: Conventional echocardiography data of cases with inferior ST-raise MI before & afterward PCI.

	Control	Pre-PCI	Post-PCI	p-value
LVESD	37.7 ± 1.7	40.6 ± 2.6	39.3 ± 2.9	P1<0.05, P2=0.083
LVEDD	45.3 ± 1.9	53.4 ± 1.3	52.8 ± 1.6	P1< 0.05, P2=0.057
LVEF	57.74 ± 3.77	50.38 ± 3.46	55.26 ± 2.38	P1<0.001, P2<0.001
RVFAC	42.59 ± 2.09	35.33 ± 1.24	37.65 ± 2.06	P1<0.001, P2<0.05
TAPSE	20.56 ± 3.63	15.67 ± 1.13	17.51 ± 1.48	P1<0.001, p2<0.05

RVFAC: Right Ventricular FractionalAreaChange
TAPSE: TricuspidAnnular Place SystolicExcursion
Data are offered as (mean ± SD), P1 pre-PCI versus controls, P2 post-PCI versus pre-PCI.
IndependentsamplesStudent t-test

Table 2: The global and regional LV longitudinal strain patterns in cases with inferior STEMI before & afterward PCI.

	Control	Pre-PCI	Post-PCI	p-value
Left ventricular strain				
Global strain%	-19.8 ± 1.4	-11.1 ± 1.8	-15.9 ± 1.5	P1<0.001, P2<0.001
Regional longitudinal strain%				
Apical	-20.1 ± 1.5	-10.6 ± 3.1	-14.8 ± 2.7	P1<0.001, P2<0.001
Mid	-20.2 ± 1.7	-8.9 ± 4.0	-13.9 ± 3.0	P1<0.001, P2<0.001
Basal	-20.9 ± 1.6	-9.0 ± 3.8	-13.7 ± 3.6	P1<0.001, P2<0.001

Data are offered as (mean ± SD), P1 pre-PCI versus controls, P2 post-PCI versus pre-PCI. Independent samples Student t-test

RV apical and mid longitudinal strains were significantly higher after PCI than before PCI with (P value<0.001) (Table 3).

All LV regional longitudinal strains were categorized into apical, mid, and basal levels. LV apical, mid, and basal longitudinal strains were significantly less in patients with inferior wall MI than in control. LV basal longitudinal strain show least increase after PCI; nonetheless, LV apical and mid longitudinal strains were significantly greater after than prior to PCI (Figures 1 and 2).

Discussion

Regional myocardial strain was calculated from the speed gradient obtained from TDI. However, TDI is dependent on Doppler angle, leading to a harder data acquisition and interpretation. Also, the clinical application of strain calculated by TDI need users with high experience because of the signal-to-noise low ratio, 2D speckle-tracking imaging is a modern echocardiographic method for the objective evaluation of myocardial systolic role. Strain values was described as a superior to myocardial speeds in the calculation of segmental dysfunction severity as a result of severe MI [11,12].

Lately, the hardware and software were improved to make the measurements independent on angle of myocardial strain established on the 2D speckle-tracking echocardiography. Strain calculations via the speckle tracking technique were able to recognize the existence, position, and transmural spread of MI [4,5] and to prognosis the clinical results and LV restoration to the normal condition after MI [6,7].

Table 3: The global and regional RV longitudinal strain patterns in cases with inferior STEMI before and afterward PCI.

	Control	Pre-PCI	Post-PCI	p-value
Right ventricular strain				
Global strain%	-20.1 ± 1.3	-13.2 ± 2.1	-16.7 ± 1.4	P1<0.001, P2<0.001
Regional longitudinal strain%				
Apical	-20.0 ± 1.51	-10.2 ± 1.73	-15.5 ± 1.5	P1<0.001, P2<0.001
Mid	-19.9 ± 1.3	-11.8 ± 1.3	-16.9 ± 1.3	P1<0.001, P2<0.001
Basal	-20.5 ± 1.40	-15.2 ± 1.7	-18.0 ± 1.0	P1<0.001, P2<0.001

Data are offered as (mean ± SD), P1 pre-PCI versus controls, P2 post-PCI versus pre-PC. Independent samples Student t-test

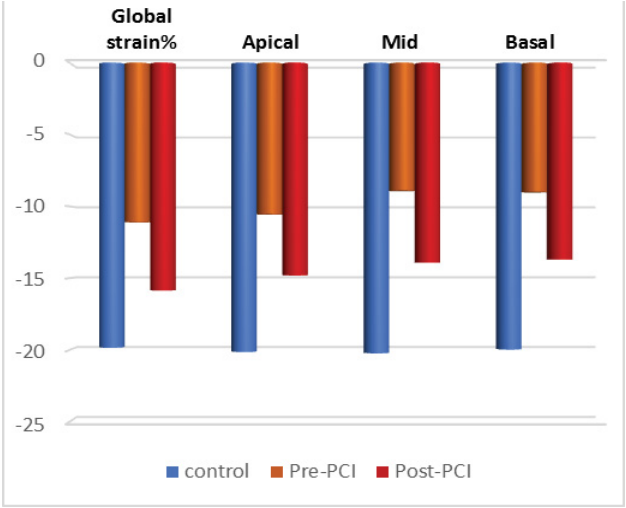

Figure 1: Comparison between the global and regional LV longitudinal strain patterns in cases with inferior STEMI before and afterward PCI and control group.

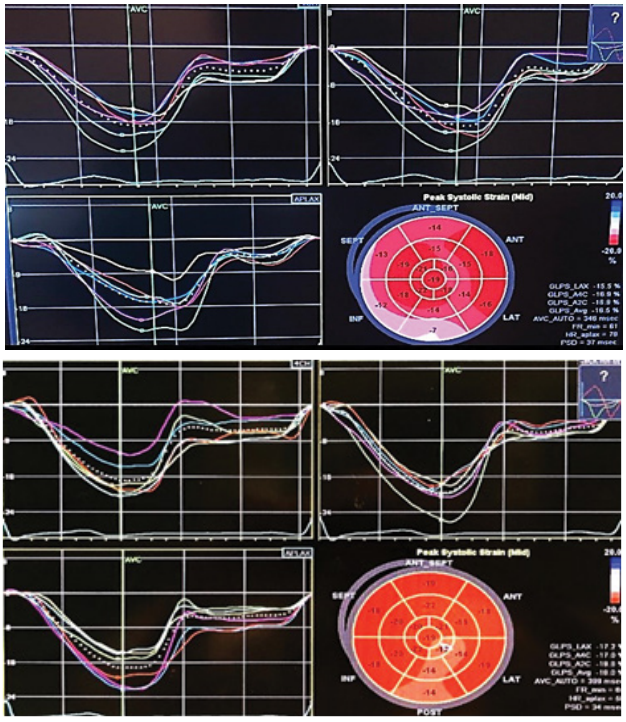

Figure 2: LV global and regional strain curves showing noticeable improvement post-PCI in comparison to pre-PCI.

Concerning the clinical features, patients and their analogues controls were selected to be identical in age, gender. Compared to Group II (control), DM, hypertension, dyslipidemia, smoking and obesity were more prevalent in-patient group. 34 patients (85%) had implanted a primary stent and 6 cases (15%) received balloon angioplasty with stent implantation. Post-PCI, all cardiovascular therapy was preserved from retardation. No re-occlusion, ischemic coronary conditions, or in-hospital mortality happened within the study time, more cases with IWMI than in control, (P value<0.001). LV basal longitudinal strain show least increase afterward PCI; however, LV apical and mid longitudinal strains were significantly greater afterward PCI than before (P<0.001).

Regarding RV global longitudinal strain, Cases suffering from IWMI was lower than controls (P<0.001). However, it was significantly higher afterward PCI than before PCI (P<0.001).

All RV regional longitudinal strains are classified into segments (apical, mid, and basal). RV segments longitudinal strains were significantly lower in cases suffering from IWMI in comparison with in control group (P<0.001). RV basal longitudinal strain didn't vary significantly as mid and apical segments before and afterword PCI (P<0.05); while, RV apical and mid longitudinal strains were significantly higher afterword than before PCI with (P<0.001).

It is important to know that, RV longitudinal strains gradually decreased from base to peak in IWMI cases.

The MI is marked by the discontinuous symmetric distribution of LV maximum systolic strain, which was confirmed by some other studies.

Sun et al. [13] concluded that the regular distribution of systolic strain from peak to basal levels was missing throughout myocardial ischemia and infarction.

The heterogeneous values of longitudinal strain post MI obtained by speckle tracking strainin present studyhave the same results of Dambrauskaite et al. [14]. They concluded that the RV segmental strain/SR values were not symmetric (higher in the mid segments) in normal people; however, Kowalski et al. [15] reported that the higher values of strain and SR were in apical portion of RV free wall.

The study of Ingul et al. [16] recorded a gradient of systolic distortion strain from mid-infarct over the infarct and border zone to normal myocardium. Global strain reproduces the mean segmental myocardial comparative shortening and is expressive of high sensitivity and specificity in the recognition of LV systolic dysfunction in cases of post-MI [17].

The current study recorded that LV global strains have a significant decrease in contrast with the control group, and they were obviously better afterward PCI. These results are in agreement with literature.

The study group of Kukulski et al. [18] reported a significant decrease in strain degree and strain happened in at-risk segments through severe ischemia by epicardial artery obstruction and this index improved to normal values instantly afterward balloon depression.

Ingul et al. [16] concluded that in AMI cases managed by PCI the global strain directories were significantly get better in 48 hours.

The current work also recorded an improvement in the local strains afterward PCI were normally placed in the infarct and close to myocardium, particularly in the apical and middle segments of LV. The PCI-caused re-perfusion recovers the reduced local systolic strain, which can be referred to the recovery of permanent ischemia myocardium and functional retrieval of stunned myocardium [16].

Conclusion

The 2D speckle-tracking echocardiography helps in overall and confident evaluation of myocardial contractility and treatment outcomes. Uniform allocation of local strains is missed as a consequence of ischemic actions. The local longitudinal systolic strains of LV and RV gradually reduced from base to peak, Re-perfusion by PCI consequences in significant revival of LV and RV comprehensive strains that was fundamentally present in the infarct and close to myocardium of apical and middle segments.

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